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

December 2018

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

PASCO CORPORATION

KOKUSAI KOGYO CO., Ltd.

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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> • Develop the standard operation specifications for digital topographic maps. • Technology transfer relating to digital topographic mapping. • Technology transfer relating to promotion of utilization of digital topographic maps data.	＜Problems to be tackled by EMA＞ • 85% of medium scale topographic maps covering the whole country are analog maps and are in the process of being digitally converted. • The operation specifications and the standards for quality control have not been developed yet. • EGII has not been able to produce and provide accurate and reliable digital topographic maps which reflect the latest data.
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^2 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 3rd 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.

Scope of Work																			
Phase	Pase 1										Phase2		Phase3							
Fiscal Year	2013	2014				2015				2016			2017				2018			
Month	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	2-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12
Work in Ethiopia																				
Work in Japan																				
Reporting	IC/R1	PG/R1 IC/R2					IT/R		PG/R2			DF/R FR	IC/R		PG/R1			PG/R2		DF/R FR
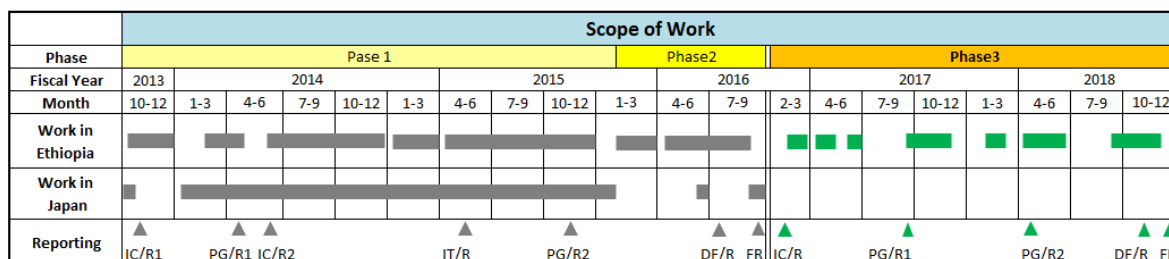
Figure 1　　　Schedule and the Design of the Project

(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.
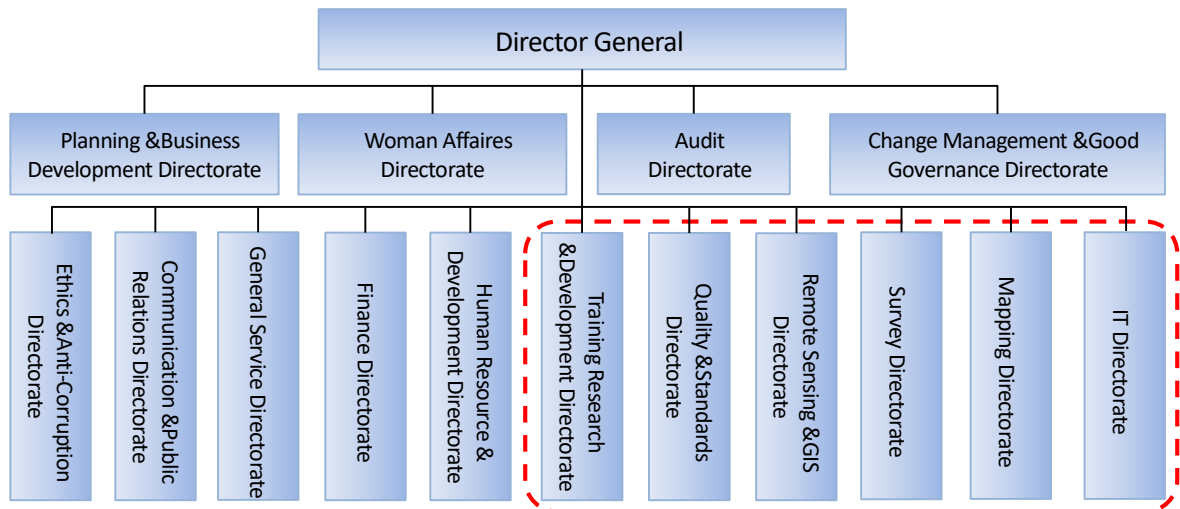
Figure 2   Organization chart

