Japan International Cooperation Agency（JICA）
Ethiopia Water Technology Center (EWTEC)

REPORT

International Training Course on the Application of Geographic Information System (GIS)

in Groundwater Management

Ethiopian Groundwater Development and Water Supply Training Project (EWTEC) Phase II

March, 2007

Kokusai Kogyo Co., LTD

Dr. Lei Peifeng

Contents

1. OUTLINE of the TRAINING COURSE

1. 1 Purpose

A JICA project [Ethiopian Groundwater Development and Water Supply Training Project (EWTEC)] is going to Phase II. The main task of the project is to implement the training for groundwater development and water supply, and the main activities of the project are as follows:

(1) Implementation of training courses on various topics for groundwater development and management.

(2) Research and development

(3) Implementation and implementation support for RWS, including (drilling technology, electro-mechanical maintenance technology, rehabilitation of wells and so on.

The training courses are classified to basic course and advanced course. Basic course is conducted by experts and technicians of Ethiopia. Most advanced course is conducted by JICA Experts. Contents of the advanced courses are as follows:

(1) Groundwater Modeling (GM)

(2) GIS Application

(3) Planning and Designing (PD)

(4) Operation and Maintenance (OM)

(5) Remote Sensing (RS)

According to the demands from not only Ethiopia but also other African countries, two courses from the above mentioned advance courses; GM and GIS Application are planned as International training courses, to make other Africa countries have the chance to make their water resource related technicians take part in the training to learn how to use GIS in their work of water resources management.

This training course of [Geographic Information System (GIS) Application for groundwater management] is one of the international training courses. The task of the JICA expert assigned for the course is to prepare the contents, curriculum, textbooks and other materials for the course and implementation of the course.

1. 2 Expert

The basic information about JICA Expert for this course is as follows:

(1) Name: Lei Peifeng

(2) Organization : Kokusai Kogyo Co., Ltd.
Overseas Operations Department
Environment Management Division

(3) Address : 〒183-0057

Harumicho 2-24-1, Fuchu City, Tokyo, Japan

Tel : 042-307-7450 Fax :042-330-1039

E- Mail : peifeng_lei@kkc. co.jp

URL : http//www. kkc.co.jp

1. 3 Instruction Fields

Assigned as a JICA expert for the advanced training course “GIS application for groundwater management”, I arranged the following contents as the instruction Fields:

- Fundamental theory of GIS
- Basic functions and skills of GIS operation
- Preparation of GIS data
- Thematic maps creation by using GIS
- Groundwater Modeling creation supporting by using GIS

1. 4 Assignment Duration

The assignment duration is 45 days from February 4, 2007 to March 19, 2007.

1. 5 Content of Task

Contents of this expert assignment are as follows:

- Software preparation
- Software installation (for all the 29 computers used in the training course)
- Examination and determination of the training content, division of the contents to modules and preparation of the text books for each module
- Preparation of data for both lecture and practice
- Preparation of the presentation materials
- Preparation and execution of the training plan
- Evaluation of contents, curriculum and other matters concerning with the training course
- Preparation of this assignment report

2. Contents of Training

2. 1 Title of the Training Course

"The First International Training course of GIS application in Groundwater management for African Countries"

2. 2 Purpose of the Training

The main purpose of this training course is as follows:

（1） Learning of the fundamentals of GIS

（2） Learning of the basic skills of GIS operation

（3） Learning of the methods to input all the data held by the participants into GIS database.

（4） Learning of the methods to get GIS data from external data sources and to make data from all external sources integrated into the GIS database held by participants

（5） Learning of the method to perform analysis by using GIS and the data held by participants, and then create all kinds of thematic maps

（6） Being aware of the basic concept of groundwater simulation mode, and then learning of the method to support the groundwater model by using GIS

2.3 Period of the Training

This training course was enforced in the period for four weeks from February 19, 2007 to March 9, 2007.

2.4 Participants

28 participants from 16 African countries attended this training course. 12 of them were from Ethiopia and the other 16 from 15 other African countries. As a principle, one participant was invited from one country other than Ethiopia, however, there are actually 2 governments in the country of Sudan and then 2 participants from Sudan attended the course.

10 participants from Ethiopian were employee of central and / or local governments. And two EWTEC staff also attended the course.

