

**The Federal Democratic Republic of Ethiopia  
Ethiopian Geospatial Information Institute**

**The Capacity Development Project for Digital  
Topographic Mapping in the Federal  
Democratic Republic of Ethiopia (Phase 3)  
Final Report  
(Summary)**

**December 2018**

**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)**

**PASCO CORPORATION**

**KOKUSAI KOGYO CO., Ltd.**

<b>EI</b>
<b>JR</b>
<b>18-142</b>



# Table of Contents

<b>CHAPTER 1. OVERVIEW OF THE PROJECT .....</b>	<b>1</b>
1.1. BACKGROUND OF THE PROJECT .....	1
1.2. THE OBJECTIVES OF THE PROJECT.....	2
1.3. EGI'S BACKGROUND INFORMATION.....	4
1.4. DELIVERABLES .....	10
<b>CHAPTER 2. PROJECT EVALUATION AND RECOMMENDATION .....</b>	<b>11</b>
2.1. ACHIEVEMENTS.....	11
2.2. EVALUATION.....	16
2.3. CONCLUSION .....	18
2.4. RECOMMENDATION .....	19
2.5. FACTORS.....	23
<b>CHAPTER 3. CONTENTS OF IMPLEMENTATION .....</b>	<b>25</b>
3.1. WORK FLOW .....	25
3.2. PROJECT ACTIVITY IMPLEMENTATION DETAILS .....	26
<b>CHAPTER 4. CONTENT OF WORK RELATING TO TECHNOLOGY TRANSFER.....</b>	<b>28</b>
4.1. UPGRADING OF SKILLS IN PHOTOGRAMMETRY .....	28
4.2. UPGRADING SKILLS FOR PRODUCING TOPOGRAPHIC MAPS .....	32
4.3. STRENGTHENING OF THE GIS TECHNOLOGY IN EGII AND OTHER USER ORGANIZATIONS .....	37
4.4. UPGRADING LEVELING SKILLS .....	43
4.5. STRENGTHENING OF THE MANAGEMENT AND OPERATION OF GEOSPATIAL INFORMATION.....	48
4.6. MATERIALS AND EQUIPMENT REQUIRED FOR OPERATIONS OF THE PROJECT .....	54
<b>CHAPTER 5. STRUCTURE FOR IMPLEMENTING THE PROJECT.....</b>	<b>55</b>
5.1. ROLES AND RESPONSIBILITIES OF THE PROJECT TEAM MEMBERS.....	55
5.2. STRUCTURE FOR IMPLEMENTING THE PROJECT.....	56
5.3. STAFFING SCHEDULE .....	56

## List of Figures and Tables

Figure 1	Schedule and the Design of the Project.....	3
Figure 2	Organization chart.....	4
Figure 3	Work Flow of Technology Transfer for Photogrammetry.....	28
Figure 4	Productivity Transition.....	31
Figure 5	Flowchart for technology transfer of topographic map production.....	32
Figure 6	Work Flow of Technology Transfer for GIS Technology.....	37
Figure 7	Scenes from the Seminar.....	40
Figure 8	Scenes from the 2 <sup>nd</sup> GIS workshop.....	41
Figure 9	Scenes from the 2 <sup>nd</sup> GIS seminar.....	42
Figure 10	Work Flow of Technology Transfer for Leveling.....	43
Figure 11	First order leveling training.....	46
Figure 12	First order leveling route plan 1/50,000 (Addis Ababa).....	47
Figure 13	First order leveling route plan 1/2,000,000 (National).....	47
Figure 14	Work Flow for the Management and Operation of Geospatial Information.....	48
Figure 15	Project Implementation Structure.....	56
Table 1	Background and Details of the Project.....	1
Table 2	Policy.....	3
Table 3	Counterpart Directorate structure.....	5
Table 4	Counterpart Directorate structure.....	6
Table 5	List of training courses organized by EGII.....	6
Table 6	EGII's present Situation (equipment and technology, etc.) and phase 3 targets.....	7
Table 7	List of Deliverables.....	10
Table 8	Human and equipment resource inputs.....	11
Table 9	Initial situation of 3 <sup>rd</sup> phase and its target.....	12
Table 10	EGII's productivity.....	13
Table 11	List of EGII's insourced GI production and updating work.....	14
Table 12	Implemented Technology transfer for photogrammetry.....	29
Table 13	Technology transfer detail of DEM generation & editing.....	30
Table 14	Implemented Technology Transfer for Topographic Mapping.....	33
Table 15	Results of technology transfer (Symbolization).....	34
Table 16	Results of Technology Transfer (AC & QE).....	34
Table 17	Results of Technology Transfer.....	35
Table 18	Technology transfer results (Digital editing & generalization).....	36
Table 19	Implemented Technology Transfer for GIS.....	37
Table 20	Evaluation of Technology Transfer (GIS).....	39
Table 21	Questionnaire result (EGII trainer training/training of experts).....	40
Table 22	Questionnaire result (EGII trainer training/training of experts).....	41
Table 23	Implemented Technology Transfer for Leveling.....	43
Table 24	Capacity Evaluation.....	44
Table 25	Results of Technology Transfer.....	45

Table 26	Technology transfer schedule for GI management and operation .....	48
Table 27	EGII Budget transition .....	49
Table 28	Issues and Planned Activities .....	51
Table 29	list of outputs and its contents .....	51
Table 30	Document range and effective range .....	53
Table 31	Approval process.....	53
Table 32	List of Materials and Equipment.....	54
Table 33	Details of Roles and Responsibilities Allocated to Each Team Member.....	55
Table 34	The staffing schedule.....	56

## Abbreviations

AT	Aerial Triangulation
CAD	Computer Aided Design
CODIST	Committee on Development Information, Science and Technology
CORS	Continuously Operating Reference Station
DTM	Digital Terrain Model
DEM	Digital Elevation Model
EGIA	Ethiopian Geospatial Information Agency
EGII	Ethiopian Geospatial Information Institute
EKI	Ethiopia KAIZEN Institute
EMA	Ethiopian Mapping Agency
ENSDI	Ethiopian National Spatial Data Infrastructure
GI	Geospatial Information
GIS	Geographical Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSDI	Geospatial Data Infrastructure
GTP	Growth and Transformation Plan
GUI	Graphical User Interface
INSA	Information Security Network Agency
JCC	Joint Coordinating Committee
OJT	On-the-Job Training
OSS	Open Source Software
PCM	Project Cycle Management
PDM	Project Design Matrix
RCMRD	Regional Center for Mapping and Resources for Development
TOT	Training Of Trainer
UNGGIM	UN Committee of Experts on Global Geospatial Information Management
UNECA	United Nations Economic Commission for Africa
USAID	United States Agency for International Development

## Chapter 1. Overview of the Project

### 1.1. Background of the Project

“The Capacity Development Project for Digital Topographic Mapping in the Federal Democratic Republic of Ethiopia” has been planned to be implemented for approximately five years from October 2013 to the year 2018 with the background and details written on the table below. The activities shall be implemented as Phase 3, the final phase of the three phases which constitute the Project.

The name of the government agency responsible for producing the Ethiopian national maps used to be “Ethiopian Mapping Agency (hereinafter referred to as “EMA”)”. In February 2018, EMA was renamed to “Ethiopian Geospatial Information Agency (hereinafter referred to as “EGIA”)”. This change had the following three purposes behind it.

- 1) To clarify that EGII is the national governmental body which is responsible for development of Geospatial Information (hereinafter referred to as “GI”).
- 2) To enhance development of GI for national land.
- 3) To make the name and its roles correspond to each other.

The Government of Ethiopia reorganized the government ministries and agencies in October 2018. By this reorganization, the authority to supervise EGIA was transferred from the National Planning Commission to the Ministry of Innovation and Technology and EGIA was renamed “Ethiopian Geospatial Information Institute (EGII)”.

**Table 1 Background and Details of the Project**

Period	Matters	Details
1970s - Present	EMA has implemented the production of medium scale topographic maps (mainly the scale of 1:50,000) which covers the whole country.	The topographic maps covering 85% of the whole country have been produced until now.
2010	Ethiopian Five-year Development plan (Growth and Transformation Plan: GTP) was started.	The priority items set under Ethiopian Five-year Development Plan are “Local Development” as well as the development of “Agriculture”, “Industry” and “Infrastructure”, etc. There has been the need for providing “accurate topographic maps” which are indispensable for implementing the development projects in each sector effectively and efficiently depending on the demand of relevant agencies.
2010 - 2013	The request for technical assistance was made to JICA <The details of the request> <ul style="list-style-type: none"> <li>• Develop the standard operation specifications for digital topographic maps.</li> <li>• Technology transfer relating to digital topographic mapping.</li> <li>• Technology transfer relating to promotion of utilization of digital topographic maps data.</li> </ul>	<Problems to be tackled by EMA> <ul style="list-style-type: none"> <li>• 85% of medium scale topographic maps covering the whole country are analog maps and are in the process of being digitally converted.</li> <li>• The operation specifications and the standards for quality control have not been developed yet.</li> <li>• EGII has not been able to produce and provide accurate and reliable digital topographic maps which reflect the latest data.</li> </ul>
May 2013	Dispatched the “Project Team for Formulating Detailed Plan” from JICA.	
July 2013	The Records (minutes) of Discussions (R/D) have been mutually signed between EMA and JICA.	

Period	Matters	Details
October 2013 - January 2016 (Approx. two years)	Phase 1 of “The Capacity Development Project for Digital Topographical Mapping in Ethiopia” was implemented.	<The Capacity Development for Producing the topographic maps with the scale of 1:10,000 · 1:25,000> Operation specifications, map representation specifications and quality control manuals have been developed. Support for establishing organizational structure (field verification, seminars, JCC, etc.) has been provided. Technology transfer for producing topographical maps was implemented (procurement/basic and applied technologies). The website was built (field verification/design). Topographic maps were produced (in Japan).
February 2016 - September 2016 (Approx. one year)	Phase 2 of “The Capacity Development Project for Digital Topographical Mapping in Ethiopia” was implemented.	<The Capacity Development for Producing the topographic maps with the scale of 1:10,000 · 1:25,000> Support for establishing organizational structure (seminars/JCC/international conferences) has been provided. Technology transfer for producing topographical maps was implemented (Pilot training period). The website was built. (Building) Topographic maps were produced (in Japan).
February 2017 - December 2018 (About two years)	Implementation of Phase 3 of “The Capacity Development Project for Digital Topographical Mapping in Ethiopia”.	EGII’s technological capabilities for map production and quality control will be verified, and EGII’s technological capabilities in need or insufficient will be enhanced. Advice and monitoring for Topographic Map Development Plan and capacity development for leveling operations will be provided to EGII.

## 1.2. The Objectives of the Project

### (1) The Objectives of the Project

The Overall Goal of the Project and the purpose of the project and phase 3 in order to accomplish the higher goals are as follows.

#### Overall Goal of the Project

The accurate and reliable geospatial database for the national land which can promote sustainable development of economic and social infrastructure shall be developed.

#### Project purposes

1. Digital topographic maps data with the scale of 1:10,000 and 1: 25,000 for the area of 1,140km<sup>2</sup> around Mojo and Adama in the Oromia Region shall be developed.
2. The EGII will produce topographic maps by themselves through the implementation of technology transfer.

As a result, the technological capabilities of EGII will reach such level that EGII will become self-reliant and will be able to implement the actual operation of producing digital topographic maps based on an adequate organizational structure. EGII’s operation of producing topographic maps shall be actually implemented and managed.

#### The Purposes of Phase 3

1. To evaluate current technical capacity of EGII and provide necessary support.
2. Monitor and support on topographic map development program and Leveling operation.



## (2) The Duration of the Project

The whole period of this cooperation is approximately five years from October 2013 to end of 2018. This phase falls under the 3<sup>rd</sup> and last of the project stage.

The Project Team's policy is to implement activities which will support EGII to become the core organization to develop and manage GI in the country, with the suitable and achievable, realistic acts in technical and organizational aspects, according to the performance evaluations from the past phases.

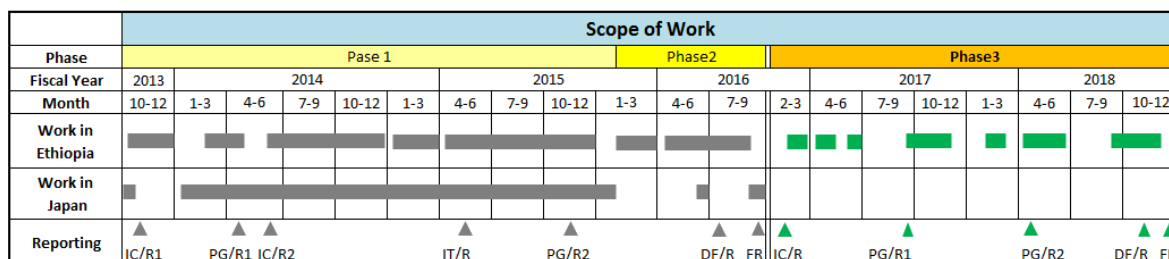


Figure 1 Schedule and the Design of the Project

## (3) Implementation policy and remarks

The project was implemented with the following policy and remarks.

Table 2 Policy

Items	Points to Consider	
JCC	JCC (Joint Coordinating Committee) will be organized to promote the data utilization and project progress reporting, with relevant members.	
Technology Transfer	Common	Training shall be made after considering the present situation and issues including technical capabilities, organization structure and legal system / rules and regulations, budget and the equipment in possession and formulating the plan for technology transfer.
	Photogrammetry	Aim to enhanced large volume map production capacity and quality control operation requiring high accuracy, and the relevant production system shall be established
	Topographic Maps production	Support to the staffs who have finished technology transfer in Phase 1 and 2, in order that they can serve as trainers and implement technology transfer to other unexperienced staffs
	GIS	As the first step, the Project Team will train EGII operators to become trainers. As the second step, the Project Team will support EGII trainers fostered in the first step who will be the trainer in the training for other government body operators.
	Leveling	The existing elevation data (benchmarks) in Ethiopia are extremely insufficient compared with the area size of national land and their deployment balance. Insufficient numbers and balance will lead to accuracy decrease in aerial triangulation after acquiring new aerial photography or satellite images. A long-term plan including establishing a leveling network shall be prepared. The standard operation specifications for the leveling were developed in the previous phase.
	Organizational system support	Support on EGII's organizational system for a continuous independent management scheme in topographic mapping projects, in parallel to the project objective 2. Also to concern the following points for "GI utilization" which are; framework of Topographic map updating plan; strengthening data sharing, reducing duplication in aerial photography, surveying and mapping; securing human resource and budget.
Communication in International Conferences	Cooperate and attend to international conferences, in order to present EGII's activities, mandate and aim. Support EGII so that the details of the project can be shared in international conferences such as UNGGIM-AFRICA (UN Committee of Experts on Global Geospatial Information Management: AFRICA) and RCMRD (Regional Center for Mapping of Resources for Development) are held in Ethiopia, and the outcome of such effort shall be shared with JICA.	

### 1.3. EGII's background information

#### (1) Mandate

- 1) Collect, produce, store, organize, administer and distribute GI
- 2) Establish, preserve and cause the preservation of geodetic ground control points
- 3) Undertake surveying activities and collect, document, analyze and disseminate the result
- 4) Prepare produce, and disseminate general purpose map
- 5) Prepare produce, and disseminate special map
- 6) Undertake revision and updating of general purpose and special purpose map
- 7) Prepare, publish and distribute national and regional atlases
- 8) Co-ordinate and control GI products by other bodies
- 9) Provide competency certificates for professional and organizations engaged in GI
- 10) Undertake presentation of international and regional boundaries
- 11) Plan and undertake training activities related to GI
- 12) Plan and perform research activities related to GI

#### (2) Organization structure

The departments constituting EGII are written below. Among them, the departments mainly related to this Project as the counterpart are Mapping Directorate, Surveying Directorate, Remote Sensing and GIS Directorate, Quality & Standards Directorate, IT Directorate, Training Research and Development Directorate.

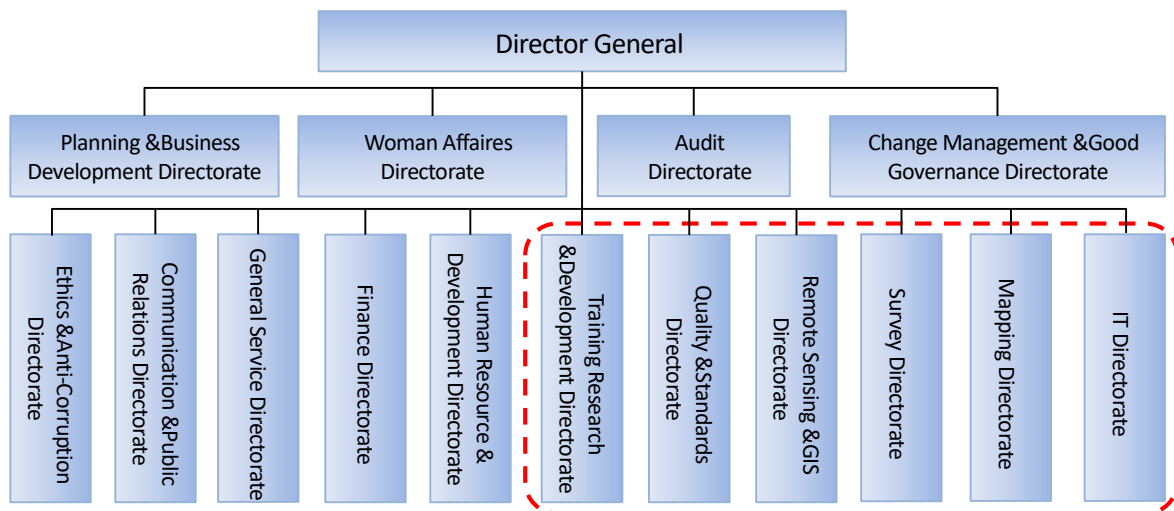


Figure 2 Organization chart

**(3) Technology Transfer counterpart department**

EGII is an organization with 350 staff members in total. The personnel composition of the departments mainly related to this Project is indicated in the table below. In the technology transfer of previous phases, only selected trainees were trained to target as a leader in the production department. In this phase, those leaders were further trained to implement internal training to other staffs.