(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)
Mapping Directorate (MD hereafter)	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)
Surveying Directorate (SD hereafter)	Large Scale Survey Geodetic Survey Engineering and Survey Computation	Geodetic surveying Control points survey CORS management	30	12 (1 retired, 5left)	22 (2 from phase 1, 2) (3 left)
Remote Sensing and GIS Directorate (GIS hereafter)	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)
Quality and Standards Directorate (QC hereafter)	Quality Control Quality Assurance	Quality Control Quality Assurance	5	4 (1 retire)	3 (3 from phase 1, 2)
IT Directorate (IT hereafter)	Information administration and Distribution System Administrator	Database management System management	8	3 (1 left)	3 (1from 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
Total		**15**	**34**	**69**	**72**	**68**	**68**	**63**
New recruits (persons)		38	35	67	56	58	136	5
Total number of EGII staff members (persons)		380	357	356	358	374	384	316
Staff members sent to graduate school (persons)		32						
Staff members who resigned after finishing graduate school (persons)		20						
Staff members who continue to work for EGII after finishing graduate school (persons)		12						
Note 1: The fiscal year in Ethiopia is from July to June of the following year.								
Note 2: The reason for the low turnover between July 2016 and June 2017 is that the government announced the revision of the wage structure of government employees in January 2017, which led the staff members to expect an increase in their wages, making them less eager to leave the job.								
Note 3: EGII has a program to send staff members to graduate school for career development. In the last 10 years, 32 staff members were sent to graduate school under this program and 20 of them have resigned. Those who go to graduate school for two years are obliged to work for EGII for at least four years after graduation. If they resign before the end of this period, they have to pay back the wages they received from EGII during the two years.								

The project team has overviewed that the work method is an individual system, which leads to insufficient inheritance in work, data and knowhow. Therefore, the project team has set principles to decrease this negative impact (refer to 4-5. (3) 3)).

(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   EGII's present Situation (equipment and technology, etc.) and phase 3 targets

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
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 o 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 un sufficient
	Organizational activities		Overall	Regular participation to international GI conference	EGII'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 sufficient 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	EGII is not capable of starting pilot for the development of the national leveling network that will be needed in the long term

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 1st 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	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
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 $100km^2$/month	1 trainer to be trained. 3 new operators with $80km^2$/month productivity to be trained. 3 experienced experts with $400km^2$/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 EGII.
		Progress Report 1	5 copies in Japanese (Summary) 15 copies in English	September 2017 10 copies in English to be submitted to EGII.
		Progress Report 2	5 copies in Japanese (Summary) 15 copies in English	April 2018 10 copies in English to be submitted to EGII.
		Draft Final Report		November 2018
		Main Report	15 copies in English	10 copies in English to be submitted to EGII.
		Summary	15 copies in English	10 copies in English to be submitted to EGII.
		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 EGII.
		Summary	15 copies in English 10 copies in Japanese	10 copies in English to be submitted to EGII.
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 EGII 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 1st order leveling operation	4.0MM	
	Coordinator/ Organization structure supoprt2	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	1st 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 1st 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 3rd phase and its target

Category	EGII's technical level at the beginning of Phase 3	Target	Activities	Achievements
Photogrammetry	3 experts with productivity of 100km2/month	· Capable of "work planning", "progress management", "work efficiency" and "accuracy control" at practical level. · The existing training is general entry level target for newly hired employees, and not enough trainees	· Provide practical OJT based technology transfer.	Fostered 3 experts capable of DEM editing at 400km2/month plus 3 experts capable of DEM editing 80km2/month.
Mapping	EGII had 4 experts having productivity of 1.5 month / sheet	· Foster trainers who will train beginner experts. · Acquire techniques for scales other than 1/10,000 and 1/25,000. · Data uniform (ArcGIS) · The existing training is general entry level target for newly hired employees, and not enough trainees	· TOT training · Support on technology transfer from EGII trainer to EGII new trainees (expansion of target scales and data generalization). · Support on organized training course by EGII. · Develop symbol regulations for other scales. · Update work regulations. · Improve method for accuracy control.	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	· EGII needs to foster trainers · EGII needs to expand GIS users and to provide technical support for them. · The existing training is general entry level target for newly hired employees, and not enough trainees	· Train EGII experts to be a trainer. · Assist the new trainers in organizing a workshop.	Fostered 4 trainers
1st order leveling	None	· Monitor and advise for 1st order leveling implementation · Grow human resource for pilot project implementation	· Provide technology transfer for "theory and observation techniques", "survey planning" and "accuracy control".	Fostered 4 experts capable of providing technical guidance for 1st 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.	· Enhance capability of management and operation of geospatial information	· Make a plan for topographic map development. · Make rules, schemes and guidelines for "enhancement and promotion of data sharing", "de-duplication of survey work" and "securing human resources and retention".	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,