The name, country, organization and position of all the participants were listed into Table1 attached to this report.

2.5 Materials Used for the Training Course

Materials used in this training course are as follows:

(1) Hardware

- Desktop Computers: thirty (30) sets
  (Besides the 28 participants, each of them has a computer for his (her) exclusive use during the whole period of the training course, two (2) extra computers were prepared, one was used as the server computer of the course and the other was for the assistant)
- UPS: ten (10) sets
- Office Lan system (All PCs are connected with this Lan system）
- One LCD projector

- Additionally, bags, stationeries, CD for data, CD case and others were also used.

(2) Software

- Global Mapper 7
- MicroDEM (a free software supported by USGS)
- MapScan (a free software released Statistics Division of the United Nations)
- Diva GIS (a free GIS software)
- Surfer
- ArcView
- ArcGIS
- PMWIN
- Country based GIS data (administrative boundaries, rivers, Lakes, roads, inhabitant village distribution, topography contours and measured points, the meteorological observation data (precipitation and others), the place name data, land use maps, population distribution maps and so on)
- DEM (Digital Elevation Model) data: (SRTM, 90m mesh DEM for the whole Africa continent and GTOP-30, about 940m mesh DEM for the whole Africa continent)
- The mosaic image data Mrsid, which is based on Landsat with the resolution of 14.5m. All Mrsid data to cover the whole African Continent were prepared.

2.6 Training Curriculum

Curriculum of this training course was specially arranged for containing the fundamentals and applications of GIS in groundwater management. It is obviously impossible to make all the participants master all the functions and skills of GIS within this short term training course. Therefore, the curriculum was religiously prepared to contain the most essential and most practical technologies for satisfying the most kinds of needs for groundwater management. The curriculum is decided on the basis of not

only the experience of the lecturer, but also the results from other technicians who worked in the same field. This curriculum aimed at making all participants to become the first class GIS technician in the field of water resources management in case he (she) settled all the contents within the course. According to the purpose of this course, the curriculum was composed of 5 modules.

(1) Module 1 : Fundamentals of GIS

- Conception and definition of GIS
- Construction of GIS
- Function of GIS
- The classification of the GIS data
- The characteristics of the spatial data and the attribute data
- The characteristics of raster data
- The characteristics of vector data
- The acquisition technique of the GIS data, including the introduction of Open GIS Web Site
- The necessity and method to integrate GIS data

(2) Module 2 : Basic Skills of GIS

- The fundamental function of the GIS software used in this course
- According to all kinds of requirements of analysis to extract necessary data and / or conduct reclassification by using the query and selection function of GIS.
- conduct classification or reclassification of The reference function of GIS is used, as for each event, together, the extraction of the necessary data and re-classification
- Creation of all kinds classification maps by using extracted and /or reclassified data
- Arrangement and edition of attribute data (adding, deleting and simple

calculation)

- Making the existing tabular data (in formats of Excel, Text and others) to be attributed to spatial data, so that those data become available for GIS application.

- Methods of spatial data editing
  Reclassification of area (polygon) data (union and splitting)
  Conversion among different shape files (point, polyline and polygon)
  Edition of spatial data (adding and deleting)
  Movement of points
  Reformation of polyline and polygon

(3) Module 3 : GIS Data Preparation

- GIS data format conversion of
- Projection conversion
- Using Spatial data to take coordinates from point data, calculate length and area from polyline and polygon data.
- Integrate a scanned paper map into GIS database (georeference).
- How to make a point based on the image data, a line and surface data
- Creation of spatial data (point, polyline and polygon) on the basis of an image.
- Creation a point data by coordinates information
- Tracing (digitizing) method a paper map (manually and semi-automatically)

(4) Module 4 : Analysis of GIS Data and Creation of All Kinds of Thematic Maps using Based on the Analysis Result

- Creation of classification maps based on attribute data
- Creation and edition of Pie map and bar chart map
- Emphasizing and decoration of main subject by using layer structure of GIS

- Introduction of the conception of DEM
- Extraction of DEM to fit to the investigation area
- Format conversion of DEM
- Creation of all kinds of 2-D and 3-D DEM topographical maps by using DEM.
- Creation of all kinds of contour maps
- Creation of groundwater flow direction map
- Creation of section graph