**Table 3 Counterpart Directorate structure**

Directorate	Items				
	Teams in the Directorate	Main Work	Staff No.	Trainees (phase 1, 2)	Trainees (phase 3)
<b>Mapping Directorate (MD hereafter)</b>	Digital Photogrammetry Digital Cartography Digital Orthophoto Name Collection Reproduction	Photogrammetry Topo-map production and updating Symbolization Ortho image production Geographical name survey	60	27 (2 retired, 7 left)	16 (8 from phase 1, 2) (4 as trainers)
<b>Surveying Directorate (SD hereafter)</b>	Large Scale Survey Geodetic Survey Engineering and Survey Computation	Geodetic surveying Control points survey CORS management	30	12 (1 retired, 5 left)	22 (2 from phase 1, 2) (3 left)
<b>Remote Sensing and GIS Directorate (GIS hereafter)</b>	Remote Sensing GIS Thematic Analog to Digital Map Revision	GIS data structuralization Thematic map production and updating	50	6 (2 left)	8 (2 from phase 1, 2) (2 as trainers)
<b>Quality and Standards Directorate (QC hereafter)</b>	Quality Control Quality Assurance	Quality Control Quality Assurance	5	4 (1 retire)	3 (3 from phase 1, 2)
<b>IT Directorate (IT hereafter)</b>	Information administration and Distribution System Administrator	Database management System management	8	3 (1 left)	3 (1 from phase 1, 2)

(The number of participants in the technology transfer in Phases 1 and 2: As the technology transfer in Phases 1 and 2 was implemented as a continuous training course, the same trainees participated in the two phases.)

**(4) Human resource situation**

There were issues of turnover (young, mid staffs in internal transfer or leave for other jobs) from the beginning of the project shown as follows (detail in 4.5.).

**Table 4 Counterpart Directorate structure**

YEAR		2017	2016	2015	2014	2013	2012	2011
PERIOD	From	Jul-17	Jul-16	Jul-15	Jul-14	Jul-13	Jul-12	Jul-11
	To	Oct-17	Jun-17	Jun-16	Jun-15	Jun-14	Jun-13	Jun-12
Early resignation (persons)		12	28	62	59	61	59	54
Mandatory retirement (persons)		3	4	6	10	7	6	8
Death (persons)			2	1	3		3	1
<b>Total</b>		<b>15</b>	<b>34</b>	<b>69</b>	<b>72</b>	<b>68</b>	<b>68</b>	<b>63</b>
New recruits (persons)		38	35	67	56	58	136	5
Total number of EGII staff members (persons)		380	357	356	358	374	384	316

**(5) Organized Training**

EGII has been announcing the following training courses for in/out side of the organization. Though generally there is some lack of hardware, software and trainers.

The subject training is categorized in 5 (Geodetic survey, photogrammetry, GIS, Remote sensing, cartography) courses, with practical contents. This is because of the lack of trainers. The training is now mainly for the newly hired staff and other organizations.

**Table 5 List of training courses organized by EGII**

Type	Detail				
	Applicants	Content	Duration	Trainees (max)	Frequency (year)
Basic/Advanced	EGII and External trainees	Surveying, Photogrammetry, Cartography, GIS, Remote Sensing and LIMS	6 weeks	30	1
By subject	Internal and external trainees	Theory	5days	20 ~30	1
		Practical (5 courses)	20days	5 each	
		Project (5 courses)	5days	5 each	
		Field work	5days	20~ 30	

**(6) EGII's challenges and phase 3 activities**

From the final report of phase 2, EGII's challenges have been sorted, and the activities and targets are shown in table 6.

**Table 6 EGI's present Situation (equipment and technology, etc.) and phase 3 targets**

Items		Directorate (*)	Present Situation (quantities shown in parentheses)					
			Before Phase 1 & Phase 2	After Phase 1 & Phase 2	Before Phase 3	Targets of Phase 3 (Deficiencies to be filled)	Background of target	
Organizational Structure	Rules & regulations	Overall	Standard documents have not been made	Survey regulation, 1/10,000&25,000 symbol regulation, quality control manual has been made	There are no symbol regulations other than for 1/10,000&25,000 scale	Unified documents for 1/5,000&50,000 scale are prepared.	There are no/old specifications for ongoing 5,000 and 50,000 project	
	Planning & budgeting	Overall	The budget is increasing every year	Same as on the left.	Organizational long-term policy plan and the relating budgeting does not exist	Productivity and budget estimation will be clarified with the long-term plan	Continuous business planning and budgeting is insufficient	
	Organizational activities	Overall	Regular participation to international GI conference	EGI's presence has been strengthened through JCC, seminar and conference meetings	User interest on data utilization needs has grown	To organize 1 JCC, 2 seminar, 2 user training, and attend 1 international conference if there is a chance	More PR relation should be made to raise topics, report activities and share information	
	Equipment Management	Overall	Shortage of equipment resource	Equipment was provided and necessary training has been completed	Lack in digital data management rules, standard and technology	Guidelines for equipment management is prepared	Production line needs improvement in sufficient equipment management	
	Human resource	Overall	Shortage of human resource	Basic technology transfer has been made	Improvement in production system should be made	Guidelines for human resource management is prepared	Production system needs improvement due to insufficient management is not existing	
Material Aspects	Equipment for ground survey	Transit EDM/TS	SD	Existing equipment was mostly old, they had only few latest equipment.	Same as on the left.	There are no rules relating to equipment inspection and management	Existing equipment will be appropriately managed and will be in effective use.	Rules and regulations for equipment inspection and management is prepared
		GNSS receiver	SD	Existing equipment was mostly old, and they have maintenance issues in outdated versions	4 GNSS receivers, 1 analytical software has been provided and operating		None in particular	None in particular
		Leveling	SD	Existing equipment are old and outdated	Same as on the left.		Same as on the left	2 Digital equipment for first-order leveling for pilot work is prepared

Items			Directo rate (*)	Present Situation (quantities shown in parentheses)								
				Before Phase 1 & Phase 2	After Phase 1 & Phase 2	Before Phase 3	Targets of Phase 3 (Deficiencies to be filled)	Background of target				
Material Aspects	Equipment for photogrammetry	Aerial triangulation	MD	3 licenses exist with limited support option	3 licenses with full support option has been provided	Same as on the left	None in particular	None in particular				
		Creation and editing of DEM	MD						1 DEM creating, 1 DEM editing license has been provided	Same as on the left	Additional 2 DEM creation, and 2 DEM editing software are provided and operational	Limited software is creating bottleneck in DEM operation
		Production of ortho images	MD						3 licenses for ortho production and mosaic processing has been provided	Same as on the left	None in particular	None in particular
		Digital plotting (stereo)	MD	Not existing.	3 digital stereo workstations (for stereo CAD) has been provided	Same as on the left	None in particular	None in particular				
	digital compilation and GIS Equipment	MD GIS	Several existing GIS software	5 CAD software, and 1 PC for GIS has been installed	EGII and ESRI agreed for unlimited licensing	Proposals for the effective separation of CAD work and GIS work	Main production software has changed to ArcGIS					
	Web GIS hardware	IT	1 existing SQL server	1 GIS server and 1 SQL server has been provided to MD	Web publication of the JICA project product	Data categorization for web upload to be defined	Data category is not defined which is making data disclosure issue					
	A0 printing equipment	MD GIS	2 to 3 are existing	1 A0 plotter has been provided	Same as on the left	None in particular	None in particular					
	Immaterial Aspects (Technology and Human Resources)	GNSS survey, leveling Ground Control Point Survey	SD	There was insufficiency in the planning, theory and practical experiences in both GNSS survey and leveling.	Technology transfer for GNSS survey was carried out.	There are no experts able to carry out leveling.	At least 2 1 <sup>st</sup> order leveling equipment managers and work managers to be trained. 2 leveling observation teams (4 staffs per team) will be trained.	No experienced staffs in EGII to start project				
Premark Installation and aerial photography		MD	There was insufficiency in the experience of conducting the work for producing topographic maps.	Technology transfer was carried out for the Premark installation and for the planning and checking of aerial photography.	Same as on the left	The ability to create a control point description is build	Point description is necessary for aerial Premark installation					
Field identification, Field completion		MD	There was insufficiency in the experience of conducting the work for producing topographic maps.	The technology transfer through OJT has been implemented.	Same as on the left	None in particular	None in particular					

Items		Directo rate (*)	Present Situation (quantities shown in parentheses)				
			Before Phase 1 & Phase 2	After Phase 1 & Phase 2	Before Phase 3	Targets of Phase 3 (Deficiencies to be filled)	Background of target
Immaterial Aspects (Technology and Human Resources)	Aerial triangulation,	MD QC	Possess certain skill level	Basic training was carried out	3 operators are capable of aerial triangulation in the range of 1,000 models	1 trainer and 5 new operators to be trained	No trainers existing. Limited staffs to conduct project sufficiently
	DEM Editing,		Possess certain skill level	Basic training was carried out	Three operators with a production capacity of 100km <sup>2</sup> /month	1 trainer to be trained. 3 new operators with 80km <sup>2</sup> /month productivity to be trained. 3 experienced experts with 400km <sup>2</sup> /month productivity to be trained.	Non trainer existing. Limited staffs to conduct project sufficiently
	Ortho Production		Possess certain skill level	Basic training was carried out	3 operators are capable of ortho imaging on a volume of 1,000 models	1 trainer and 5 new operators with skill of ortho imaging on a volume of 1,000 models to be trained	Non trainer existing. Limited staffs to conduct project sufficiently
	Digital plotting, Digital editing, Map symbolization	MD QC	Very less experience in stereo environment and knowledge of scale dependence work method	training has been implemented for 1/10,000 and 1/25,000 scale mapping	4 operators with a production capacity of 1.5 months/map	1 trainer and 3 new operators with 3months/map productivity to be trained.	Non trainer existing. Limited staffs to conduct project sufficiently
	GIS field	GIS	Technically capable of data production	Training for data structuralization has been carried out	5 operators skilled in data structuring	2 EGII trainers to be trained 5 new operators in topographic map production and structuring/GIS analysis to be trained	Non trainer existing. Limited staffs to conduct project sufficiently
		Other organizations	Technically capable of data production	Training for data structuralization has been carried out	Cultivation of users in other fields	At least 2 training sessions implemented by EGII trainers to user organizations	No opportunities to explore potential users from other industries

※MD : Mapping, SD : Surveying, RG : Remote Sensing & GIS, QS : Quality & Standards

## 1.4. Deliverables

The deliverables of this Project are shown as follows.

**Table 7 List of Deliverables**

Items		Quantities	Remarks	
1	Project Operation Report, etc.	Inception Report	5 copies in Japanese (Summary) 15 copies in English February 2017 10 copies in English to be submitted to EGIL.	
		Progress Report 1	5 copies in Japanese (Summary) 15 copies in English September 2017 10 copies in English to be submitted to EGIL.	
		Progress Report 2	5 copies in Japanese (Summary) 15 copies in English April 2018 10 copies in English to be submitted to EGIL.	
		Draft Final Report		November 2018
		Main Report	15 copies in English	10 copies in English to be submitted to EGIL.
		Summary	15 copies in English	10 copies in English to be submitted to EGIL.
		Summary in Japanese	5 copies in Japanese	
		Final Report		End of December 2018
		Main Report	15 copies in English 5 copies in Japanese	10 copies in English to be submitted to EGIL.
Summary	15 copies in English 10 copies in Japanese	10 copies in English to be submitted to EGIL.		
2	List of procured Equipment		1 set To be submitted to JICA when the Project is completed.	
3	Operation Report		1 set Monthly (to be submitted to JICA by the 15th of the following month.)	
4	Collected documents		The list summarized by field shall be attached.	
5	Documents for public relations	(1) The outline of the activities under this Project, the procedure of implementation (2) The Scope of Work (3) The general situation of target regions (basic information such as the area, population, industry, social situation, etc.) (4) The successful result and outcome of the Project (5) Conclusion/recommendations	200 sets in English Electronic data (in free format) 150 sets to be submitted to EGIL at the time when the Final Report is submitted.	
6	Digital photos	(1) Images that enable the clear understanding of the present situation of project site. (2) Information about other similar projects. (3) The living conditions of local residents and the actual bottlenecks shall be put together with attaching simple caption, so that the situation before and after the implementation of this project can be compared.	1 CD-R List of the records of digital images (in Word format) About 20 sheets of digital images (in jpeg format) to JICA	
7	Other Items to be Submitted	Minutes (Records of Discussion), etc.		
		Letters sent to or received from the Government of Ethiopia		



## Chapter 2. Project Evaluation and Recommendation

### 2.1. Achievements

#### (1) Inputs

Inputs from Japan side are as follows.

**Table 8 Human and equipment resource inputs**

Task		Content (item in table6)	Input	
Specialist	Project Manager/ Organization structure support1	Support on; Map update plan framework; Data sharing promotion; work duplication reduction; and to secure human resource	4.5MM	22.5MM
	Deputy project manager/ Photogrammetry	Follow up support on Photogrammetry (DEM generation/editing, ortho image production)	4.0MM	
	Mapping	Follow up support on mapping (digital plotting/editing, symbolization)	4.0MM	
	GIS	Follow up support to EGII, and training for user organizations	4.0MM	
	Leveling	Strengthening 1 <sup>st</sup> order leveling operation	4.0MM	
	Coordinator/ Organization structure support2	Support on; Map update plan framework; Data sharing promotion; work duplication reduction; and to secure human resource	2.0MM	
Software	Photogrammetry (DEM generation)	With maintenance	2 licenses	
	Photogrammetry (DEM editing)	With maintenance	2 licenses	
	Data analysis	Leveling data	1 license	
Hardware	1 <sup>st</sup> order leveling instruments	Level staff, staff base, tripod included	2 sets	
	Leveling data analysis laptop		1 set	

#### (2) Outputs and outcomes

- 1) Technology and knowledge about photogrammetry (operation planning and process management, enhance productivity, accuracy control) has been transferred.
- 2) TOT training support and technology on multiple scales mapping operation has been transferred.
- 3) Support on EGII GIS operation, support on TOT training and production of its curriculums, text material has been done.
- 4) The technology and knowledge for 1<sup>st</sup> order leveling in theory, technique, planning and accuracy control for establishing the leveling network has been transferred.
- 5) The framework for GI management and administration has been discussed and documented. Including the support on the promotion in data sharing, reduction of work duplication, securing human resource by guideline documents.
- 6) Enhanced skills were a positive effect to complete the 1/50,000 analog topographic map to digital conversion work.
- 7) Data sharing and promoting utilization has led to actual data sharing (nationwide SPOT image).

### (3) Achievement of the phase 3 objective

Objectives of phase 3 were follows.

- To evaluate current technical capacity of EGII and provide necessary support.
- Monitor and support on topographic map development program and Leveling operation.

From the following reasons, the Project Team understands that the project objectives have been achieved.

**Table 9 Initial situation of 3<sup>rd</sup> phase and its target**

Category	EGII's technical level at the beginning of Phase 3	Target	Activities	Achievements
Photogrammetry	3 experts with productivity of 100km <sup>2</sup> /month	<ul style="list-style-type: none"> <li>• Capable of “work planning”, “progress management”, “work efficiency” and “accuracy control” at practical level.</li> <li>• The existing training is general entry level target for newly hired employees, and not enough trainees</li> </ul>	<ul style="list-style-type: none"> <li>• Provide practical OJT based technology transfer.</li> </ul>	Fostered 3 experts capable of DEM editing at 400km <sup>2</sup> /month plus 3 experts capable of DEM editing 80km <sup>2</sup> /month.
Mapping	EGII had 4 experts having productivity of 1.5 month / sheet	<ul style="list-style-type: none"> <li>• Foster trainers who will train beginner experts.</li> <li>• Acquire techniques for scales other than 1/10,000 and 1/25,000.</li> <li>• Data uniform (ArcGIS)</li> <li>• The existing training is general entry level target for newly hired employees, and not enough trainees</li> </ul>	<ul style="list-style-type: none"> <li>• TOT training</li> <li>• Support on technology transfer from EGII trainer to EGII new trainees (expansion of target scales and data generalization).</li> <li>• Support on organized training course by EGII.</li> <li>• Develop symbol regulations for other scales.</li> <li>• Update work regulations.</li> <li>• Improve method for accuracy control.</li> </ul>	Fostered 1 trainer. Fostered 3 new experts having productivity of 3.0 month / sheet
GIS	EGII had 5 experts had capable of GIS data structuralization	<ul style="list-style-type: none"> <li>• EGII needs to foster trainers</li> <li>• EGII needs to expand GIS users and to provide technical support for them.</li> <li>• The existing training is general entry level target for newly hired employees, and not enough trainees</li> </ul>	<ul style="list-style-type: none"> <li>• Train EGII experts to be a trainer.</li> <li>• Assist the new trainers in organizing a workshop.</li> </ul>	Fostered 4 trainers
1 <sup>st</sup> order leveling	None	<ul style="list-style-type: none"> <li>• Monitor and advise for 1<sup>st</sup> order leveling implementation</li> <li>• Grow human resource for pilot project implementation</li> </ul>	<ul style="list-style-type: none"> <li>• Provide technology transfer for “theory and observation techniques”, “survey planning” and “accuracy control”.</li> </ul>	Fostered 4 experts capable of providing technical guidance for 1 <sup>st</sup> order leveling. Fostered 4 experts capable of doing the work.
Organization structure support	Work regulations, symbol regulations for 1/10,000 and 1/25,000, quality management manual is existing. Formed JCC and user groups. Participating to seminars and international conferences.	<ul style="list-style-type: none"> <li>• Enhance capability of management and operation of geospatial information</li> </ul>	<ul style="list-style-type: none"> <li>• Make a plan for topographic map development.</li> <li>• Make rules, schemes and guidelines for “enhancement and promotion of data sharing”, “de-duplication of survey work” and “securing human resources and retention”.</li> </ul>	Developed a long-term plan, updated the survey regulation and developed GI policy

\*Table 9 shows the items which were covered in Phase 3. These items were extracted from Table 6 and reorganized in Table 9.

For example: “Aerial triangulation, DEM creation and Ortho creation” of Table 6 is “Photogrammetry” of Table 9.