1) Target achievement status: overall technical aspect

As described in 1.3. (5), EGII had few staff capable of providing practical trainings while receiving requests of trainings from other governmental agencies. As EGII has had permanent license of GIS software, the Project Team held the workshop, prepared materials, carried out trainer trainings and provided technical support for "practical/ advanced training" of the GIS course (refer to 4.3). Two trainers from Training Research &Development Directorate and Mapping Directorate (two from each directorate) were selected base on a discussion among the Project Team and managers of these directorates.

Contents of photogrammetry are created and updated from analog aerial photo based to digital aerial photo and satellite image based (refer to 4.1).

2) Target achievement status: Photogrammetry

The target has been achieved. Technology transfer for daily operation were made in work planning before implementation, visualizing and sharing progress with milestone, issue sharing, and quality standardization, in 3 categories which are Aerial triangulation, DEM generation/editing and ortho image production, which lead to enhancing work efficiency (Detail shown in 4.1).

3) Target achievement status: Mapping

1 trainer and 3 new operators with 1sheet/1month productivity have been trained. The trainees acquired skills for preparation of print-ready files of 1/10,000 scale topographic maps and techniques for map symbolization for 1/10,000 scale as well as other scales using ArcGIS, through the training named "map symbolization". Three trainees who had had 2-3 years' work experience in EGII mastered practical level stereo plotting. Moreover, the trainees acquired knowledge and techniques for accuracy control and quality evaluation where related manuals were completed. The trainees also learned generalization techniques using both by hand (conventional methods) and by automatic processing using ArcGIS through the training named "digital editing and generalization" (Detail shown in 4.2).

4) Target achievement status: GIS

EGII invited experts from the user organizations and held GIS workshops twice during this Phase. The trainers who had been trained through this Project played a major role and operated those workshops without any problems (Detail shown in 4.3). Participants' understanding level in the workshop has increased by approximately 80% (according to the questionnaire 4-3. (6) table 33). EGII now is capable of organizing future workshops by itself without any problems.

5) Target achievement status: 1st order leveling

22 experts attended the 1st order leveling training of theory, basic techniques, work planning, to accuracy control according to the work regulation which was created in the previous phase. 4 members has achieved the trainer level, other 4 as work manager level, total 8 members are evaluated as 1st order leveling experts. The project team has confirmed that the experts can observe 1.5km/day in the evaluation test (Detail 4.4).

6) Target achievement status: Organization structure support
- As for "development of topographic development plan", EGII's business can be clearer based on its future outlook and continuous by developing "EGII's long-term plan (draft)"

instead of "topographic development plan".

- As for "enhancement and promotion of data sharing", the Project Team together with EGII made "EGII's long-term plan (draft)" and "GI Policy (draft)" which describe directions regarding enhancement of relationship among government and cooperation of industry, government and academic bodies, to promotion of publicity, share, distribution and utilization of data.

- As for "deduplication of photography, survey and topographic map production work", the Project Team together with EGII added such statements as "an agency having a plan to produce GI shall submit the plan to EGII and have an approval before starting the work. And the agency shall submit survey results to EGII" in the Survey Regulation. Therefor when this document is approved, data submission and sharing will be a legal enforcement. Moreover, the Project Team together with EGII developed "data management manual (draft) within EGII" which will contribute to solve duplication under proper management.

- As for "secure human resources", the Project Team together with EGII established a carrier path guideline. Since turnover is caused by wage differential, both EGII and this Project cannot do anything to this directly. Staff quit their job because of anxiety about the future and little loyalty. Based on this, this carrier path guideline was made taking into account improvement of staff's motivation and visualization of future possibilities, and make improvements in organization operation with the long-term plan. Moreover, the technology transfer method and the IT Policy (draft) deal with issues of technological outflow and data loss caused by turnover.