(5) Module 5 : Supporting the Creation of Groundwater Simulation Model

- Introduction of the development history of and current situation of the groundwater simulation
- Introduction of main groundwater simulation modeling program and their characteristics
- The data structure of groundwater simulation model
- Method to create grid for groundwater simulation model with GIS
- Method to calculate irrigation amount for each GM grid

  Selection of satellite image

  The extraction of the image from the satellite image to fie the study area

  Converting the image to grid data of different bands

  Matching the Grid Code with the objective entity (for example, farm land)

  Extracting of the objective entity from different bands of grid data

  Creation of the special grid data for the objective entity (for example, farm land) by combination of all related grid of bands

  Creation of farm land map (polygon) by converting the grid data to vector data

Calculation of farm land area for each GM grid cell by combining the farm land map with GM grid

Calculating the irrigation amount for each GM grid by using farm land map and irrigation unit data

- Creation of river distribution map by using DEM
- Creation of basin (Catchment) distribution map by using DEM

2.7 Daily Sheet of the Training Course

Within the training course, 4 classes were in every week day, and one class lasted one (1) hour. Because more than half of the participants have no experience of GIS operation and some participants have even rare experience to use computer, most time within the classes were taken by lecture in order to introduce as more contents to participants as possible. And the practice and assignments have to be implemented out of the classes. The daily sheet of the training course is shown in Table2.

3. Evaluation

3. 1 Knowledge

Although rather than GIS theory, the application of GIS in water resources management, especially in groundwater management is the main topics of this course, it is still necessary to understand the basic concept and outline of GIS. Therefore, the conception, construction, history and other relative matters were briefly introduced in Module 1. The introduction was conducted by using examples of GIS application in previous studies and investigations. All the participants were able to comprehend how GIS can be used for improve the efficiency and precision in their work of water resources management.

Basic knowledge of GIS that is absolutely important for GIS application was not only introduced in Module 1, but also repeated through other modules. Points of the knowledge introduced in this course are as follows:

- Difference of spatial data and attribute data of GIS
- Raster data and vector data

- Type and characteristics of raster data and vector data.
- Data source and format conversion
- Projection and projection conversion

Based on the comprehension of the above knowledge introduced in this course, all participants have become aware that all their existing data including paper map, tabular data, aerial photograph or satellite image, and so on, can be taken into their GIS data base. And all participants become aware how to use GIS to process their existing data for new geography data creation and further analysis.

3. 2 Technology

Technology in this course was divided into basic technology and applied technology, or technology for GIS data creation and application.

Within Module2, the technology of GIS data query, selection and extraction were introduced as follows:

- Set standard(s) for a special area to selection necessary data
- Integrating the existent numerical data (such as the vital statistics, the groundwater pumping amount, water quality analysis result, and so on) into GIS database as attribute data.
- The method to create a GIS database
- Union two or more kinds of classification maps to get a new more detailed classification map
- Summarizing the same area to get a simplified but more concise map.
- The method to covet shapes of spatial data among point, polyline and polygon.
- The method to edit all kinds of spatial data (point, polyline, polygon)

The above technology is expected to be the basis for participants to integrate their existent data into GIS data base. Therefore, all participants practiced seriously and interestingly, and all of them could fulfill the practice within the course following the lecture and referring to the text book.

The basic skills for spatial data creation or preparation were mainly included in Module 3 as follows:

- Conversion of data format.
  Similar to the difference of the GIS software, spatial data are kept with different format. To use all kinds GIS data into the main GIS software for this training – ArcView and others, it is necessary to perform data format conversion. All participants succeed in data conversion at least in the following practices:

  Convert the *.E00 file into shape file to obtain the basic data of their own country (administrative boundaries, roads, rivers, and so on) using the relative data downloaded from internet by the lecturer for all the participants.

  Convert DEM data from Gtop30 or SRTM format into ASCII Arc grid, so that they were able to create the topography maps for their countries in the later assignment.

- Projection Conversion
  Based on the comprehension of elementary knowledge of the projection, all participants become aware of the method to convert projections between the main projections of geographic (longitude and latitude) and UTM. By converting the projection from geographic (longitude and latitude) into UTM, all the participants fulfilled the calculation of real area.