The project team judged whether an expert is capable of being a trainer or not by examining his/her work speed, quality of outputs, his/her level of understanding of the work, his/her level of understanding of his/her trainees and overall supervision,

**(4) EGII’s GI production status**

Phase target: To evaluate current technical capacity of EMA and provide necessary support.

EGII has acquired the following capacity to produce GI, through the trainings provided through Phase 1 to 3. The target for Phase 1 and 2 were to improve EGII’s productivity of in-house work. The target for Phase 3 was to foster trainers and to establish a TOT scheme which was needed because EGII started having more contracted work.

The OJT-based technology transfer was implemented during the actual mapping work. The trainees managed to improve the work efficiency and perform troubleshooting effectively with the guidance of practical tasks in the actual mapping work provided by the Project Team members.

EGII increased its productivity as shown in Table 10 after completion of the technology transfer according to plan. This productivity is expected to be increased even more by keeping doing their business in future.

**Table 10 EGII’s productivity**

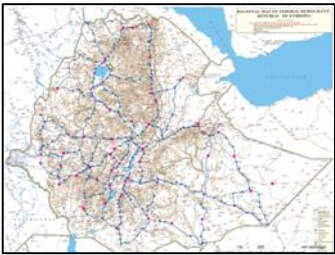
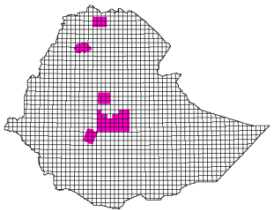
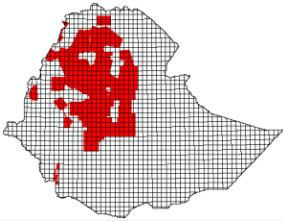
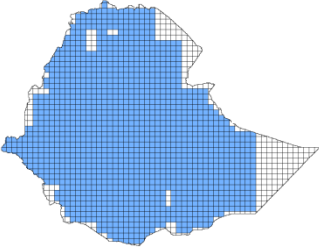
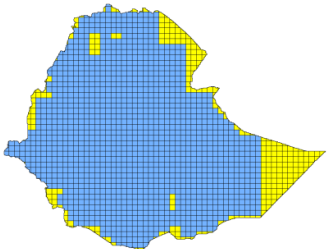
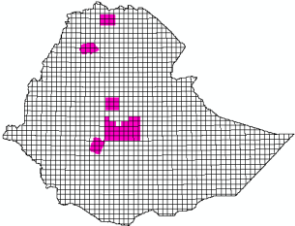
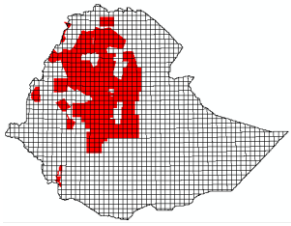
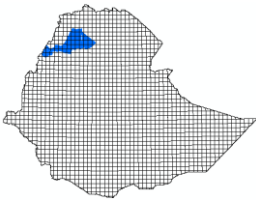
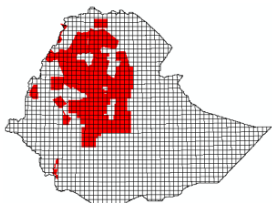
Category		Equipment	Before Phase 3	Experts	Result (productivity)
1 <sup>st</sup> order leveling		Level 2 sets	As shown in Table 6	Approx. 15	80km/MM (8 experts)
Aerial triangulation			Ditto		
DEM creating/editing		Photogrammetry equipment 7 sets	Ditto	8	400km <sup>2</sup> /MM (3 experts) 80km <sup>2</sup> /MM (3 experts)
Ortho image creation		Ditto	Ditto	7	50 sheets/PC-Month
Topographic map creation (2D)	1/5,000	ArcGIS 50 sets (Approx.)	Out of scope at the beginning	3	5km <sup>2</sup> /MM
	1/10,000		As shown in Table 6	3	20km <sup>2</sup> /MM
	1/25,000		Ditto	3	100km <sup>2</sup> /MM
	1/50,000		Out of scope at the beginning	3	500km <sup>2</sup> /MM
Topographic map creation (Contour line)	1/5,000	Photogrammetry equipment 7 sets	Ditto	7	.20km <sup>2</sup> /MM
	1/10,000		As shown in Table 6	8	400km <sup>2</sup> /MM (3 experts) 80km <sup>2</sup> /MM (4 experts)
	1/25,000		Ditto	Approx. 1	1,500 km <sup>2</sup> /MM
	1/50,000		Out of scope at the beginning	Approx. 1	3,000 km <sup>2</sup> /MM
Contour line update, digital conversion, auto-generation from DTM		ArcGIS 50 sets (Approx.)	Ditto	Approx. 1	1,140km <sup>2</sup> /MM

**(5) EGII’s GI production works**

Phase target: To evaluate current technical capacity of EMA and provide necessary support.

EGII’s insourcing for GI production and updating, and contracted work from other agencies are as shown in the next table.

**Table 11 List of EGII’s insourced GI production and updating work**

Project		June 2018	3-5 years target
[self-source] Ground control point survey Leveling survey			
[self-source] Topographic mapping	1/10,000		 EGIA will start mapping by prioritizing areas
	1/50,000	 Blue: conversion from analog to digital is completed (as of June 2018) White: no map data	 Blue: to update from SPOT image Yellow: to be newly created from SPOT image
[Contract work] DEM Production & editing (70% of the contracted area of 43,000km2 is completed)			
[Contract work] Ortho image production (30% of the contracted area of 254,000km2 is completed.)			

The areas shown in the “3-5 years target” for the “1/10,000 topographic mapping” in Table 11 is indicating area where aerial photographs are existing. The Government of Ethiopia does not have a plan to develop 1/10,000 topographic maps of the entire country. It is practically difficult to do so due to the nation's size is three times larger than Japan.

## **(6) EGII's long term plan for GI production and updating**

Phase target: Monitor and support on topographic map development program and leveling operation

The Project Team and EGII has discussed and produced the drafted EGII long-term plan regarding to GI production and updating. The key points are as follows.

- 1) Purpose of the long-term plan
  - To secure accuracy of survey and to avoid duplication of survey work caused by different agencies.
  - The period of the plan is 15 years starting from 2019.
- 2) Roles of EGII with regards to GI production
  - Capacity enhancement for “production and promotion of utilization of GI at national level” which is one of the basic policies.
  - EGII's roles with regards to distribution and promotion of use of the GI data owned by public agencies
- 3) Promoting GI data utilization
  - Acts to promote easy to use data and enhance public distribution GI owned by public agencies
  - Prepare environment for private sector to smoothly use GI owned by public agencies.
  - Human resources development and knowledge spread
  - Enhancement and usage of EGII's training center.
- 4) Specific business items

The following business items are described in the long-term plan

  - GNSS survey
  - Expansion of CORS, 0 and 1<sup>st</sup> order control points
  - Setup of nationwide level network
  - Establishment of a geoid model
  - Aerial photography, acquisition of satellite images
  - Topographic map creation at several scales
  - Thematic map creation
  - Geographic name collection
- 5) The plan term is 15 years from FY2019 to FY2034. Details are in separate volumes.

## **2.2. Evaluation**

### **(1) Relevance**

The relevance of this project is high due to the following reasons.

The project was formed based on the Japanese “International assistance policy”. And according to the “The 2<sup>nd</sup> Growth and Transformation 5YP (2015/16 - 2019/20)” mentions that agriculture, industrial development, environmental protection and infrastructure development must be continuously focused, also taxation and land development management capacity must be improved. As GI are fundamental data sets for these aspects, enhancing EGII’s capacity to enabling a stable production of accurate and reliable national spatial data is highly relevant.

### **(2) Effectiveness**

The objectives of this Project have been achieved as described in “(3) Achievement of the phase 3 objective of 2.1 Confirming achievements”.

- This Project contributed to increased number of work orders from other government agencies. EGII received an order for DEM and ortho-photo creation at scale of 1/10,000.
- This Project made a contribution to more requests from other government agencies to participate to EGII’s training courses. EGII has been receiving more requests from other government agencies to provide training for their staff.
- This Project made a contribution to utilization of the topographic maps for tourism. EGII created a tourist map of Adama-city under the supervision of the Project Team by using the 1/10,000 digital topographic map. The Project Team together with EGII provided this map to Oromia administration, Adama-city, tourist associations, travel agencies, hotels and high schools etc. Although the effectiveness of this tourist map itself cannot be properly evaluated yet in this short period of time, EGII has already started considering to update this map since there have been positive reactions from those recipients. This course of activities made EGII recognize that the 1/10,000 digital topographic map had a potential to be used for variety of applications not only within EGII but also in other organizations, which is one of the most important effectiveness that this Project has realized.

### **(3) Efficiency**

The project input quantity, quality and timing were most efficient.

During phase 3, EGII was involved in several contract works which was a good impact so that the project team could utilize this to train the operators with real content with real daily issues as an OJT method with live feedbacks and trouble shooting.

An important point when acquiring techniques for topographic map creation and level is to have continuous as well as improved training on regular basis. As each JICA specialist visited Ethiopia and provided their training 4 times through Phase 3, they checked outcomes from the previous training(s) and transferred technology to cover something missing and something new after their second visit. Overall, the technology transfer was done with a highly efficient way.

**(4) Impact**

The following positive impacts, which will not have any negative impact has been encountered.

- 1) The amount of GI production and updating work using data from other governmental projects has been increasing since EGII announced its enhanced GI production capacity through the technology transfer and installation of equipment at the seminar.
- 2) EGII has completed converting the existing analog topographic maps covering near whole country to digital by using their enhanced production capacity.
- 3) Data sharing (SPOT images covering the whole country) among the governmental agencies has realized as a consequence of the series of activities for promotion of data sharing and utilization.

**(5) Sustainability**

From the results of each technology transfer, the following outcomes have been confirmed.

- 1) EGII's technique was surely improved and EGII is now capable of creating more accurate maps more efficiently (refer to 2.1(3) for more detail).
- 2) During Phase 3, few new staff were trained by latest techniques and knowledge transfer system using OJT, TOT method and generalized manuals. The created carrier path guideline and data management manual can avoid technological gap during turnover. EGII's organizational structure will be well maintained by continuously operating these inputs, which will help EGII to carry out independent topographic map creation (refer to 4.5 for more detail).
- 3) Trained EGII staff became to be able to perform typical works by using the created versatile manuals which consist of the latest technologies.
- 4) To develop the national level guidelines (e.g. EGII's long-term plan, GI policy and survey regulations), can expect expansion of geospatial information creation business. In addition, awareness among the relevant organizations for importance of data publicity and sharing will be deepened and utilization system will be promoted if EGII keeps mentioning about it at meeting and seminars.
- 5) By having organized meetings and seminars, EGII showed its presence as a national geospatial information management agency and at the same time strengthened relationship between relevant agencies.

Based on the items mentioned above, EGII's sustainability is expected.

### **2.3. Conclusion**

Objectives of Phase 3 were the followings.

- 1) To evaluate current technical capacity of EGII and provide necessary support.
- 2) Monitor and support on topographic map development program and Leveling operation.

As for 1), the target of each technology transfer item was achieved, which led to the following outcomes.

- Increased number of experts having capability of performing standard works after having applied the most suitable technology transfer method.
- Accumulation of techniques and information by the developed technology transfer scheme.
- Standardized map results by the developed symbol regulations and map design for different scales.
- Increased number of projects from other government agencies.
- Increased efficiency and effectiveness of production and dissemination performance.
- EGII trainers have enhanced experts' skill in user organization.
- EGII's own thematic map (e.g. the tourist map) creation by having improved techniques.

However, technology transfer for map creation of large scale (e.g. 1/5,000, 1/2,000 etc.) and medium scale (1/50,000, 1/250,000 etc.) topographic maps as well as thematic maps (e.g. land condition, land use, atlas etc.) was not provided since they were not covered by the objectives of this Project. EGII will need to be capable of these items in future as a national geospatial information agency.

As for 2), EGII acquired capacity of performing pilot projects and thus objective was achieved.

Regarding "advising to and monitoring of EGII's topographic development plan", this was also achieved since the Project Team together with EGII developed or updated the EGII's long-term plan (draft), GI Policy (draft), carrier path guideline (draft), IT policy (draft), survey regulation (draft) and data management manual (draft), three month training manual (draft), work regulation and symbol regulation (draft) and EGII became capable of expanding its business based on these. Remaining challenges for EGII are that they need to have these documents approved within EGII and by the superior organization, and then appropriately operate any activities based on the documents.



## **2.4. Recommendation**

Following recommendations are made for EGII to achieve the overall goal after this Project, which is “The accurate and reliable geospatial database for the country which can promote sustainable development of economic and social infrastructure shall be developed”.

### **(1) Promotion and utilization of GI**

The Project Team recommends the following activities to EGII.

- 1) To establish a system to ensure that the governmental agencies and local governments submit their plans of survey and map production and survey results to EGII without exemption as proposed in the EGII’s long-term plan and the survey regulation.
- 2) To revise the policy for public domain data disclosure and provision via the internet and update the GI policy. To establish a data distribution system as a role model of other organizations (refer to 2-1. (3).6) and table 48).
- 3) To establish a national level council (provisional name: Council for GI development in Ethiopia) which will determine a policy for Ethiopia’s development and provision of geospatial information. EGII will be a secretariat of this council and play a leading role. Mid-term objectives (for about next 5 years) will be set and progress will be reviewed every year. As EGII does not have authority to establish this inter-ministerial council by itself, it shall seek assistance of the higher-level organizations such as the Ministry of Innovation and Technology for the establishment of the council.
- 4) To provide training for members of the council to promote utilization of geospatial information. To provide training on the use of GIS for data utilization and analysis.
- 5) To establish a data clearing house and make location and other related information of each GI clearer. To establish a data clearing house in EGII.
- 6) Hold GI related seminars semi-annually to build relationship with other organizations and search needs, to discuss industry futures.
- 7) Public domain GI should be published basically for free. However, collection of actual costs shall be considered where needed.
- 8) To clarify the rules and standards for data disclosure and provision.
- 9) To clarify copyrights of the data owned by each governmental agency.
- 10) To develop 1/50,000 topographic maps of unmapped areas and to update the existing 1/50,000 topographic maps.
- 11) To promote the nationwide establishment of CORSSs, control points and benchmarks.

#### Background for the recommendation and challenges

- 1) The duplication of work in the survey and map production work is an issue to be solved in the mapping work in Ethiopia. The solution of this issue is to follow Japan’s public survey regulation which states the requirement to “submit survey plans and results to the responsible agency” and add this state to EGII’s survey regulation.

- 2) Various government agencies own their own GI data in Ethiopia. The use of these data in various public services has been hindered by the lack of information on the availability of contents of and ways to obtain such data. To solve this problem, the GI Policy (draft) shall be updated and a system for data disclosure and provision shall be established.
- 3) The establishment of data disclosure and provision system is required for utilizing the GI data owned by different government agencies. However, the use of different approaches for data disclosure and provision by these agencies has been an obstacle to promoting use of the GI data. Therefore, it shall be necessary to establish an organization responsible for the development and provision of GI data in the entire government to standardize the different approaches taken by various agencies and promote the development and provision of GI data.
- 4) The user level and operation method of GIS for utilizing GI data is not the same condition in different government agencies. The government shall provide standardized training on the use of GIS for promoting the utilization of GI data.
- 5) To contact various government agencies and gain access to GI data owned by them individually is time-consuming work. Therefore, a centralized system to manage their data is required. A data-clearing house shall be established for the operation of this system.
- 6) Many agencies own and use GI data, though each of them has developed and utilized them in its own way. Therefore, opportunities to share their experience in the development and utilization of GI data are needed.
- 7) It is recommended that GI data to be provided free of charge for promoting their use, though several agencies consider it necessary to collect actual expense from data users.
- 8) In principle, as much GI data as possible shall be disclosed. However, strict control may apply to the disclosure of some of the security-related data. It should be noted that very strict control is imposed on data concerning national defense.
- 9) Disclosure of certain data may be refused on the ground that these data are protected under copyright law. Organizations including the council mentioned above shall discuss issues concerning copyrights and form a collective opinion of the government on the issues.
- 10) The existing 1/50,000 topographic maps shall be updated because they were produced a long time ago and do not represent the latest geospatial information. Because no topographic map is available for the areas not covered by the existing 1/50,000 topographic maps, 1/50,000 topographic maps of these areas shall be produced as the basic maps of Ethiopia.
- 11) The number of control points in Ethiopia is insufficient for its vast area. Therefore, the establishment of CORSs that can be used for surveying a relatively large area is required, particularly for their use in cadastral survey in urban and rural areas. As the density of control points and benchmarks in this country is not enough due to the nation size, various agencies have requested the development of new control points and benchmarks.

### Evaluation of feasibility of recommended activities

- 1) The statement to be added to the Survey Regulation is similar to those stipulated for the public survey work in Japan mandating the submission of work plans and survey results. The purpose of the addition is to eliminate work duplication in the surveying and mapping work. The importance of the elimination of the work duplication in the mapping work, which has also been recognized in Ethiopia, shall be emphasized when explaining the need for the addition to the ministers concerned. As the procedures required for the revision of the regulation have been clearly set, deliberate explanation at an approval committee meeting will be sufficient for revising the regulation.
- 2) Because it is very difficult for EGII to call an inter-ministerial meeting through an ordinary channel, it is recommended that EGII seek strong support of the Office of the Prime Minister to hold such a meeting. The use of this top-down approach is expected to increase the probability of realizing such a meeting. Although it is expected to take time to organize such a meeting, EGII will be able to contribute significantly to the realization of the meeting by taking lead in the establishment of a system for the data disclosure and provision with the establishment of its own system, which can serve as a model for other organizations.
- 3) As mentioned earlier regarding to the GI policy, the government agencies have less awareness of the need to establish the National Council for ENSDI. Therefore, it is recommended that EGII seeks strong support of the Office of the Prime Minister for calling a stakeholder meeting to promote their understanding. The use of this top-down approach is expected to increase the probability of realizing such a meeting. Although it is expected to take time to establish the council, EGII shall continue strengthening cooperation with the Office of the Prime Minister for its early establishment.
- 4) EGII shall take lead to provide training for promoting the utilization of GI data before the establishment of the National Council for ENSDI to demonstrate the importance of and necessity for the establishment of the council.
- 5) As the data-clearing house will be established after the establishment of the National Council for ENSDI, matters concerning the establishment of the clearing house shall be included in a series of discussions on the establishment of the council. It is likely to take time to establish the clearinghouse. Important jobs that the council shall have to perform include the investigation into the GI data owned by various government agencies and the production of metadata. The importance and advantages of establishing the data-clearing house should be understood by agencies producing and utilizing GI data.
- 6) A seminar on GI data, as well as the training for its use, has been implemented in this project. EGII shall take the lead in holding seminars for promoting the utilization of GI data and making the participants of the seminars understand the importance and advantages of developing GI data.
- 7) , 8) and 9) The discussion on the matters concerning data disclosure (including the cost sharing, maintenance of public order and protection of copyrights) is expected to take time as they are to

be discussed by the council to be established. Therefore, a measure specifically for each case shall be used for data disclosure until a comprehensive rule on the GI data disclosure has been established. A data user shall pay at least the actual cost of the data disclosure for the data use. The disclosure of GI data concerning the national security is not likely to be allowed. As copyrights on GI data are regulated by the copyright law of Ethiopia, whether specific copyrighted GI data may be disclosed or not shall be decided in accordance with the provisions of the law.