- Georeference
  The most essential technology to integrate into the GIS database a hard copy of a paper map with which no coordinate information is attached. Relatively longer time were taken for the comprehension of the technology than that being expected before, however, all participants fulfilled the practice. And the georeferenced map was used in the later practice for point file creation.

- Vectorization (digitizing)
  Technology for extracting the subjective entities (point, polyline and polygon) from a georeferenced map (raster data). All participants fulfilled both methods of manual vectorization and semi-automatic vectorization by using the free software Mapscan which was released by Statistics Division of United Nations.

Main technology contained in Module 4 is method to create all kinds thematic maps for water resources management by using GIS data obtained from all kinds of data sources.

- Various classification maps.
  All participants fulfilled the practice of creating a population density distribution map by using attribute data of population and the land area.

- Various chart maps.
  All participants fulfilled the practice of pie map creation for expressing the situation of arsenic contamination in Bangladesh by using the data from the result of lecturer in previous survey. Also, the bar chart maps to show the change in population at rejoin level in Ethiopia were fulfilled by all participants.

- Three-dimensional (3-D) topographical map
  USNASA and USGS released 90m mesh (resolution) and 1 km mesh free topographical data were used to create 3-D topographical map. The task is more difficult than the above maps creation, so that the practice was not only conducted in the class for creating the 3-D topography map of Ethiopia following the lecturer, but also repeated in the assignment for country or region level 3-D topography map creation. (refer to the assignment result1)

- Contour map
  All participants fulfilled the practice of precipitation contour map creation for Mexico after the practice of the same kinds contour map creation following the lecturer.

- Cross section
  2 kinds of methods were introduced in the class to create cross section by using ArcView and Global Mapper. All participants could fulfill the practice.

Within the Module 5, the technology for GM creation supporting was included as follows:

- The outline of the groundwater simulation. model
  Demonstration was taken as the main method for this content, because it is far beyond the time limit and scope of this course to introduce in detail the method of groundwater model creation. The questionnaire survey showed a result that some participants were not well satisfied in this part perhaps because they have strong expectation in learning the technology of GM creation. However, this expectation can only be realized by taking part into the GM training course or extending the training duration. Those who have taken part into the GM course, or have some experience of GM creation, could full understood the relation and importance of GIS application for GM creation supporting, however those who

did not know the GM at all before this course might still be not so clear about the GM.

- It didn't go until the understanding of the model itself could be done completely to the trainee whom an experience didn't have at all to the groundwater model itself oneself though the trainee treated in the groundwater model to a certain extent used GIS how and he could understand that the input data of the groundwater model were made.

- Delineating the river route
  Delineation of river route is not only necessary for GM creation, but also important for almost all work related to water resources management. Therefore, no matter how well they could comprehend the GM, all participants were expected to master this technology and all of them could fulfill the assignment of creation a river distribution map for their own country or rejoin (refer to assignment result2).

- Distribution map of water consumption amount
  In order to conduct groundwater flow calculation, it is necessary to calculate the water consumption amount and use the calculation result to create the input data for the GM. However, even though agriculture is the main sector of water consumption in many developing countries, the current situation is that there is not available statistics or monitor about agricultural water. Therefore to improve the precision of the GM, it is necessary to use GIS technology for extraction the farm land distribution, calculate the distribution of irrigation amount and then make the calculate result arranged according to the GM structure. The technology is relatively complicated containing many procedures; however, all the participants could fulfill the practice.

As a conclusion, it can be considered that all participants have generally completed the learning of GIS application technology contained in this course.

4. Recommendation and Suggestion

4. 1 Recommendation

Similar to the GIS training course implemented last year for Ethiopia technicians, the difference among participants in level of computer usage and experience in GIS operation even in work career greatly influenced the progress of the course. More time

was taken for basic technology learning than is was expected for module 1 to 3, so that no enough time could be used for the application technology (Module 4 and 5). This is also a reason that the GM technology could not be taken more in this course. To solve the problem, an assistant was used for individual tutorial to those participants who was extremely later than the majority, and this method proved to be help for progress of the course. However, the assistant himself did not comprehend whole the contents of the course, so he could not do more than to listen to the lecture together with other participants within much class time. To avoid this problem, in next course and maybe other training courses, if the assistant could be selected from the participants with relative good record, the progress would be expected more smoothly and the training would be expected to improve.