- 10) EGII shall give priority to the updating work of the existing 1/50,000 topographic maps using satellite images (ground resolution of 1.5 m) which the images were shared from the Central Statistical Agency under a data sharing scheme. EGII will be able to complete the updating work of the existing maps as it has already begun the updating work. EGII shall produce new 1/50,000 topographic maps of the unmapped areas with their current personnel and equipment, and making effort to recruit and assign new personnel and procure additional equipment at the same time.
- 11) The existing 0 order control point can be upgraded to CORS by installing additional GNSS equipment. Thirty existing 0-order control points shall be upgraded to CORSs in this way. CORSs are valuable because they can be used for cadastral survey in urban and rural areas. New 0-, 1st- and 2nd-order control points and a nationwide benchmark network shall be established. The first pilot project for the establishment of benchmarks shall be implemented in the area around Addis Ababa.

## **(2) Data management**

All GI data are to be managed in accordance with the policy of Ethiopian GI committee (draft name). All of the agencies who own GI data manage their GI data with common data formats and common folder structures. As a future vision, there should be a data clearing committee and system which enables to search any types of data which organizations hold, though the project team will propose procedures for data management inside EGII.

## **(3) IT skill capacity**

EGII's current IT skill is not yet sufficient when considering management and distribution of GI data. Thus, the following measures need to be taken. (EGII shall take such measures including those for personnel assignment.)

- 1) To allocate several staff who have the latest IT skills in the IT directorate.
- 2) To establish and provide IT training courses at the training center.

Specific training course for IT staffs and other staffs should be provided separately. External trainers should train the IT staffs in initial stage. The overall goal is to educate IT staffs to become trainer level. For other staff, there will be "beginner" and "intermediate" courses and both will focus on IT security training.

## **2.5. Factors**

### **(1) Positive factors**

- 1) At the beginning of this Project, many GI produce / consumers had limited understanding regarding duplication of survey and map creation work. However, several organizations realized the importance of avoiding duplication after series of discussions through the Project and EGII staff has started mentioning importance of avoiding duplication at meetings. As a result, Central Statistical Agency (CSA) and Information Security Network Agency (INSA) shared their SPOT images covering entire country with EGII.
- 2) The technology transfer made EGII's younger staff motivated and some of the participants of the GIS training offered to give a presentation at a seminar.
- 3) The government started to recognizing importance of geospatial information as well as importance of the national agency responsible for survey. As a consequence, the name of EGII was approved by the congress and EGII will have responsibility to manage GI data.
- 4) There were business duplications between EGII and Information Network Security Agency (INSA) for a long time. The reorganization of the government ministries and agencies has made INSA affiliated with the Ministry of Peace, the responsibility for the NSDI-related work transferred from INSA to EGII and, thus, made EGII an organization responsible for the overall management of GI data in the entire government.

## **(2) Lessons**

TOT method in which some of EGII's experts were trained to be trainers and then these trainers trained younger experts was applied so that techniques will be continuously transferred within EGII. With this method, the trainers' sense of responsibility and motivation raised and EGII's organizational culture was transferred from individual based operation to team-based operation.

As a result, technology transfer scheme within EGII was developed and productivity was improved by increased number of experts and raised technical level. Moreover, quality improvement was realized by having common understanding of specification and daily work quality management.

The above-mentioned method was successfully applied because this Project provided series of technology transfer from basic to advanced technology training of trainers. The Project Team believes that this method can be highly effective to have technology remain within the organization and to be used in the future. In addition, combination of advantages of well experienced experts' analog based techniques and younger experts' software operating skill worked effectively.

The Project Team believes that it was able to implement the technology transfer with the process mentioned above because EGII was the counterpart organization, as the successful implementation of this type of technology transfer requires that a counterpart organization have the number of staff and an organizational structure appropriate for its implementation. A step-by-step approach is effective for implementing the technology transfer and a period of two years or so is required for each step of the technology transfer.

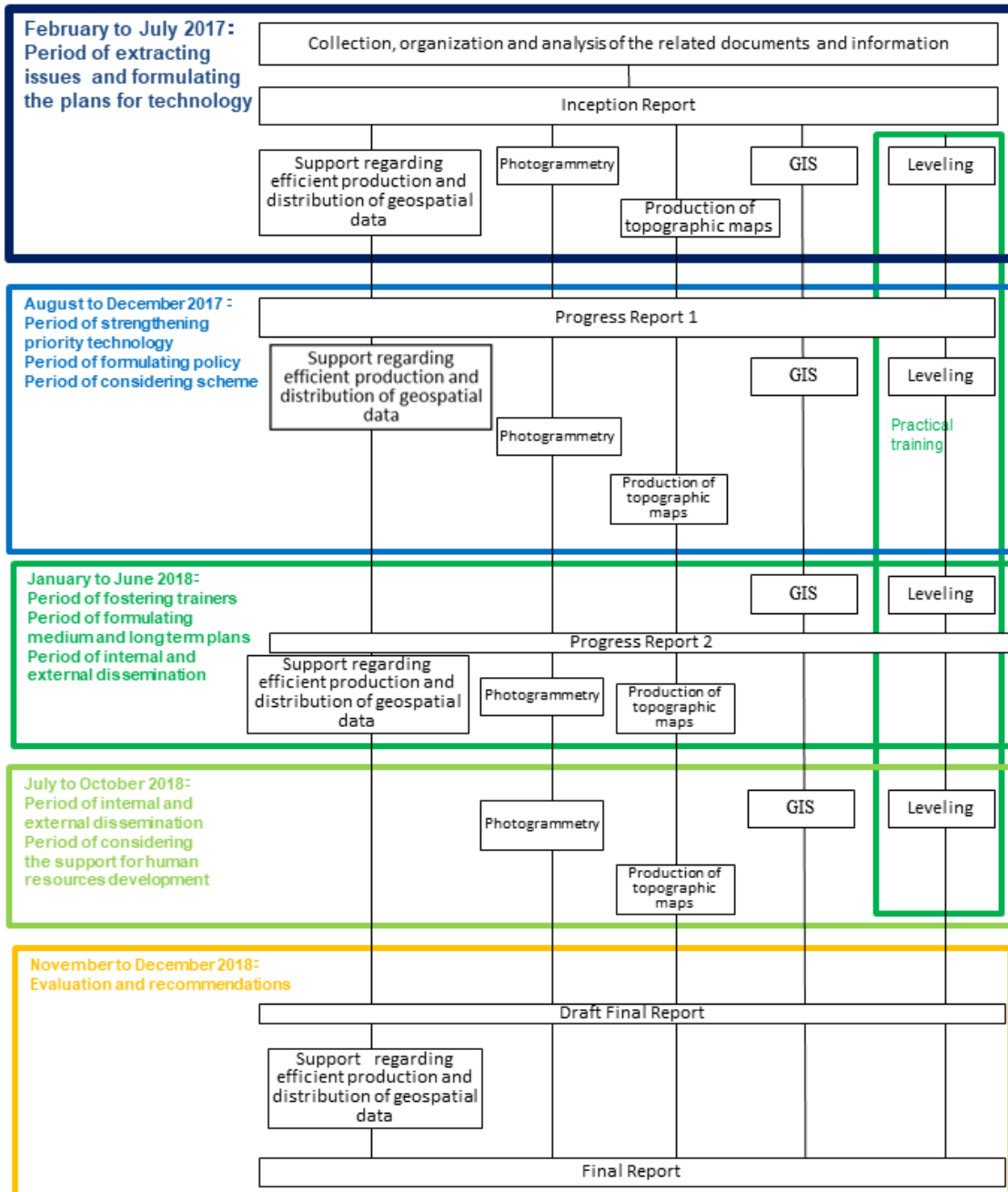
EGII has already been given "roles" in the government including the role of performing work contracted from other government agencies. This fact has contributed significantly to the effective implementation of the technology transfer. If an organization responsible for map production is not able to produce accurate maps, a vicious cycle may emerge: As no one will place an order for map production to such an organization, there will be no incentive to produce maps for its employees and, as they will not produce maps without incentive, no one will place an order of map production to them. However, the performance of the contracted work by EGII has generated a positive cycle in Ethiopia.

## Chapter 3. Contents of Implementation

### 3.1. Work Flow

The work flow for the whole period of this phase and the method of implementation for each work item are described below.

The overall work flow is shown as follows.



### 3.2. Project Activity Implementation Details

The details of each activity in this project shall be shown in the following.

**[ 1 ] Collection, Organization and Analysis of the related documents and information {Activities in Japan}**

The documents collected during Phase 1 and Phase 2 were analyzed, and any additional information obtained in Japan was collected, organized and analyzed.

**[ 2 ] Preparation of Inception Report {Activities in Japan}**

The implementation policy and planning of Phase 3 activities, the structure for implementation as well as the plan for technology transfer were summarized, and the inception report was prepared and submitted by JICA.

**[ 3 ] Explanation about the inception report and consultation with EGII {Activities in Ethiopia}**

The Project Team explained the content of the inception report to EGII, and gave explanations on the details of the operation and the policy for the implementation, etc. The Project Team also made consultations with EGII regarding the structure for implementing the activities. The details of the explanations and consultations were summarized into meeting records (minutes), and the agreement of EGII was obtained.

**[ 4 ] Activities pertaining to technology transfer {Activities in Ethiopia}**

In order to improve the issues related to geospatial information of Ethiopia and EGII noted under 1-3, technology transfer will be implemented focusing on the following technologies. Details are given under "4. Content of Work Relating to Technology Transfer".

- 1) Follow up and gap filling of Skills in Photogrammetry
- 2) Follow up and gap filling of Topographic Map Production Technology
- 3) Follow up and gap filling of GIS Technology in EGII and Other User Organizations
- 4) Capacity Development on Leveling Technology
- 5) Supporting Geospatial Information Management and Administration

**[ 5 ] Preparation of Progress Report 1 {Activities in Japan}**

The Project Team prepared Progress Report 1 describing the progress achieved in the technology transfer after the submission of the Inception Report and submitted it to JICA.



[ 6 ] **Explanation and Consultations with EGII of the content of Progress Report 1 {Activities in Ethiopia}**

The Project Team submitted the Progress Report 1 to EGII, and gave explanations and had a consultation with EGII on the details of the report. The details of the explanations and consultations were summarized into the records (minutes) of meeting, and an agreement from EGII was obtained.

[ 7 ] **Preparation of Progress Report 2 {Activities in Japan}**

The results of the operations as well as the status of progress on the technology transfer after the Progress Report 1 was submitted shall be summarized and the Progress Report 2 shall be prepared.

[ 8 ] **Explanation and Consultations with EGII of the content of Progress Report 2 {Activities in Ethiopia}**

The Project Team will submit the Progress Report 2 to EGII, and give explanations and have consultations with EGII on the details of the report. The details of the explanations and consultations shall be summarized into the records (minutes) of meeting, and an agreement from EGII shall be obtained.

[ 9 ] **Preparation of Draft Final Report and Consultations with EGII of the content of Draft Final Report {Activities in Japan and Ethiopia}**

The Project Team submitted the Draft Final Report (DF/R) that summarizes the operations implemented so far, and gave explanations and had a consultation with EGII on the details of the report. The details of the explanations and consultations were summarized into the records (minutes) of meeting, and an agreement from EGII was obtained.

[ 10 ] **Preparation of Final Report {Activities in Japan}**

The Final Report was submitted to JICA, after making addition or revision in light of the comments made by EGII on the Draft Final Report.

## Chapter 4. Content of Work Relating to Technology Transfer

The content of the technology transfer implemented to date is shown below.

### 4.1. Upgrading of skills in Photogrammetry

#### (1) Approach of technology transfer and implementation flow

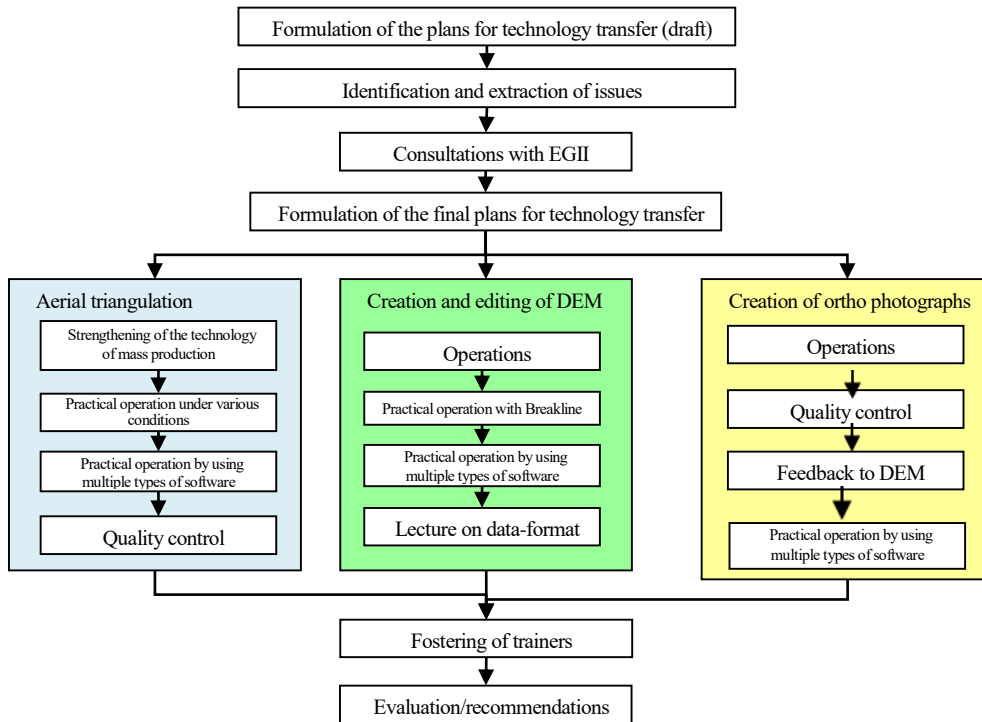


Figure 3 Work Flow of Technology Transfer for Photogrammetry

**(2) Status of technology transfer implementation**

Technology transfer implementation status as follows.

**Table 12 Implemented Technology transfer for photogrammetry**

	Period	Theme	Works
1 <sup>st</sup> training	Week 1 (9-14 May)	Equipment Management	Study on DEM editing work and interviews with the operators
	Week 2 (15-21 May)	Work efficiency (status identification)	DEM cut out by map sheet training, Index creation training Training on DEM editing by map sheet
	Week 3 (22- 28 May)	Work efficiency (status identification)	DEM editing by map sheet training, Study and recommendation of a practical DEM editing method
	Week 4 (29 May - 4 June)	Work efficiency (recommendation, demonstration)	Demonstration of the DEM editing method recommended by the Project Team; Technology transfer for schedule control
2 <sup>nd</sup> training	Week 1 (27 Nov. -3 Dec.)	Work efficiency (Mid-term review)	Observation of DEM editing work, interviews with operators
	Week 2 (4-10 Dec.)	Quality control	Lectures on quality control (Aerial triangulation, DEM editing)
	Week 3 (11-17 Dec.)		Practice in quality control (Aerial triangulation, DEM editing)
	Week 4 (18-20 Dec.)	Work efficiency (Applied technology)	Lectures on and practice in moving the results of aerial triangulation between different software programs
3 <sup>rd</sup> training	Week 1 (12-18 Feb.)	Preparation	Updating of equipment and validation of operation Consultation regarding technology transfer plan
	Week 2 (19-25 Feb.)	Trainer training, ToT training	Aerial triangulation theory Practice in aerial triangulation (Working from the manual, adjustment calculations)
	Week 3 (26 Feb. - 4 Mar.)	Trainer training, ToT training	Practice in aerial triangulation DEM and ortho theory
	Week 4 (5 - 12 Mar.)	Trainer training, ToT training	Basic practice in DEM Practice in ortho Applied practice in DEM
4 <sup>th</sup> training	Week 1 (16-20 May)	Preparation	Consultation regarding technology transfer plan
	Week 2 (21-25 May)	Trainer training, ToT training	Photogrammetry work planning training, Ortho image production training DEM editing OJT
	Week 3 (28 May - 1Jun)	Trainer training, ToT training	
	Week 4 (4 - 10 Jun.)	Trainer training, ToT training	DEM editing OJT, EGII internal training support Final evaluation

**(3) Participants in the technology transfer**

Experts belonging to the Mapping Directorate and the Quality and Standard Directorate (QS) participated in the technology transfer. The TOT staffs (trainer, trainee) were selected based on discussion with the respectful director.

**(4) Results of technology transfer (operations optimization)**

1) Aerial Triangulation

The operators which were trained in phase 1&2 have been trained as a trainer in phase 3, and trained 5 trainees in phase 3. The trainees' basic understanding/skill, advanced skill, multiple software operation and accuracy control of aerial triangulation have been confirmed by the project team. The TOT staffs (trainer, trainee) were selected based on discussion with the respectful director.

As the training has been done, EGII trainers are now capable to teach photogrammetry training. The results are as follows. The evaluation is based on project team’s observation and quality inspection.