4. 2 Suggestion

The maintenance of the computer is one of the important factors, which also greatly influences the progress of the course. It has been said and I myself also experienced last year that problems always occurred from the out of date computer, so that the progress had to be slow down. Within this course, not only new computers were prepared but also computer technician were made active use, so that there was rare problem occurred from computer and network. To ensure the computer system working well it might be necessary to renew the computer in time and keep the active use of the computer technician in future and in all similar training courses.

Before installation software into computer for this course, the anti virus software was installed in advance and the newest virus list was used for security inspection. Therefore, not any problem about virus infection occurred in the course. Participants from other African countries had little opportunity to be infected by virus, because computers in the classroom are not connected to internet. However, several participants residing in Addis Ababa stayed in their own houses, so it is hardly to say they are absolutely out of the danger of virus infection. And this matter is not only important for this course, but also for other training courses and even for daily maintenance of the computers. One essential countermeasure would be to designate a special staff from EWTEC for all computer system management. At least it is would be considered necessary to designate a staff for regularly and frequently renewal of the virus list in accordance with antivirus software installed in EWTEC computer systems. For example, the Norton anti virus program provides new virus list every Thursday, and if this program is used for computer security, and the renewal of the virus list could be

implement on every Friday or at least next Monday, the anxiety of virus infection would be reduced to an extremely little extent.

Table1 List of Participants for GIS Training Course, 2007

	Country	Organization	Name	Position
1	Botswana	Directorate of Public Service Management Department of Water Affairs	Mr. Douglas Gaongalelwe	Geophiscal Team
2	Ghana	Ministry of Water Resource, Works and Housing	Ms. Elfreda Naa Lomoteley	Hydrogeologist Water Resource Coordination
3	Kenya	Ministry of Water and Irrigation	Mr.Bernard C. Muhang'u	Hydrogeologist
4	Lesotho	Ministry of Water Resource, Department of Water Affairs	Mr. Teboho Matlanyane	Hydrogeologist
5	Malawi	Ministry of Irrigation & Water Development	Mr. Ganizani D.C. Matiki	Hydrogeologist
6	Mozambique	National Water Directorate, Rural Water Department	Mr. Francisco R. Naene	Geologist
7	Namibia	Ministry of Agriculture, Water and Forestry	Mr.Mathews G. Katjimune	Senior Hydrogeologist
8	Nigeria	Federal Ministry of Water Resource, Hydrology and Hydrogeology Department	Mr. Mukaila S.Babarinde	Hydrogeologist
9	Rwanda	Ministry of Land, Environment, Forestry, Water and Mines	Mr. Serushago Boniface	Surveyor
10	Sudan	Ministry of Irrigation and Water Resource	Mr. Egbal B. Adam	Hydrogeologist
11	Sudan	Ministry of Water Resource and Irrigation, Government of Southern Sudan	Mr. William P.W. Duku	Civil Engineering
12	Swaziland	Ministry of Natural Resources and Energy, Geological Survey and Mines department	Mr. Sakhiwe Nkomo	Hydrogeologist
13	Tanzania	Ministry of Water, Department of Water Resource, Water Resource division	Ms. Enna Msangi	Hydrogeologist

	Country	Organization	Name	Position
14	Uganda	Ministry of Lands and Environment, Directorate of Water Development	Mr. Erisa Kyeyune	Hydrogeologist
15	Zambia	Ministry of Energy and Water Development, Department of Water Affairs	Mr. Andrew Mtonga	Hydrogeologist
16	Zimbabwe	Zimbabwe National Water Authority	Ms. Chipo Hlatywayo	Hydrogeologist
17	Ethiopia		Mr. Afework Hailu	
18	Ethiopia	SNNPR Water Resource Development Bureau	Mr. Mesfin Gobena	Hydrogeologist
19	Ethiopia	Amhara Water Resource Development Bureau	Mr. Nigussie Kebede	Team Leader of Study Team
20	Ethiopia	Addis Ababa Water & Sewerage Authority	Mr. Walelegn Workneh	Division Head
21	Ethiopia	Water Works Design and Supervision Enterprise	Mr.Ermias Tesfaye	Head of Hydrogeology Division
22	Ethiopia	Oromiya Water Resource Bureau	Mr. Lemessa Mekonta	Head of Study & Design Development
23	Ethiopia	Geological Survey of Ethiopia	Mr. Tesfaye Kasaye	Geophysicist
24	Ethiopia	Ministry of Water Resource	Mr.Wubshet Demeke	Head of Water Resource
25	Ethiopia	Ministry of Water Resource	Mr. Addisu Tesfaye	Sanitation Engineer
26	Ethiopia	Ministry of Water Resource	Mr. Endris Mohamed	Drilling Machinery Maintenance Technology Course Coordinator
27	Ethiopia	Ministry of Water Resource	Mr. Shumet Kebede	Groundwater Investigation Training course Coordinator
28	Ethiopia	Ministry of Water Resource	Mr. Mulugeta Kinfu	Groundwater Investigation Training course Coordinator

Table 2 Implemented Daily Sheet

Date		Lecture Hour			
		09:30 - 10:30	**11:00 - 12:00**	**14:00 - 15:00**	**15:30 - 16:30**
Feb. 11	**Sun.**	**Arrival of Participants**			
Feb. 12	Mon.	Registration, Orientation	Opening Ceremony (From 11:30)	GIS Definition	Why GIS
Feb. 13	Tue.	GIS production examples	History and Characteristics of GIS	Acquisition and Creation of GIS data	GIS Data Quality Control
Feb. 14	Wed.	Start GIS software ArcView	Spatial Query and Extracting		Attribute data editing(1)
Feb. 15	Thu.	Attribute data editing(2)	Attribute data editing(3)	Spatial Data editing (1) : Union	Spatial Data editing (2) : Summarizing
Feb. 16	Fri.	Spatial Data editing (3): Shape changing	Spatial Data editing (3): Polyline	Spatial Data editing (4): Polygon	
Feb. 17	**Sat.**	Holiday			
Feb. 18	**Sun.**	Holiday			
Feb. 19	Mon.	GIS data format conversion		Map Projection Fundamentals and Main Projections	
Feb. 20	Tue.	Projection Conversion	Georeference (1) Simple case	Georeference (2) Using ArcView	Georeference (3) Using GM
Feb. 21	Wed..	Georeference (4) Using ArcGIS	Point Type Data Inputting	Point Theme Creation Pick up form image	Polyline Creation (1) Tracing
Feb. 22	Thu	Polyline Creation (2) Vectorizing	Polygon Creation(1) Tracing	Polygon Creation(2) Format Conversion	
Feb. 23	Fri.	Graduated Color Map Creation	Unique Color Map Creation	Pie Map Creation	Bar Chart Map Creation
Feb. 24	**Sat.**	Holiday			
Feb. 25	**Sun.**	Holiday			
Feb. 26	Mon.	Digital Elevation Models (DEM) and 2D Topography Maps (Using MicroDEM)		3D Topography Maps Creation by Using MicroDEM	
Feb. 27	Tue.	Various 3D Topography Maps and their Decoration		DEM Extraction and Exporting	Changing DEM to ArcView Grid
Feb. 28	Wed.	Hills Shade Map Creation	Grid Projection Conversion	Grid and Tin based Topography Map Creation and Decoration	
Mar. 01	Thu.	Contour Map and Vector Map Creation		Section Map Creation	
Mar. 02	**Fri.**	Holiday			
Mar. 03	**Sat.**	Holiday			

Date		Lecture Hour			
		09:30 - 10:30	**11:00 - 12:00**	**14:00 - 15:00**	**15:30 - 16:30**
Mar. 04	**Sun.**	Holiday			
Mar. 05	Mon.	River and Watershed Delineation by Using DEM			
Mar. 06	Tue.	Analysis of Image data for calculation of Irrigation Amount			
Mar.07	Wed.	Fundamentals of GWM		Exercise of Groundwater Simulation Model Creation	
Mar.08	Thu.	Revision of Whole the Contents Included in the Course		Supplementary Instruction of Additional Data Downloading from Server	
Mar. 09	Fri.		Closing Ceremony		
Mar. 10	**Sat.**	**Departure of Participants**			

Appendix 1：

Result of Questionnaire Survey

A questionnaire Survey was conducted to understand the sensation of participants on this training course. 17 questionnaires were withdrawn and several participants promised to send the questionnaire some late time.