2) DEM generation and editing

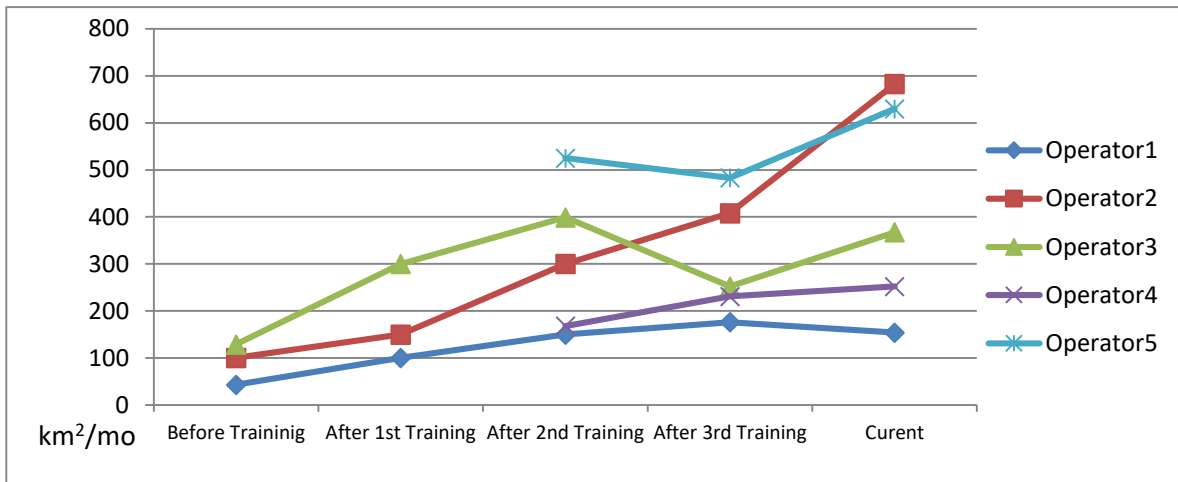
JICA expert has supported the ongoing internal contract project through the 1<sup>st</sup> to 3<sup>rd</sup> technology transfer. EGII is at the present time engaged in the execution of an order for a large-scale (4 blocks of 4,500 km<sup>2</sup> each) DEM editing job, and orders for more jobs of a similar type are expected. However, for a variety of reasons the work was not proceeding as planned, and it was not possible for those involved in the work to progress in pace with each other.

With regard to this issue, the Project Team made proposals for improvement, gave demonstrations and implemented training aimed at effecting the improvements. The initial issues, content of the technology transfer carried out, and the results of the technology transfer are shown below.

**Table 13 Technology transfer detail of DEM generation & editing**

Original setup	Issues	Content of proposals and technology transfer implemented	Results
<ul style="list-style-type: none"> <li>• One operator was in charge of working and managing one block.</li> <li>• One block is one work unit.</li> <li>• The work period was long (several years).</li> <li>• 4 operators were maximum assigned due to limit in equipment.</li> <li>• Subsequent work begins only after the whole work set is completed.</li> </ul>	<ul style="list-style-type: none"> <li>• Equipment are outnumbering the operators.</li> <li>• There is little/no awareness of tracking progress over the short term (per day, per week, per month).</li> <li>• The lack of milestones makes it difficult to set targets.</li> <li>• The large amount of data causes software freezes and lengthens processing times.</li> <li>• There are fluctuations in quality within the same block and between blocks.</li> </ul>	<ul style="list-style-type: none"> <li>• Split one block into 1/10,000-scale sheets (approx. 250 sheets per block).</li> <li>• Before starting work print out the relevant data so that those involved can confirm the content and points to be rectified.</li> <li>• Draw up a progress chart (per day) and a progress index.</li> </ul>	<ul style="list-style-type: none"> <li>• Daily targets were made clear.</li> <li>• It became possible to draw up a concrete work plan.</li> <li>• The ability to have an appropriate level of quality throughout the job has reduced excess work.</li> <li>• Quality control can be implemented in parallel and with shared responsibility.</li> <li>• Appropriately-timed feedback on quality control is possible.</li> </ul>

The productivity transitions of each operator through technology transfer are as follows. Operator 1 is a team leader rank and was not able to attend full day production work.



**Figure 4 Productivity Transition**

Additional to the mentioned training, there was TOT from EGII trainers to EGII new operators. The following operators (out of 5 experienced and 3 new operators, 3 with productivity of 400km<sup>2</sup>/month, 3 with 80km<sup>2</sup>/month) were educated through Phases 1 ~ 3. So the target of phase 3 has been achieved. The evaluation is based on project team's observation and quality inspection.

### 3) Ortho image production

This training was implemented as a TOT from EGII trainers to 5 EGII operators. From the training with the 11,000 aerial images of 28,000km<sup>2</sup> areas to produce 1/50,000 index size ortho image, the technical capacity on mosaic, image quality adjustment and image selection has been confirmed for the new operators as the following table. The evaluation is based on project team's observation and quality inspection

### 4) Manuals

Manual for daily ortho image production has been produced. In addition to this, the JICA specialist has introduced movie screenshots (which is a free software to record the screen activities) so that all the operation can be recorded as internal asset.

## 4.2. Upgrading Skills for Producing Topographic Maps

### (1) Approach of technology transfer and implementation flow

Director of the Mapping Directorate and the team leaders of the Digital Orthophoto, Digital photogrammetry and Digital cartography Teams and the team leaders of the Quality & Standards Directorate participated in the discussion regarding the plan of the technology transfer for Topographic Mapping. The figure below shows a comparison of the technology transfer plan revised in accordance with the outcome of the discussion and the draft plan described in the Inception Report. As the Project Team had identified map symbolization as the subject in which the capacity of EGII staff had to be reinforced most urgently in the interviews and the study of their work places, the team selected the technology for map symbolization as the first technology to be transferred. In the technology transfer for digital plotting, digital editing and resizing/scaling-down that followed the technology transfer for map symbolization, the team first provided training to enforce as standard the implementation of comprehensive accuracy control and quality evaluation throughout these processes.

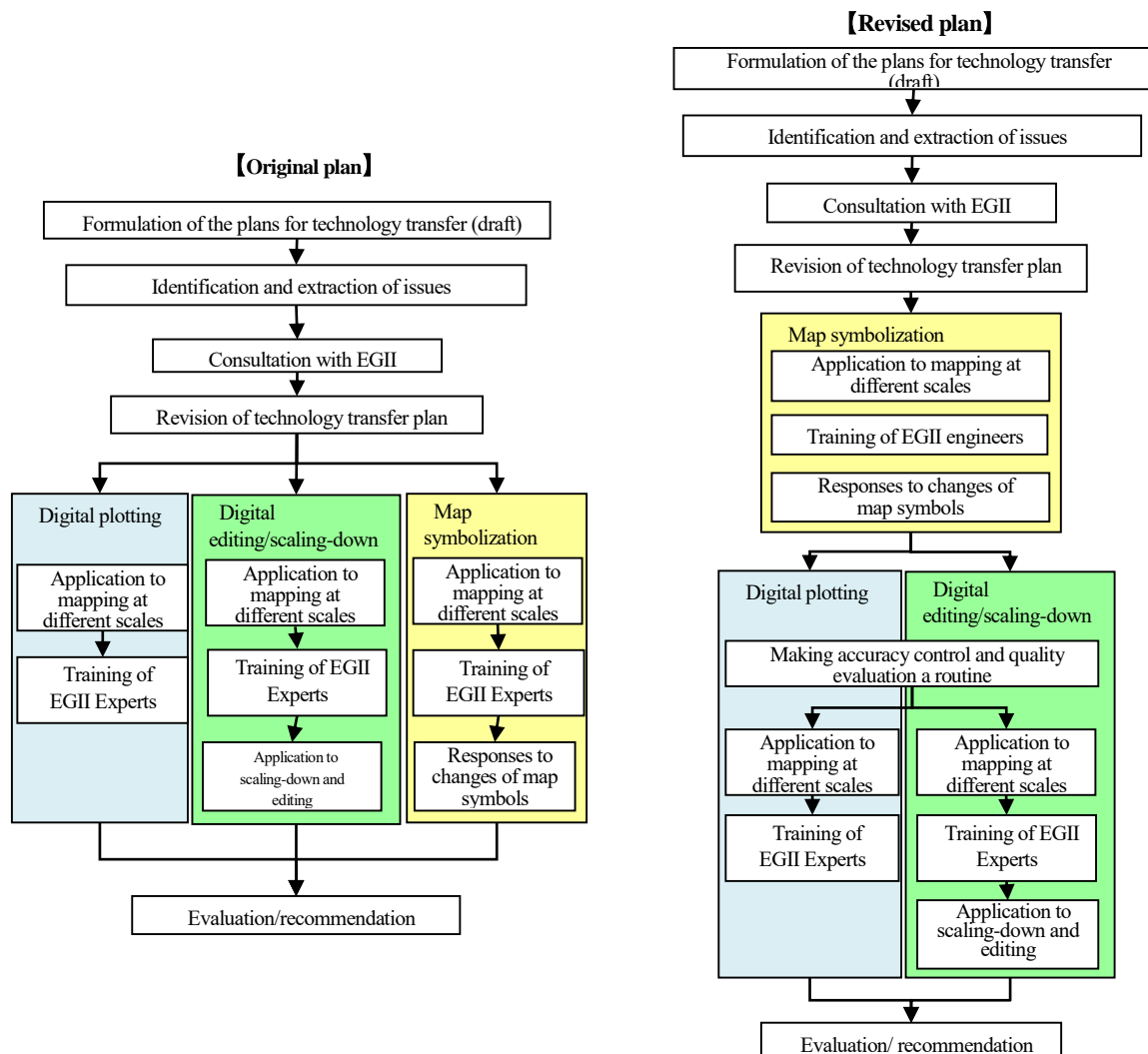


Figure 5 Flowchart for technology transfer of topographic map production

(2) Status of implementation of technology transfer

Table 14 Implemented Technology Transfer for Topographic Mapping

Period	Theme	Works
1 <sup>st</sup> training	Week 1 (19th – 23rd June)	Discussion on technology transfer planning Forming an agreement on the contents of the technology transfer and their priority order, and detailed planning of the technology transfer in the relevant areas Initiation of technology transfer with map symbolization using Arc GIS and Q/C including accuracy control and quality evaluation Interview with the Mapping Team and inspection of their work and work place
	Week 2 (26th – 30th June)	Survey of present situation, identification of issues Preparation of training materials for the technology transfer for map symbolization using ArcGIS Development of a method to create topographic map symbols mainly with open-source software, Inkscape
	Week 3 (3rd – 7th July)	Map symbolization Quality control Training for the technology transfer for map symbolization using ArcGIS (for 1/10,000 maps) Training for the creation of several map symbols Practice of the creation of complex map symbols by combining multiple symbols
	Week 4 (10th – 14th July)	Map symbolization Quality control Training for the technology transfer on Q/C, quality evaluation and preparation of product specifications Explanation of the outline of the process of introducing accuracy control in the practical Q/C
2 <sup>nd</sup> training	Week 1 (20th – 25th November)	Preparation, interviews, etc. Training in digital plotting (for the inexperienced): questionnaire, basic theory, stereo training Preparation for conversion of map symbols from CAD to GIS
	Week 2 (27th November – 3rd December)	Map symbolization Quality control Fostering of trainers, training of experts Preparation for conversion of map symbols from CAD to GIS Training in digital plotting (Experienced experts→the inexperienced) : basic exercises(Outline of 3D plotting, basics of 1/10,000-scale topographic map, basics of stereoscopy, basics of feature drawing, etc.)
	Week 3 (4th – 10th December)	Map symbolization Quality control Fostering of trainers, training of experts Conversion of map symbols from CAD to GIS Lectures on quality control of topographic maps Training in digital plotting
	Week 4 (11th – 17th December)	Map symbolization Quality control Fostering of trainers, training of experts Discussions by manager class on symbolization and development of topographic maps in other scales Technology transfer for quality control (Aerial triangulation, DEM editing) Training in digital plotting (Experienced experts → the inexperienced): Pilot exercises (covering 2.3km <sup>2</sup> )
3 <sup>rd</sup> training	Week 1 (7/11-7/13)	Preparation Preparation and training schedule discussion
	Week 2 (7/16-7/20)	Symbolization 1/10,000 map design discussion and training Inspection with several map sheets
	Week 3 (7/23-7/27)	Quality control Quality management with ArcGIS Data Reviewer Lecture about data reviewer and accuracy control
	Week 4 (7/30 - 8/3)	Update work regulation Updating work regulation
4 <sup>th</sup> training	Week 1 (9/4 - 9/7)	Preparation Training schedule discussion
	Week 2 (9/10-9/14)	Generalization (TOT) Lecture of generalization and training using ArcGIS tool for 10,000 to 25,000 scale generalization TOT training
	Week 3 (9/17-9/21)	Accuracy control Accuracy control training of full mapping procedure (AT to editing)
	Week 4 (9/24-9/28)	Quality evaluation Quality evaluation training of topographic maps with quality evaluation table
	Week 5 (10/1-10/5)	Finalize work regulation Finalize work regulation (adding satellite image plotting) Finalize 1/50,000 symbol regulation

**(3) Participants in the technology transfer**

Experts belonging to the “Mapping Directorate” and the “Quality and Standard (QS) Directorate” participated in the technology transfer. The TOT staff (trainer role) was selected from the staffs who attended to the previous phase training, based on discussion with the respectful director. The TOT trainee has been selected by discussion with respectful director according to necessity.

**(4) Results of technology transfer**

The technology transfer target (1 trainer, 3 operators with 1sheet/3months capacity) can be said accomplished according to the team leaders understanding and capability level which they are able to implement independent work.

The project team evaluated the trainees based on technical level, speed, quality and cartographic adjustment. The TOT trainer role staff has been trained in the previous phase and already has basic skill, and know has the capacity to “Train” others. The evaluation of the TOT trainers’ capacity to “Train” is based on project team’s observation and the map quality of trainees. The training items are as follows.

1) Map Symbolization

The initial issues and technology transfer implementation results are as follows.

**Table 15 Results of technology transfer (Symbolization)**

Item	Issues	Proposals and implementation status	Results
Map sybolization	<ul style="list-style-type: none"> <li>EGII plans to develop production technology and a production line using ArcGIS.</li> <li>They have a strong desire for technology transfer in map symbolization for the preparation of topographical maps using ArcGIS.</li> </ul>	<ul style="list-style-type: none"> <li>Technology transfer in symbolization using ArcGIS for 1/50,000-scale topographical maps (Creation of map symbols and marginal information )</li> <li>Map symbol creation using the free software InkScape and practice in conversion to ArcGIS</li> </ul>	<ul style="list-style-type: none"> <li>Development of a map symbolization manual for ArcGIS</li> <li>Development of a 1/10,000-scale symbol catalog (Transition from CAD to ArcGIS)</li> <li>Development of marginal data (ArcGIS) for 1/10,000-scale printed topographical maps</li> </ul>

A manual for topographical map symbolization in ArcGIS, a symbol catalog for 1/10,000 scale topographical maps using ArcGIS and marginal data for 1/10,000 scale printed topographical maps using the catalog were prepared.

Technology transfer was carried out using the prepared catalog as material. As a result, a general understanding of the basic process of symbol creation was attained.

2) Accuracy control and quality evaluation

Technology transfer was carried out for the introduction of accuracy control (AC) and quality evaluation (QE), which is an area commonly relevant to the capacity development for map symbolization, digital plotting, digital editing and scaling-down and editing.

**Table 16 Results of Technology Transfer (AC & QE)**

Item	Issues	Proposals and implementation status	Results
Accuracy control and quality evaluation	There was a great need for EGII to enforce as standard the control of the accuracy of the entire map creation process, including photography, surveying and topographic mapping, and to evaluate the quality of the products of mapping.	Data accuracy control (enforcing as standard the implementation of accuracy control in the process of creating data including orthophotos)	<ul style="list-style-type: none"> <li>Conceptual lectures, creation of materials</li> <li>Introduction of accuracy control methods</li> <li>Introduction of quality evaluation</li> </ul>



Accuracy control is generally carried out in surveying including aerial photogrammetry. In Japan, implementation of accuracy control and its method are stipulated in the bylaw of the Public Survey Work Regulations.

It is essential to introduce both accuracy control and quality evaluation to EGII, because the Agency lacks in systematic accuracy control and under progress of applying methods to be established, such as the utilization of satellite images as an example.

a) Introduction of accuracy control method

In Phase 2 of this project, accuracy control sheet and accuracy control manual were developed based on the bylaw of the Public Survey Work Regulations in Japan. The Project Team carried out technology transfer on accuracy control method to be introduced in practical operations by using these existing deliverables.

Since the accuracy control sheet was designed for manual entry, a lot of manual calculations were necessary to fill in the sheet. As such, for practical implementation, the sheet had to be digitalized to make it more convenient and to enable accurate entry and easy information sharing. Accordingly, the sheet was totally redesigned and improved to fully utilize the MS-Excel functions. The improved sheet has the following three advantages:

- Automatic entry functions with embedded calculation formula for the sum, standard deviation, etc.
- Online manual entry function utilizing the comment function
- Function for comprehensive management of accuracy control sheets of all processes from control points survey to editing the data verified in the field completion

The technology transfer included a lecture on the overview of accuracy control and trial entry by using the actual photography data. In addition, the study and analysis of the work procedures currently used in QC Directorate revealed that the directorate did not handle the current state of quality control of the results of geodetic surveying or it did not have a mechanism for inspecting maps in the stages of the digital plotting and editing.

b) Introduction of quality evaluation

The method of quality evaluation is based on ISO19100 Geographic Information. A quality evaluation sheet that may be easily utilized by EGII was developed by reusing the sheet used in Japan.

The technology transfer included a lecture on the quality evaluation overview and trial entry to the quality evaluation sheet.

3) Topographic mapping

The initial issues, content of the technology transfer carried out, and the results of the technology transfer are shown below.

**Table 17 Results of Technology Transfer**

Item	Issues	Proposals and implementation status	Results
Topographic mapping	<ul style="list-style-type: none"> <li>• Fostering of experts</li> <li>• Creating technology transfer manuals, etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Fostering of stereo plotting experts</li> </ul>	<ul style="list-style-type: none"> <li>• Acquisition of basic skills</li> <li>• Clarification of issues and priority items for training of inexperienced experts</li> </ul>

Technology transfer for 3D plotting was implemented for three training participants with the following experiences (with two to three years of service for EGII).

- All the three participants had the same level of skills and knowledge.
- They have attended photogrammetry (ERDAS) training for about three months.
- They understood the terminology and outline of aerial triangulation, but did not have a clear understanding of specific input and output, objectives and each process.
- They mostly understood DEM creating/editing and ortho conversion/mosaicking.
- They had no experience in 3D plotting or using CAD software.
- Many of them had difficulty with the stereoscopy of locations with no clear features.

The evaluation of the exercise results revealed problems in “interpretation of walkways” and acquisition of elevation data of “gentle slopes/flat land/residential land” and “wooded areas.” Therefore, the Project Team has advised EGII for continuous practice. The evaluation is based on project team’s observation and quality inspection of the following table.

#### 4) Digital Editing & Generalization

The initial issues, content of the technology transfer carried out, and the results of the technology transfer are shown below.

**Table 18 Technology transfer results (Digital editing & generalization)**

Item	Issues	Proposals and implementation status	Results
Topographic mapping	Training operators Creating manuals Improve generalization techniques	Training on editing skills Training on generalization (1/10,000 to 1/25,000 and 1/50,000)	Basic skill acquirement Clarifying issues and important points for new staff training

The technology transfer for generalization in the previous phase was targeted for basic skill and understanding, so skills for actual daily work need additional input such as auto processing. The project team has implemented training on using ArcGIS auto processing tools for the following items and generalization from 1/10,000 to 1/25,000 and 1/50,000.

- Identifying the processing target by comparing the existing map and target scale map specification
- Categorization of auto and manual processing
- Merge / cut processing for multiple map sheets
- Generalization of buildings and vegetation polygons
- Generalization of road polygons to lines
- Re allocating annotations

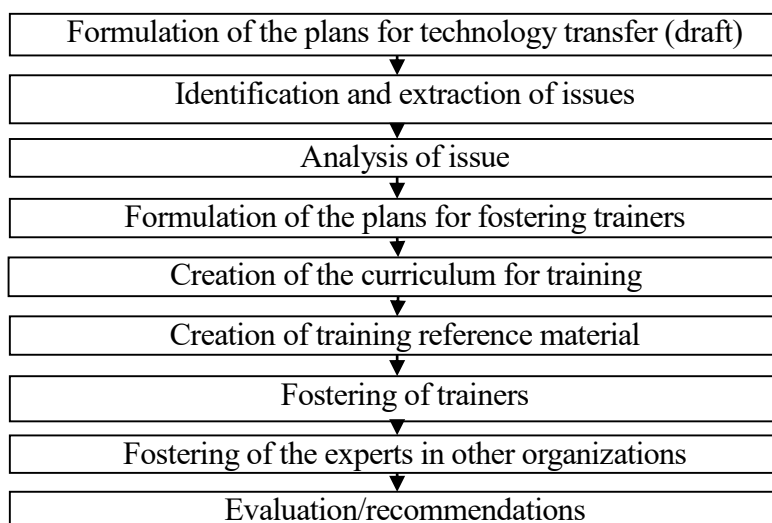
The project team has confirmed that the trainee acquired skills for independent work performance.

The trainee was team leader level and had basic understanding in theory and software, so only practical lessons was necessary. The evaluation is based on the project teams’ survey.

### 4.3. Strengthening of the GIS Technology in EGII and other User Organizations

#### (1) Approach to technology transfer and implementation flow

The strengthening of GIS technology was implemented in accordance with the following processes.



**Figure 6 Work Flow of Technology Transfer for GIS Technology**

#### (2) Status of implementation of technology transfer

**Table 19 Implemented Technology Transfer for GIS**

Period	Theme	Works
1 <sup>st</sup> training	Week 1 (5 - 9 June)	Preparation Tool development and technology transfer  Updating the OS of the server and the GIS machinery Discussion on technology transfer planning and selection of participants Development/exercises of aerial photography planning tool
	Week 2 (12 -16 June)	Survey of present situation, identification of issues Operation support tool development and technology transfer  Study of mapping work in EGII and identification of issues therein Development/exercises of a tool to convert DTM point cloud data into DTM raster data
	Week 3 (19- 23 June)	Operation support tool development and technology transfer  Creation of a tool for automatic extraction of rivers from DTMs, settings of parameters and operation practice
	Week 4 (26 - 30 June)	Operation support tool development and technology transfer  Representation of true north on maps, rotation of neatlines and production of maps Development and exercises of a tool to automatically create offset neatlines
2 <sup>nd</sup> training	Week 1 (24 - 27 Oct.)	Preparation  Preparation for technology transfer, selection of training participants
	Week 2 (30 Oct. - 3 Nov.)	Discussion on GIS training content and preparation  Exercises for the use of image georeferencing (spatial correction) tool Edge matching of data, rubber sheeting of data, data errors correction
	Week 3 (6- 10 Nov.)	Discussion on GIS training content and preparation  Detection of data errors and their correction by topology (topological properties) rules Exercises for the use of spatial analysis tool
	Week 4 (13 - 17 Nov.)	Discussion on GIS training content and preparation  Theory of tool combination flow design function (ModelBuilder) and exercise ModelBuilder exercises

	Period	Theme	Works
3 <sup>rd</sup> training	Week 1 (5 - 9 Feb.)	Preparation for GIS training and GIS seminar	Final confirmation of technology transfer materials and exercise data Preparation for GIS training Preparation for GIS seminar
	Week 2 (12 - 16 Feb.)	GIS workshop	Implementation of GIS training for EGII experts (training of trainers)
	Week 3 (19 - 23 Feb.)	GIS workshop	GIS training for user organization experts by EGII experts
	Week 4 (26 Feb. - 2 Mar.)	GIS seminar	Implementation of GIS seminar and evaluation
4 <sup>th</sup> training	Week 1 (7/23-7/27)	Preparation	Preparation for GIS workshop Preparation for GIS seminar
	Week 2 (7/30-8/3)	GIS workshop	GIS work shop to EGII staffs and to educate trainers
	Week 3 (8/6-8/10)	GIS workshop	GIS work shop from EGII trainer to user organization staffs
	Week 4 (8/13-8/17)	GIS seminar	Holding GIS seminar, evaluation

### (3) Participants in the technology transfer

Experts belonging to EGII and user organizations as described in the table below participated in the technology transfer. For Phase 1 and 2 of the technology transfer, the team selected six team leaders and a senior technical staff member as the participants of the technology transfer in this discussion, since the shortage of “human resources” and “skills” has always been a cause of inefficiency in digital mapping in EGII. To solve this issue, the Project Team held a discussion on the acquisition of technology, human resource development and maintenance of skills in each directorate and team required in order to establish a system that enables EGII staff to perform digital topographic mapping independently and sustainably.

### (4) Technology transfer results & evaluation (1<sup>st</sup> and 2<sup>nd</sup> training)

In view of the findings from the observation of the work site and the discussion with the directors and team leaders of the "Mapping Directorate" and the "GIS & Remote Sensing Directorate" as well as the team leader of each work team, the process of each work for creation of digital topographic mapping data was analyzed in detail to identify the issues and points to be improved about the work. By considering the requests of EGII as well, it was decided that the technology transfer should address these issues and points to be improved.

Also, with respect to the operations of “aerial photography planning”, “automatic extraction of rivers from DTM” and “map sheet creation” whose effective optimization is not expected with existing tools alone, new tools were developed, and technology transfer was carried out for the operation of these new tools.

The 1<sup>st</sup> training enabling the staff of EGII to have an advanced understanding of GIS software and advanced skills, clarified which items contribute well to resolution of the problems and optimization of their daily work.

The Project Team sorted these results and selected the targets of GIS workshop for the user organizations including training of trainers within EGII.

In the 2<sup>nd</sup> training, an examination was conducted using data from actual work examples. The participants’ level of understanding, work skills and results were evaluated on a scale of five. The evaluation results are shown in the table below.

The participants have different levels of work skills, but they understood the content of the training. As

such, a good result was obtained from the training.

**Table 20 Evaluation of Technology Transfer (GIS)**

<b>Training participants</b>	<b>Evaluation (point)</b>
1	4.5
2	3.5
3	3.5
4	3.5
5	4.0
6	3.5
7	4.0
8	4.0
9	3.5
10	4.0
<b>Average</b>	<b>3.8</b>

**(5) Technology transfer results & evaluation (1<sup>st</sup> GIS workshop / training for user organizations)**

After the Technology Transfers Phase 1 and 2, which were conducted from the viewpoint of technology acquisition, human resource development and succession of technical skills, the Project Team had a discussion with EGII to determine the content of GIS workshop for training of EGII trainers and training of user organizations as described below in order to enable the EGII staff to produce digital topographic maps in an independent and sustainable manner.

The workshop for training of EGII trainers was aimed at training two staff members of the “Training & Research & Development Directorate,” which is responsible for sustainable skill development of EGII experts, and team leaders of the “Cartography Team” and the “Photogrammetry Team” of the “Mapping Directorate,” which is mainly responsible for topographic mapping, so that they will be able to serve as trainers. The workshop was conducted in the form of lectures given by them to 15 EGII experts.

Participants of the training for user organizations were GIS intermediates selected through the discussion between EGII and the Project Team. The training was attended by 11 participants from nine organizations.

In the training, for each method and function, a theoretical lecture was given at first, which was followed by demonstration and exercises. Questions from the participants were answered on the spot. The Project Team provided an environment enabling them to conduct trainings by themselves in an autonomous manner whenever necessary in the future by sharing not only the data for exercises but also work manuals.

A questionnaire concerning the training was conducted for both the training of EGII trainers and the training for experts of user organizations.

According to the results of the questionnaire, most participants, who were at the level of “support or help is required” in performing data processing before the training, reached the level of “able to perform processing without referring to Help” after the training.

Some of them even reached the level of “able to develop original tools.”

From the above, the Project Team concludes that the results of the training of trainers and the training given by the trained trainers fulfilled the expectations.

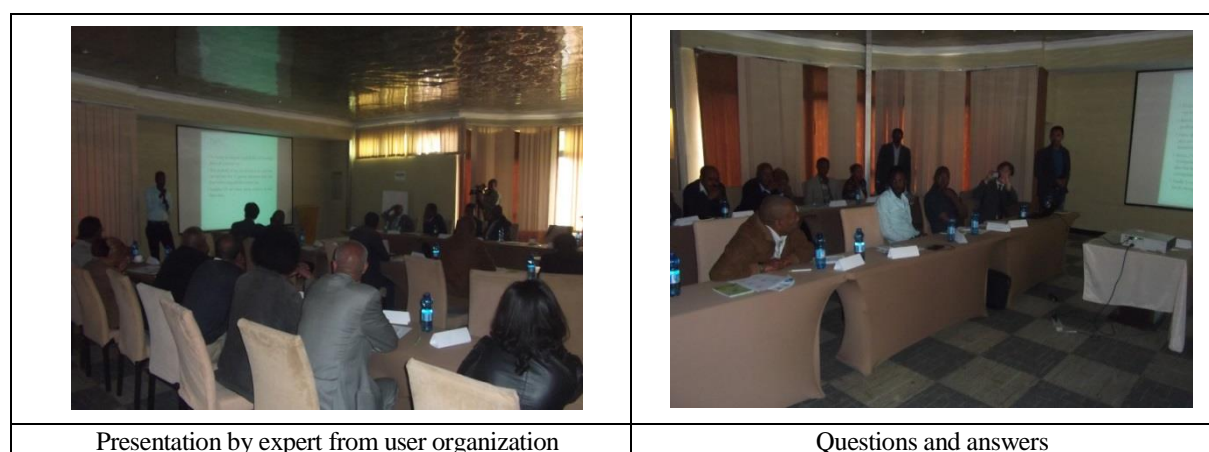
**Table 21 Questionnaire result (EGII trainer training/training of experts)**

Target technologies/functions		Level			
		1: Do not fully understand 2: Able to perform with support 3: Able to perform by referring to Help, etc. 4: Able to perform without referring to Help, etc. 5: Able to develop original tools			
		EGII trainer training/ training of experts		Training of experts from user organizations	
		Before training	After training	Before training	After training
1	Editing of vector data (points/lines/polygons)	3.2	4.3	2.5	4.5
2	Error detection by using topology	2.9	4.3	2.3	4.2
3	Data processing/extraction/measurement by using spatial analysis tools	2.7	4.0	2.2	4.1
4	Flow design by using ModelBuilder function	2.2	3.7	1.8	4.2
5	Advanced image processing	2.2	3.5	2.0	3.7
<b>Average</b>		<b>2.7</b>	<b>3.9</b>	<b>2.2</b>	<b>4.1</b>

**(6) Technology transfer results & evaluation (GIS seminar)**

On the 27<sup>th</sup> of February 2018, GIS seminar was implemented for user organizations with the objectives as described below. The seminar was attended by 25 participants from 11 organizations and information sharing was conducted with respect to continuing the workshop on a regular basis with EGII acting as the key organizer, segmenting the participant level and content, among others.

- Report of the content of GIS workshop (JICA Project Team and EGII trainers)
- Report of the effects and issues of GIS workshop (2 participants from user organizations)
- Sharing of the implementation policy of GIS workshop in the future (EGII Director General)



Presentation by expert from user organization

Questions and answers

**Figure 7 Scenes from the Seminar**

**(7) Technology transfer results & evaluation (2<sup>nd</sup> GIS workshop)**

The content of the 2<sup>nd</sup> GIS workshop has been discussed and decided, in order EGII to acquire and inherit technics and enhance human resource development, based on the accomplishment made in the 1<sup>st</sup> and 2<sup>nd</sup> training.

2 members from Training & Research & Development Directorate have been selected for the trainer role in EGII TOT workshop, targeting to enhance skills in R&D resource for continuous capacity building among all agencies. The 25 members who attended to the workshop is as follows.

12 members from 8 organizations have attended to the 2<sup>nd</sup> GIS workshop. The invitation list was decided based on discussion with EGII.



**Figure 8 Scenes from the 2<sup>nd</sup> GIS workshop**

The workshop curriculum was planned as lecture, demo then hands on training, for each function. Time for Q&A was also planned. The project team has prepared the manuals and also demo data so that the trainees can use the data by themselves whenever they want.

The project team has surveyed the applicants with a questionnaire, pre and post of the workshop. From the questionnaire, we have confirmed that initially, the applicants were in level 1, and after the workshop most of them had achieved level 4, few achieved level 5.

This result fulfilled the workshop target and the technology transfer target to educate EGII trainers.

**Table 22 Questionnaire result (EGII trainer training/training of experts)**

Item		1: Difficult to understand 2: Able to operate with support 3: Refer to help page and implement 4: Implement without help 5: Able to create original tool			
		To EGII		To USER	
		Before	After	Before	After
1	Advance editing tool	2.6	4.3	2.8	4.2
2	Surface, TIN, Terrain, Las Dataset	2.3	3.9	2.4	4.0
3	Raster data processing	2.8	4.1	2.7	4.2
4	Model builder processing	2.9	4.2	2.6	4.1
5	Python tool processing	1.4	2.9	1.5	3.0
<b>Average</b>		<b>2.4</b>	<b>3.9</b>	<b>2.2</b>	<b>4.1</b>

**(8) Technology transfer results & evaluation (2<sup>nd</sup> GIS seminar)**

The 2<sup>nd</sup> GIS seminar was held on August 16, 2018 which had 29 attendances from 12 different organizations. The continuous seminar holding and dividing training levels to more detail was discussed. The presentation topic is as follows.

- Reporting the GIS workshop (from project team)
- Explaining the component and effects of the workshop (from EGII staff)
- Future vision of technical workshops (from EGII DG)



Presentation from EGII

Presentation from USER

**Figure 9** Scenes from the 2<sup>nd</sup> GIS seminar

GIS seminar should be held continuously for strengthening organization relationship, GIS skill enhancement, raising GI necessity awareness and to promote data utilization.



#### 4.4. Upgrading Leveling skills

##### (1) Approach to technology transfer and implementation flow

Leveling skills of EGII staff members will be upgraded in accordance with the following processes.

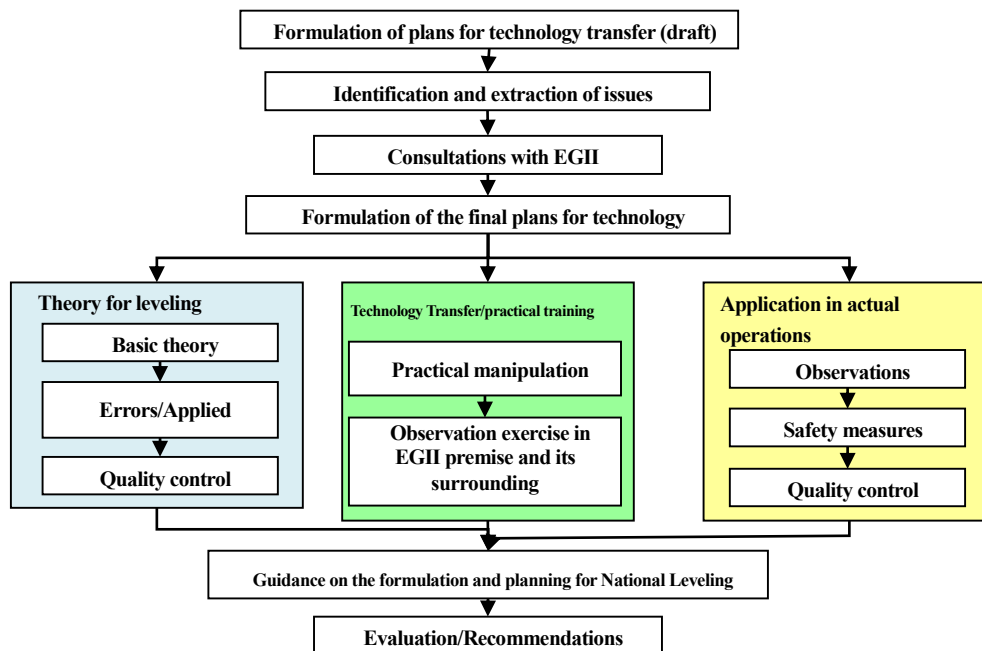


Figure 10 Work Flow of Technology Transfer for Leveling

##### (2) Status of implementation of technology transfer

To date the following technology transfer has been implemented.