The list of participants who has submitted the questionnaire by the date of 12th March,2007 is as follows:

Name	Country	Name	Country
Mr. Erisa Kyeyun	Uganda	Mr. Teboho Matlanyane	Lesotho
Mr.Bernard C. Muhang'u	Kenya	Mr. Andrew Mtonga	Zambia
Mr. William P.W. Duku	Sudan	Mr. Afework Hailu	Ethiopia
Mr. Mukaila S.Babarinde	Nigeria	Mr. Tesfaye Kasaye	Ethiopia
Mr. Serushago Boniface	Rwanda	Mr.Mathews G. Katjimune	Namibia
Ms. Enna Msangi	Tanzania	Mr. Ganizani D.C. Matiki	Malawi
Mr. Addisu Tesfaye	Ethiopia	Mr. Francisco R. Naene	Mozambique
Ms. Chipo Hlatywayo	Zimbabwe	Mr. Douglas Gaongalelwe	Botswana
Mr. Sakhiwe Nkomo	Swaziland		

The Questionnaires is composed of 11 terms and several detail questions. The 11 terms are as follows:

1. general impressions on the training course
2. Training materials
3. Training method
4. Contents of training
5. Lecture evaluation
6. Duration of training
7. Evaluation of training environment
8. Why did you attend the training course
9. Do you think that the GIS application training course for African countries is necessary to be held in next year?
10. Would you recommend this GIS application training course to others?
11. Do you have any other suggestions and/or comments which would help us make next GIS application training course more effective and useful?

For majority of items and/or questions, the answers were supposed to be classified as four(4) classes: Excellent; fairly satisfied; little satisfied and disappointed. The participants were asked to check one of the four flags under the above classes. The participants were also asked to give their comments if they would like to express their opinions to any question.

The result of the questionnaires survey is as follows:

Item(1) General impressions on the training course

Question : Are you satisfied with the GIS application training course?

Answer: Excellent 15 (88%)

Fairly Satisfied 2 (12%)

Comments from the participant who check the flag of "fairly satisfied" are as follows:

- Needed more practices
- It's intensive and the time too short. No more for practice I'm really like it.

Item(2) Training materials

Question: Are you satisfied with the following training materials?

Text Books; Presentation Materials; Stationeries and bag, PC used in training, software used in training.

Answer:

	Excellent		Fairly Satisfied	
Text Books;	16	94%	1	6%
Presentation Materials	16	94%	1	6%
Stationeries and bag	15	88%	2	12%
PC used in training	14	82%	3	18%
software used in training	14	82%	3	18%

The comments for this items relatively concentrated to the software as follows:

- All software should be prepared and given to participants on a re-writable CD.
- Because the key is are not very sure if the software will be opened in our computer at home.

Item(3) Training Method

Question: Are you satisfied with the training method?

Answer: Excellent 14,(82%)

Fairly Satisfied 3 (18%)

Comments from the participant who check the flag of “fairly satisfied” are as follows:

- It’s only that some of us are not very good in computers so he was very fast.
- There was no enough time for practice.

Item(4) Contents of Training

Question: There are five (5) modules in the training course. Please evaluate the contents of training course.

Answer:

	Excellent		Fairly Satisfied		Little Satisfied	
1. Basic Concept of GIS	15	88%	2	12%	--	--
2. Basic Skills of GIS Operation	16	94%	1	6%	--	--
3. GIS Data Preparation	14	82%	3	3%	--	--
4. Creation of Thematic Maps	15	88%	2	18%	--	--
5. Groundwater Modeling Supporting	5	29%	11	65%	1	6%

Comments from the participant who check the flag of “fairly satisfied” are as follows:

- The modules of this training course were satisfactory only that the lecture was a bit fast in some of the topics.
- More contents on new version of ARCGIS.

No comment was given from the participant who checked the flag of Little Satisfied.

.

Item(5) Lecture Evaluation

Question : How well did the lecture give you the training?

Answer: Excellent 16 (94%)

Fairly Satisfied 1 (6%)

No comments from the participant who check the flag of “fairly satisfied”.

.

Item(6) Duration of Training

Question : Please evaluation the duration of the training course?