Table 23 Implemented Technology Transfer for Leveling

Period		Theme	Works
1 <sup>st</sup> training	Week 1 (12th - 16th June)	Preparation	General meeting for elucidating the current state of leveling work for planning the technology transfer Selection of the participants Inspection of the LS15 equipment with the equipment list, lecture on how to use the surveying level
	Week 2 (19th - 23rd June)	Simple training in equipment operation	Lecture on how to use LS15 and training on outdoor observation (in the premise of EGII Office) Observation training near EGII office, downloading the observation data
	Week 3 (26th - 30th June)	Lectures/exercises	Preparation of a leveling plan (lecture) and a leveling network (discussion) Practice of pacing: distance of 50m (from a level to a staff member) Leveling route survey
	Week 4 (3rd - 7th July)	Exercises for observations	Leveling network planning, entry of acceptable range, practice of observation, Practice of pacing: Verification of the output of the technology transfer and confirmation of the plan
2 <sup>nd</sup> training	Week 1 (1st - 3rd November)	Exercises for observations	Selection of leveling route and benchmark
	Week 2 (6th - 10th November)	Exercises for observations	BM <sub>EMA</sub> →SBM.0 (approx. 2.8 km from EMA in the direction of Sendafa) Participants are divided into Group A and Group B and each group performs a two-direction observation for a distance of approximately 2.8 km.
	Week 3 (13th - 17th November)		Instructions were also given as to how to install tripods and how to handle and where to install leveling staff and the needs to make considerations for passers-by and vehicles to ensure safety.

	Week 4 (20th – 22nd November)	Evaluation	Mutual evaluation concerning exercises for observations, discussion on the next training
3 <sup>rd</sup> training	Week 1 (17th and 18th January)	Lectures	Reconfirmation of work methods and observation procedures Reflections on the previous technology transfer (in the aspect of accuracy) Feedback and reconfirmation of points to be noted
		Exercises for inspections	Inspection of leveling staff and circular levels (to eliminate errors caused by tilted leveling staff)
	Week 2 (22nd – 26th January)	Exercises for observations	Each member of the two groups performs a two-direction observation for a distance of approximately 2.8km. Focus on working according to the observation rule of first order leveling.
	Week 3 (29th January – 2nd February)		
Week 4 (5th – 9th February)	Lectures/exercises	Calculation-processing, inspection- organization, leveling rod correction, orthometric correction	
4 <sup>th</sup> training	Week 1 (11 - 17 Jun.)	Preparation	Preparation and discussions for training plan
	Week 2 (18 - 24 Jun.)	Practice	Round observation between SBM 0 and SBM 1 (one way 2km)
	Week 3 (25 Jun.- 1 Jul.)	Practice	Same as week 2
	Week 4 (2 - 8 Jul.)	Test and Evaluation	8 from group A, 7 from B, total 15 staffs have taken the test and 12 have passed

### (3) Participants in the technology transfer

All the experts who have participated to the technology transfer belong to the Survey Directorate.

Half of the participants (7 participants) who had participated in the 1<sup>st</sup> training could not attend the 2<sup>nd</sup> training, but the 2<sup>nd</sup> training had five new participants. Since all the four periods of the training should be attended in a row, the Project Team requested EGII to make considerations so that the same staff members could attend the training in a row as much as possible and obtained an agreement from them.

The total number of trainees were 22, 5 has attended all, 6 staff in 3, 5 staffs in 2, 6 staffs in 1 training. 70% has attended more than 2 times, and half has attended more than 3 times.

As a final evaluation, 8 staffs had reached the following level. The observation capacity, training capacity, implementation capacity has been confirmed.

**Table 24 Capacity Evaluation**

Staff	Observation	Training skill	Work management skill	Observation length (round km)	
				km/day	km/month
1	✓		✓	2	40
2	✓	✓	✓	2	40
3	✓	✓	✓	2	40
4	✓			1.5	30
5	✓	✓		1.5	30
6	✓			1.5	30
7	✓	✓	✓	2	40
8	✓			2	40

The staffs with training skill are sufficient to “Equipment manager”, and staffs with work management skill are sufficient as “Work manager”. With these 8 members, it is able to implement observation with 2 teams.

**(4) Results of technology transfer**

Technology transfer was carried out with the objective of resolving the following problems.

**Table 25 Results of Technology Transfer**

	<b>Issues</b>	<b>Content of proposals and technology transfer implemented</b>	<b>Results</b>
1 <sup>st</sup>	No experience in first order leveling	It was decided to give an explanation in the classroom lecture about the concept and the implementation method of first order leveling, and how to use first order surveying levels, and after that to carry out within the EGII premises the technology transfer regarding how to use surveying levels, observation methods, data analysis and safety measures, etc.	The participants became able to perform basic observations. Elimination of the causes of errors and overall accuracy control are challenges for them.
2 <sup>nd</sup>	Training focused on practical operations	Field reconnaissance of a leveling route and selection of benchmarks were implemented. Installation of temporary benchmarks and exercises for observations (approx. 2.8 km) were carried out. Technology transfer to cover the safety aspect was also carried out by giving instructions on the safe handling of equipment (surveying levels and leveling staff) and making it mandatory to wear safety vest to raise the awareness to avoid accidents.	The participants managed to complete the scheduled work volume, but the observation results were unsatisfactory.
3 <sup>rd</sup>	Training focused on observation accuracy and quality	In order to improve the skill level and to clearly identify the issues, it was planned that every participant will perform the prescribed work volume so as to clarify their responsibilities and performance levels.	The differences in the measurements between all pairs of the leveling points were within the allowable range of error, which meant that the results satisfied the standards (or were acceptable).
4 <sup>th</sup>	Enhance trainees' proficiency level	Continuous practice (one-way 2km) to improve observation accuracy and proficiency for all trainees	Taking time to train each staff for observation, which lead that almost all trainees achieved the 1 <sup>st</sup> order leveling skill

1) 1<sup>st</sup> training

The technology transfer for leveling (first order leveling) was carried out in the following order: work planning (preparation of a net adjustment plan), selection of stations (preparation of a reconnaissance map and a net adjustment map), erection of survey markers (installation of permanent markers and preparation of control point description) and observation (practice of observation and inspection and adjustment of observation equipment).

The Project Team decided that the subsequent phases of technology transfer should include inspection of field books and re-observation, preparation of the observation record (calculation for leveling staff correction and ortho metric correction), leveling network adjustment and preparation of an accuracy control sheet.

2) 2<sup>nd</sup> training

The technology transfer was carried out with a focus on the following items.

- As outdoor training, field reconnaissance of the leveling routes between Addis Ababa and Dukem (approx. 30 km southeast) and between Addis Ababa and Sendafa (approx. 40 km northeast) and selection of benchmarks were carried out.
- Also, a benchmark was installed (SBM.0) on the concrete foundation of the bridge located around 2.8 km from the EGII benchmark in the direction of Sendafa and the route between the two benchmarks was designated as a leveling route for observation practice.

- The 13 participants were divided into Group A and Group B for the observation practice. Since many of them neglected the rules of first order leveling in performing the observation, observation methods and procedures were explained to them whenever appropriate.

3) 3<sup>rd</sup> training





It was decided that the Technology Transfer Phase 3 should be carried out specifically aiming at familiarization among participants with the observation work and it was agreed that the technology transfer should consist of observation of the same route that is, a 2.8 km route from EGII BM to SBM.0 by all the participants and evaluation of the results. At the end of the technology transfer, all the observation data was re-inspected, and a lecture and practical training were conducted on subsequent works, such as calculations for reduction scale correction and orthometric correction.

Each group of the participants managed to complete three sessions of two-direction observation (a total of six sessions) in the technology transfer. The calculation and inspection of the observation results revealed that the differences in the measurements between all pairs of the leveling points in two sessions were within the allowable range of error, which meant that the results of these sessions satisfied the standards (or were acceptable).

4) 4<sup>th</sup> training

The project team has confirmed basic skill in almost all (12 out of 15) trainees, from the 1<sup>st</sup> to 3<sup>rd</sup> training. The 4<sup>th</sup> training is to understand and obey the work regulation, and practice to improve observation accuracy.

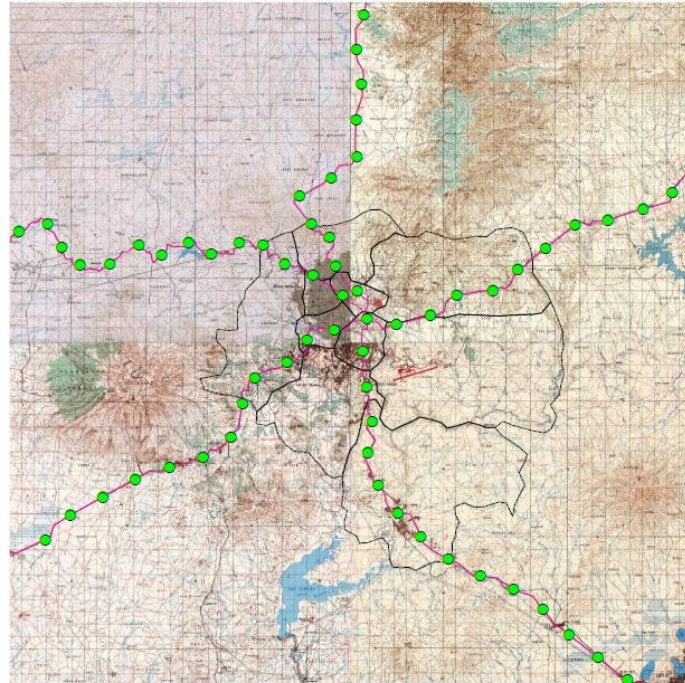
In order to achieve the target, the project team has selected a new point (SBM1) which is 2km from SBM0, and trained all staffs step by step to enhance proficiency.

	
<p>Observation</p>	<p>Basic skill training</p>
	
<p>Data analysis training</p>	<p>Lecture</p>

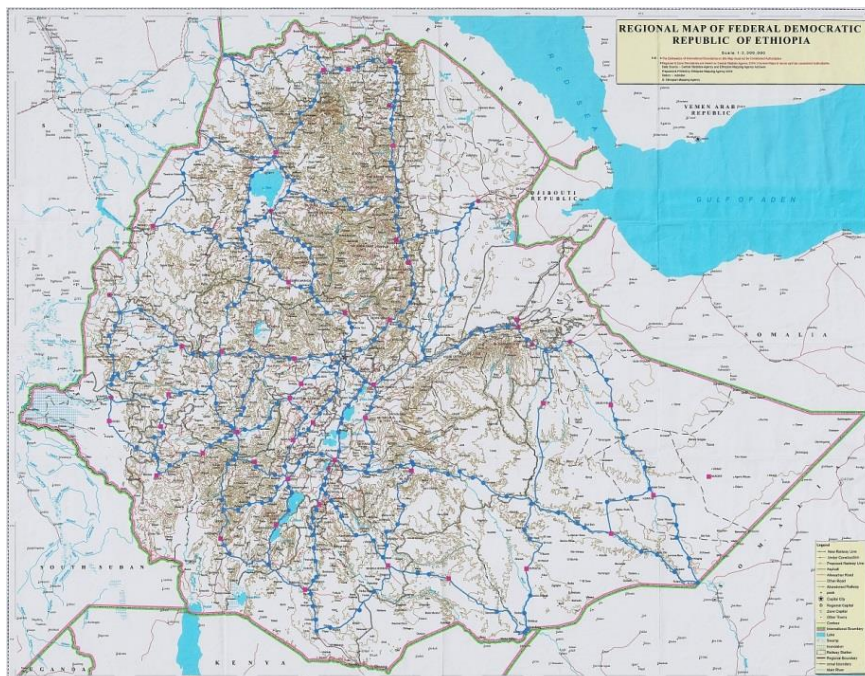
**Figure 11 First order leveling training**



In order to support EGII's future 1<sup>st</sup> order leveling project, the project team has created and proposed 2 leveling route plans. One is for the pilot project covers Addis Ababa and its' surrounding with 3km interval BM monument, total of 200km length. Second is a rough plan for nationwide plan which runs through major cities with total of 13,000km length. The second route plan can be referred when creating a detail work plan.



**Figure 12 First order leveling route plan 1/50,000 (Addis Ababa)**



**Figure 13 First order leveling route plan 1/2,000,000 (National)**

## 4.5. Strengthening of the Management and Operation of Geospatial Information

### (1) Approach to technology transfer and implementation flow

The strengthening of the management and operation of geospatial information (GI) will be implemented in accordance with the following processes.

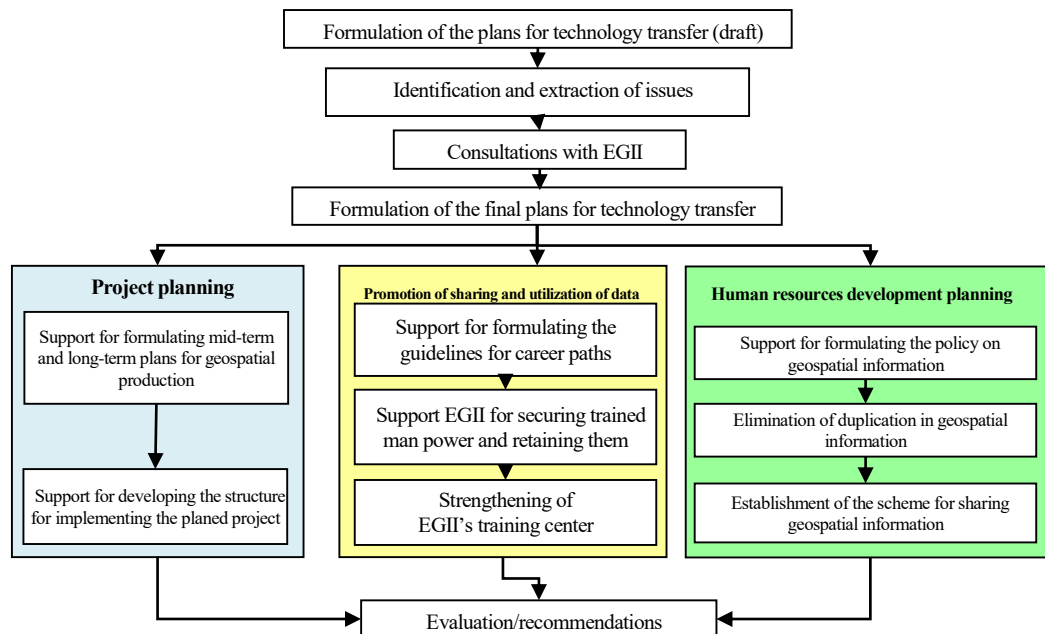


Figure 14 Work Flow for the Management and Operation of Geospatial Information

### (2) Implementation schedule of technology transfer

Table 26 Technology transfer schedule for GI management and operation

Term	Target	Work Content
Jul to Dec. 2017	Initial survey for each category	Capacity assessment survey and future vision survey for 3 (Business planning, data utilization, human resource) categories
Jan. to Jun. 2018	Preparing documents based on current capacity and achievable goals	Clarify the capacity gaps, bottle necks, or operation issues from survey and breaking it down to documents
Jul. to Aug. 2018	2 <sup>nd</sup> survey and discussions based on documents	Follow up survey and discussions to refer the situation of daily production, core structure and technical teams
Sep. to Nov. 2018	Applying 2 <sup>nd</sup> survey results to documents	Final discussions to finalize the draft documents

### (3) 1<sup>st</sup> and 2<sup>nd</sup> survey result

The project team has confirmed the following issues in organizational structure and human resource.

#### 1) Organizational business structure

The transition of EGII budget in the last 6 years is described as follows. The table below shows the EGII budget from fiscal 2005 (2012 in the western calendar). According to this table, the budget had increased from fiscal 2005 to fiscal 2009, but the budget of fiscal 2010 is almost the same as that of the previous year. However, in actuality, 20 to 30% of the budget remains unexecuted every year. This is because EGII is unable to purchase equipment with foreign currency.

While it is not easy to increase the overall budget, it is important to develop a valid project plan and to continuously secure the budget necessary to implement the plan.

**Table 27 EGII Budget transition**

<b>Fiscal year (Upper: Ethiopian calendar, lower: western calendar)</b>	<b>Budget (ETB)</b>	<b>Expenditure (ETB)</b>	<b>Execution ratio (%)</b>
FY2005 (July 2012 – June 2013)	34,057,640.00	23,947,337.05	70.3
FY2006 (July 2013 – June 2014)	38,322,500.00	28,080,378.61	73.3
FY2007 (July 2014 – June 2015)	43,843,126.00	35,255,718.37	80.4
FY2008 (July 2015 – June 2016)	48,885,800.00	32,840,338.03	67.2
FY2009 (July 2016 – June 2017)	54,204,610.00	42,969,058.68	79.3
FY2010 (July 2017– June 2018)	54,182,680.00		

\*The fiscal year in Ethiopia is from July to June.

\*The ratio of budget execution is not 100%, because the Agency is unable to maintain or purchase the equipment for surveying and mapping equipment with foreign currency. The allocated budget for the maintenance and purchase of equipment was not executed.

Mid/Long term plans for organization operation does not exist in EGII to clarify its' GI related activity purpose or target to the nation or staffs. The plan document is necessary as a fundamental component for its' business plans and to spread the importance of GI as a national GI management organization.

Also there are no rules and regulations with legal enforcement to set the GI standards. This situation leads to the different GI data specifications between organizations.

## 2) Data management and utilization

EGII has created an internal IT policy. The internal data storage server is divided in directorate wise, which is not suitable (for project data management).

This existing unstructured data storage system is unsuitable for data management. Due to the concept of data management and data sharing, if staffs resign, nobody can identify the data location. The concept of data management is not only within the organization, but it can lead to a nationwide problem to create duplication of works.

When the geo-portal is an important essence for data utilization, EGII's geo-portal has few disclosed data and a limited operation time. This situation is not only because of the hard component (hardware, electricity, network), but also the lack of soft components such as policies and regulations related to GI data. Currently, the background, target, intention, frequency, category, responsibility are not clarified due to this lack. Creating a policy for the mentioned items and appropriate data creation / management in each organization, and to systemize survey work approval and data sharing is necessary.