Three classes were prepared for participant to evaluate the duration as “ Too Long, Suitable and Too Short”

Answer: Too Long 1 (6%)

Suitable 8 (47%)

Too Short 8 (47%)

Comments for the duration of the training course are as follows:

The comment from the participant who checked the flag of Too Long.

- I think three weeks will do and the last week (forth week) on revision.

Comments from participants who checked the flag of Too Short.

- There was no enough time for practice.
- It is better to be long and include water modeling and creation of map.
- Many topics, but the time was too short.

Item(7) Evaluation of Training Environment

Question: Please evaluate the conditions of the training environment.

7 items were included within this items as "Training room; Lunch; Tea/Coffee; Hotel condition: Location; Environment and Atmosphere)

Answer:

	Excellent		Fairly Satisfied	
Training room	17	100%	--	--
Lunch	8	47%	9	53%
Tea/Coffee	13	76%	4	24%
Hotel condition	16	94%	1	6%
Location	15	88%	2	12%
Environment	14	82%	3	18%
Atmosphere	16	94%	1	6%

Of all participants who checked flags of Fairly Satisfied, only one person gave the comment as follows:

- Only that lunch and tea/coffee, there was limited food prepared.

Item(8) Why did you attend the training course?

Question : 5 possible reasons were supposed for this question for participants to answer.

Answer:

Own decision	7	41%
Recommendations by your superior	9	53%
Your Office's decision	4	23%
Other person(s) not available	--	--
Others	--	--
Total	20	117%

Three participants checked the flags of "Own decision" and "Recommendation by your superior" at the same time, therefore, the number of answer for this questions is more than the number who sent back the questionnaires.

Item(9) Do you think that the GIS application Training course for African Countries is necessary to be held in next year?

All participants answered YES to this question, and for the reason of their selection, the answers are as follows:

- It is very important for Africa countries.
- Many need the serve.
- It will empower the African scientist.
- More people have to be aware.
- So that others can benefit.
- This training might be extending to many countries.
  JICA can provide experts to train people in their responsible countries where JICA is working.
- To improve the application.
- To expand (promote) use and application of course in the countries.
- To give us the knowledge how to deal with technology.
- This is a new science it helps to facilitate things easier to create maps and to interpret.
- This works enable advancing and upgrading of the present participants.
- Explain to water technique and proper management of water resources of Africa is imperative. Thus the course is very important and necessary for all African countries.
- Because we can say we have not enough notions about GIS application yet.

Item(10) Would you recommend this GIS application Training course to others?

All participants answered YES to this question, and for the reason of their selection, the answers are as follows:

- There are many many friends if they get this fortunate they want to use it to create maps and interpretation.
- Because this training is useful in the water management so is better for others to get knowledge for the benefit of my country.
- To get knowledge also.
- His relevant in day to day management of groundwater data.
- Very practical.
- The same as us.
- The course has been very useful for me, hence I think it can help others.
- I think GIS is good training. Recommended before other applications.

- To improve awareness.
- The knowledge is opportunity derivable. Please invite and organize this course for more participants.

Item(11) Do you have other suggestions and /or comments which would help us make next GIS application training course more effective and useful?

There is not options prepared for this question. 10 from 17 (59%) answers gave their suggestions and / or comments as follows:

- No, but it is so good.
- It would be good to do more practical exercises. Especially on hoe to collect data and compilation.
- * Including applications in surface water modeling.
  * Include the basic setting up of ArcGIS, because it looks a little complicated.
- The teacher has to be very slow in teaching participants, because some participants are slow learners and some do not have enough knowledge of computers.
- Use more new version of ArcGIS as very powerful.
- Balance between theory and practice. Suggestion: 70% theory and 30% practice.
- Everything is good. It must be kept like as it is. But to those who come from A/A should offer them the same accommodation and facilities. I got it anyway, very nice. If the bed reserved, it would have time to practice at night.
- The duration of the course is too short. And no time is allocated for practice. So it will be very food to make the duration of the course to be conducted in two months and enough time should be allocated for practice.
- Time must be 4-5 days at least. And I think the GIS and remote sensing are related and some one must take them both.
- Items 1-4 should be compressed to 2 weeks then the 3rd week should be groundwater modeling (impact), then the last week for revision, Thanks.