## 3) Human resource

As shown in 1.3, table 4, the biggest problem of EGII is the high turnover of young staff members. There is a shortage of mid-level experts caused by the frequent turnover of staff members, which means that staff members often leave EGII to work for another government agency or else. Also, it is always urgently required to provide technical training to young experts.

Most staff members with less than three to five years of service leave the job every year. The most

common reason for resignation is the wages. Young staff members tend to have a strong wish to transfer to a private company or another government agency offering better wages. Turnover of staff members with two or three years of service results in a critical situation because technology cannot be carried over or developed even if newly recruited staff members are trained and as such, mid-level staff members cannot be developed. Fortunately, the project is being implemented thanks to the hard work of the current mid-level and veteran staff members, but the Project Team feels a sense of crisis, considering the future of the project.

The comparison between the salary scale of EGII and that of CSA has revealed that the salary of newly employed staff members of CSA is 1.8 times more than EGII, and the salary of directors of CSA is 2.8 times more than EGII, even though EGII and CSA belong to the same ministry (before reorganization). As this salary discrepancy existed before EGIA was reorganized into EGII, EGIA prepared a salary scale similar to that of CSA and submitted it to the supervising authority for approval. However, EGIA was reorganized into EGII before receiving a response to the submitted salary scale. While salaries of public servants generally increase every two years, those of staff members of EGII do not as the current salary scale of EGII is not designed to allow such an increase for its entire staff. Therefore, young staff members of EGII discontented with low salaries seek to find new jobs in other government agencies that offer higher salaries. The Project Team hopes for the approval of the new salary scale submitted by EGII by the supervising organization.

The transfer of many staff members of INSA to EGII due to the latest reorganization has provided a good opportunity for EGII to achieve the overall revision of its salary scale. The Project Team hopes that the new Director General of EGII will take this opportunity to solve the problem of low salaries.

In January 2017, the Ethiopian government announced the revision of the wage structure of government employees. It is expected that this revision will take place as soon as possible.

Turnover's direct influence is loss of institutional knowledge and skills. The project team took methods such as creating easy to use manuals and specifications, and implementing TOT training to prevent skill loss. And updating the IT policy with a data storage procedure document to prevent unstructured data storage, which makes data search very difficult and time taking, also not having clear carrier path is another issue.

There is an external training system existing in EGII to prevent turnovers. There were 32 staffs dispatched as university students in the past 10 years, but 22 staffs had resigned within 4 years. This account for about 68% out of total work force, thus this is relatively big figure. However, if these staff members were retained, they could have invigorated the Agency's work force.

In terms of human resource training, EGII has a training facility for staffs in and out of the organization with several courses including manuals. The contents of manuals, hardware and software need frequent updating. Continuing these training activities can make a huge impact on nationwide data production, utilization and promotion by enhancing the capacity of the data user organizations.



**(4) 1<sup>st</sup> and 2<sup>nd</sup> survey result**

The survey result and actions are sorted as follows.

**Table 28 Issues and Planned Activities**

Items	Issues	Planned Activities
Organizational project plans	<ul style="list-style-type: none"> <li>• Long term plan does not existing</li> <li>• GI production plans and budgeting are not stable</li> <li>• Rules and regulations for GI production are not existing</li> </ul>	<ul style="list-style-type: none"> <li>• Create a long-term plan and use as budgeting</li> <li>• Create GI policy for standardized GI production</li> </ul>
Data sharing & utilization promotion, reduction of work duplication	<ul style="list-style-type: none"> <li>• IT policy needs an update to suite the situation</li> <li>• Internal data management is inappropriate</li> <li>• Data sharing and utilization is not promoted in the country</li> <li>• There is duplication in survey / GI work within organizations</li> </ul>	<ul style="list-style-type: none"> <li>• Update the IT Policy with data storage optimization</li> <li>• Establish relationship with user/donor organizations from seminars and trainings</li> <li>• Revise the survey regulation to reduce survey work duplication</li> </ul>
Human resource	<ul style="list-style-type: none"> <li>• Turnover is a big issue</li> <li>• Carrier planning is not existing</li> <li>• Training facility should be improved</li> </ul>	<ul style="list-style-type: none"> <li>• Create a carrier path guideline</li> <li>• Inputs to optimize the training and facility</li> </ul>

**(5) Technology transfer results**

**Table 29 list of outputs and its contents**

Results	Organizational Operation	Human resource	Data utilization and sharing Reduce work duplication
<b>Formulation of a long-term plan</b>	For project prioritization, planning,, budgeting, cooperation and implementation	Strengthen the training center Bottom up the national GI related capacity to raise EGII's presence	Gov. Institute and private collaboration To promote data centralization by e.g. clearing house to reduce work duplication by refereeing to the basic survey results done by EGII
<b>Update of EGII Survey Regulation</b>	Collaboration among organizations for efficient project planning		Enhance and strengthen data sharing and utilization so that it can be realized by Government or local administration by submitting survey and mapping plans and results to EGII Reducing aerial photography, mapping or any kind of GI related work duplication by obeying to the updated survey regulation which mentions to submit any survey and mapping plan and result to EGII
<b>Updating of Survey Work Regulation</b>	Standardize, enhance accuracy and improve efficiency of GI production / updating with latest technology	Strengthen EGII's training skill in general survey works	Standardized data will lead to more easy data sharing and utilization
<b>Symbol Regulation</b>	Uniform definitions and acquisition standard to improve GI production / updating work		Uniformity of data standard will lead to more easy data sharing and utilization Uniform regulations will prevent work duplication in new production or updating work
<b>GI Policy</b>	Enhance nationwide GI production by clarifying its' background, standard, intention, target		Contribute to simplify data disclosure or sharing by clarifying fundamental GI data set specification To promote data centralization by e.g. clearing house Clarifying the data and its' custodian organization to reduce work duplication
<b>IT Policy</b>	Reviewing and updating the contents in order to enhance efficiency and sufficiency		Raise IT literacy, enhance and simplify data management / sharing mind
<b>Data storage procedure</b>	Appropriate data management will contribute to future project planning and data management		Appropriate data management with uniform standard to avoid work duplication or data loss

Results	Organizational Operation	Human resource	Data utilization and sharing Reduce work duplication
Carrier path guideline		To increase staff motivation, visualize their future carrier, and clarify the organization's business target. The employer will recognize the responsibility to manage the employee's life security. The employee will grow self-dependence to build its' carrier plan for the future with better human resource system	Job rotation will realize to understand other teams' work and to build better relationship Prevent data loss by centralizing data access.
Updating 3month training manual	Educating user organizations will lead to wide understanding of the necessity of GI	Strengthening in / out organizations to develop more capacitated human resource with latest digital technology	
GIS training	Contribute to suitable business planning and appropriate equipment and data management	Continuous TOT can contribute to wider human development, and sustain skill and technology to the organization even if turnover is existing	Enhance data sharing and relationship between agencies
GIS seminar			Opportunity to report and share agency activities with other agencies which leads to enhance data utilization and reduce duplication
International Conference	Recognize the importance of GI and production plans from activities in international conferences such like UNGGIM Africa	Activities in international conferences will make positive effect to recognize the importance of EGII	Recommending data utilization and sharing in international conferences will contribute to domestic methods

#### Data sharing with and promotion of data utilization by relevant agencies

##### 1) Data sharing

The cooperation between EGII and relevant agencies has been strengthened with the participation of the agencies in JCC and data sharing has been realized in the activities mentioned below. The understanding of the importance of the data sharing of the relevant agencies has been improved with the implementation of these activities.

- Satellite image which Central Statistical Agency (CSA) purchased for conducting the national census has been shared to EGII and will be utilized to update the existing 1/50,000 topographic maps and produce new 1/50,000 topographic maps.
- EGII is producing 1/10,000 topographic and tourist maps using the aerial photographs provided by the Ministries of Agriculture and Urban Development to perform contract work for them.

##### 2) Data utilization

The utilization of the GI data owned by EGII has been increasing gradually.

- The 1/50,000 topographic map data of EGII are being used for producing soil maps. They are also being used by the Geological Survey of Ethiopia as the base maps for producing geological maps and land use maps.

- If other government agencies have satellite images, aerial photographs or other data that can be utilized for producing basic maps, such data shall be fully utilized for the topographic map development. The actual use of such data is on the increase.

**(6) Document levels**

The necessary process for document approval is shown as follows.

**Table 30 Document range and effective range**

Document	Document level	Effective range
Long Term Plan (LTP)	Internal	Internal
EGII Survey Regulation	Regulation	National
Survey directive	Directive	Internal
GI Policy	Regulation	National
IT Policy	Internal	Internal
Data storage procedure	IT Policy attachment	Internal
Carrier path guideline	Internal	Internal
3 months training manual	Internal	Internal

\* Among the documents mentioned in the table above, the Survey Directive (draft) has already been utilized in the daily operation.

**Table 31 Approval process**

Document level	Approval process	Application duration	Progress
Proclamation	<ol style="list-style-type: none"> <li>1. To Planning Commission</li> <li>2. To council of Minister</li> <li>3. To house of people's Representatives</li> <li>4. To the president office for signature</li> </ol>	4 months	N/A
Regulation	<ol style="list-style-type: none"> <li>1. To Planning Commission</li> <li>2. To council of Minister</li> <li>3. To the prime minister office for signature</li> </ol>	3 months	Under evaluation in EGII technical committee
Directive	<ol style="list-style-type: none"> <li>1. Document preparation by assigned Committee</li> <li>2. To the Management committee of EGII for Approval</li> <li>3. To the DG of EGII office for signature</li> </ol>	2 months	
Manual	<ol style="list-style-type: none"> <li>1. Preparation by respective Directorate</li> <li>2. To the Technical Committee of EGII for approval</li> <li>3. To the Director of Quality and standard for signature</li> </ol>	1 month	

#### 4.6. Materials and Equipment Required for Operations of the Project

The materials and equipment required for operations of the Project are as follows.

All the materials and equipment listed in the table below have already been procured and used in the technology transfer.

**Table 32 List of Materials and Equipment**

<b>Name of Materials and Equipment</b>	<b>Specification/Roles</b>	<b>Quantities</b>	<b>Procured by</b>
Software for plotting and editing (for creating of DEM)	Function enhancement of equipment procured at previous phases	2 sets	Project Team
Software for plotting and editing (for editing of DEM)	Function enhancement of equipment procured at previous phases	2 sets	Ditto
Digital level	For conducting the first order leveling	2 units	Ditto
Digital Leveling analysis equipment	Result analysis for 1 <sup>st</sup> order leveling	1 set	Ditto
Lithium ion battery	Electronic power sources for digital level which are required during the field work over a long period of time	4 pieces	Ditto
Single charger	Battery chargers for lithium ion battery which are required during the field work over a long period of time	2 pieces	Ditto
USB memory sticks	For transferring the data from digital level to PC for the analysis of the data	2 pieces	Ditto
Precision invar leveling staff with bar code	3m 1 set: 2 units of staffs, 1 box for storage	2 sets	Ditto
Accurate wooden tripod	Tripod for equipment installation for leveling	2 units	Ditto
Board for leveling staff	1 unit is needed for one leveling staff	4 units	Project Team
Support stand for leveling staff	1 set: 1 unit 1.7m long, 1 unit 1.6m long, 2 units of shoe	4 sets	Ditto
Notebook PC for data analysis	For analyzing the results of leveling	1 unit	Ditto
Sunshade for survey	The protection of digital levels from direct sunlight	2 units	Ditto
Thermometer	For temperature correction of observation results	2 pieces	Ditto

## Chapter 5. Structure for Implementing the Project

### 5.1. Roles and Responsibilities of the Project Team Members

The following are the details of the roles and responsibilities allocated to each member of the Project Team.

**Table 33 Details of Roles and Responsibilities Allocated to Each Team Member**

Name	Responsible for	Details of Role
Akira Suzuki	Project Manager/Support for organization structure 1	【1】 Collection, organization and analysis of the related documents and information.
		【2】 Preparation of Inception Report.
		【3】 Explanation about the inception report and consultation with EGII
		【4】 Activities pertaining to technology transfer
		【5】 Preparation of Progress Report 1
		【6】 Explanation and Consultations with EGII of the content of Progress Report 1
		【7】 Preparation of Progress Report 2
		【8】 Explanation and Consultations with EGII of the content of Progress Report 2
		【9】 Preparation of Draft Final Report and Consultations with EGII of the content of Draft Final Report
		【10】 Preparation of Final Report
Akira Ota	Deputy Project Manager/Photogrammetry	【2】 Preparation of Inception Report.
		【3】 Explanation about the inception report and consultation with EGII
		【4】 Activities pertaining to technology transfer
		【5】 Preparation of Progress Report 1
		【6】 Explanation and Consultations with EGII of the content of Progress Report 1
		【7】 Preparation of Progress Report 2
		【8】 Explanation and Consultations with EGII of the content of Progress Report 2
		【9】 Preparation of Draft Final Report and Consultations with EGII of the content of Draft Final Report
		【10】 Preparation of Final Report
		Keiji Yamada
【6】 Explanation and Consultations with EGII of the content of Progress Report 1		
【8】 Explanation and Consultations with EGII of the content of Progress Report 2		
【9】 Preparation of Draft Final Report and Consultations with EGII of the content of Draft Final Report		
【10】 Preparation of Final Report		
Wentao Che	GIS	【4】 Activities pertaining to technology transfer
		【6】 Explanation and Consultations with EGII of the content of Progress Report 1
		【8】 Explanation and Consultations with EGII of the content of Progress Report 2
		【9】 Preparation of Draft Final Report and Consultations with EGII of the content of Draft Final Report
		【10】 Preparation of Final Report
Masakuni Nakayama	Leveling	【4】 Activities pertaining to technology transfer
		【9】 Preparation of Draft Final Report and Consultations with EGII of the content of Draft Final Report
James Kazumori Watson	Support for the Organization Structure 2/Coordination of operations	【1】 Collection, organization and analysis of the related documents and information
		【2】 Preparation of Inception Report.
		【3】 Explanation about the inception report and consultation with EGII
		【4】 Activities pertaining to technology transfer
		【5】 Preparation of Progress Report 1
		【6】 Explanation and Consultations with EGII of the content of Progress Report 1
		【7】 Preparation of Progress Report 2
		【8】 Explanation and Consultations with EGII of the content of Progress Report 2
		【9】 Preparation of Draft Final Report and Consultations with EGII of the content of Draft Final Report
		【10】 Preparation of Final Report

## 5.2. Structure for Implementing the Project

The structure of the Project Team for implementing the project shall be shown in the following.

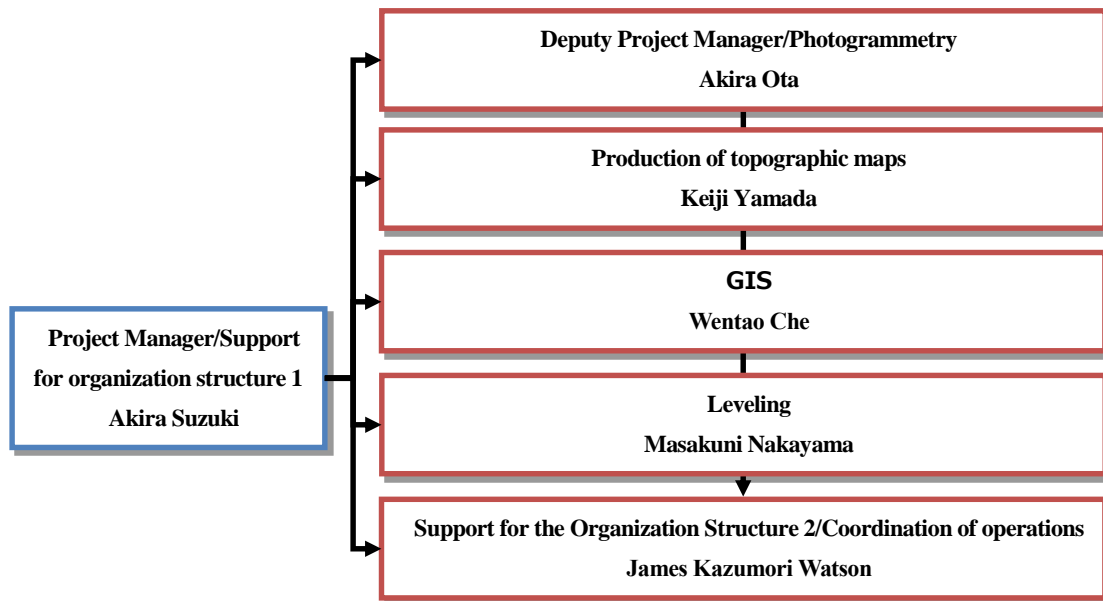


Figure 15 Project Implementation Structure

## 5.3. Staffing Schedule

The Staffing Schedule for the implementation of the Project shall be as follows.

Table 34 The staffing schedule

ROLE	NAME	AFFILIATE	Grade	2017												2018												TOTAL	
				2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	ETH	JPN	
WORK IN ETHIOPIA	Project Manager / Organization Structure support1	Akira SUZUKI	PASCO Corp.	2	■	■		■			■	■								■	■	■			4.00				
	Deputy Project Manager / Photogrammetry	Akira OTA	PASCO Corp.	3			■	■			■	■	■		■	■		■					■	■	4.00				
	Topographic map production	Kohel ISOBE	Kokusai Kogyo Co., Ltd.	3				■	■			■	■					■	■	■	■			4.00					
	GIS	Wentao CHE	Kokusai Kogyo Co., Ltd.	3				■	■			■	■	■		■				■	■			4.00					
	Leveling	Masakuni NAKAYAMA	PASCO Corp.	3				■	■			■	■		■	■		■						4.00					
	Organization Structure support2 / Coordinator	James K. WATSON	PASCO Corp.	5								■	■							■	■		■	■	2.00				
				Total work in Ethiopia																								<b>22.00</b>	
WORK IN JAPAN	Project Manager / Organization Structure support1	Akira SUZUKI	PASCO Corp.	2	□					□												□	□	0.50					
					Total work in Japan																								<b>0.50</b>
Reporting				△					△										△				△	△					
				ICR					PGR1										PGR2				DFR	FR					
				Total work																								<b>22.50</b>	

LEGEND  Work in Ethiopia  
 Work in Japan