Based on the series of activities and discussions regarding the items mentioned above, EGII became capable of developing plans etc. by themselves (refer to 4.5 for more detail).

(4) EGII's GI production status

<u>Phase target: To evaluate current technical capacity of EMA and provide necessary support.</u>

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
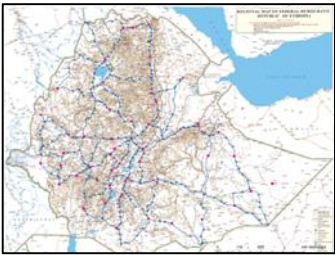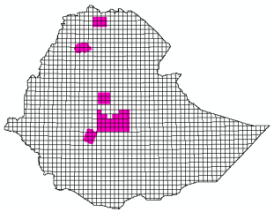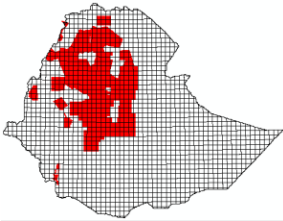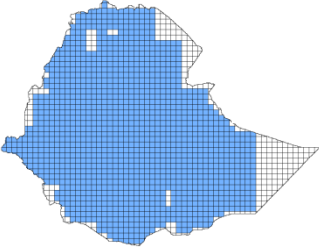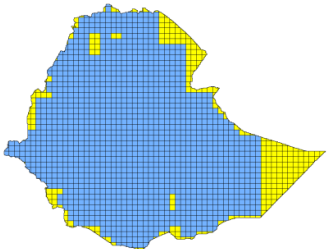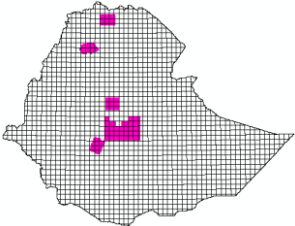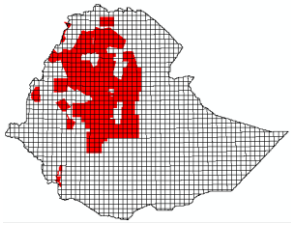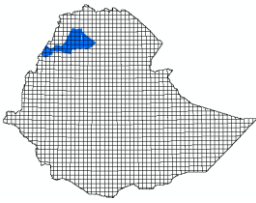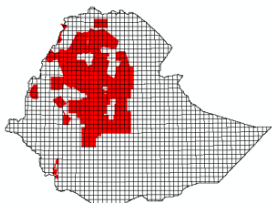
Category		Equipment	Before Phase 3	Experts	Result (productivity)
1st order leveling		Level 2 sets	As shown in Table 6	Approx. 15	80km/MM (8 experts)
Aerial triangulation			Ditto		
DEM creating/editing		Photogrammetry equipment 7 sets	Ditto	8	400km^2/MM (3 experts) 80km^2/MM (3 experts)
Ortho image creation		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	5km2/MM
	1/10,000		As shown in Table 6	3	20km2/MM
	1/25,000		Ditto	3	100km2/MM
	1/50,000		Out of scope at the beginning	3	500km2/MM
Topographic map creation (Contour line)	1/5,000	Photogrammetry equipment 7 sets	Ditto	7	.20km2/MM
	1/10,000		As shown in Table 6	8	400km^2/MM (3 experts) 80km^2/MM (4 experts)
	1/25,000		Ditto	Approx. 1	1,500 km2/MM
	1/50,000		Out of scope at the beginning	Approx. 1	3,000 km2/MM
Contour line update, digital conversion, auto-generation from DTM		ArcGIS 50 sets (Approx.)	Ditto	Approx. 1	1,140km2/MM

(5) EGII's GI production works

<u>Phase target: To evaluate current technical capacity of EMA and provide necessary support.</u>

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 were 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 the nation size is three times larger than Japan.

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(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 1st 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 2nd 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.

In the case of DEM creation, the technology transfer made productivity increase from 100km2/Man-Month at the beginning of Phase 3 to 240km2/Man-Month at the end of Phase 3, improved quality and contributed to cost reduction.

In addition, this Project enhanced the trainers and updated and improved the contents of EGII's regular trainings.

(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 CORSs, 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.
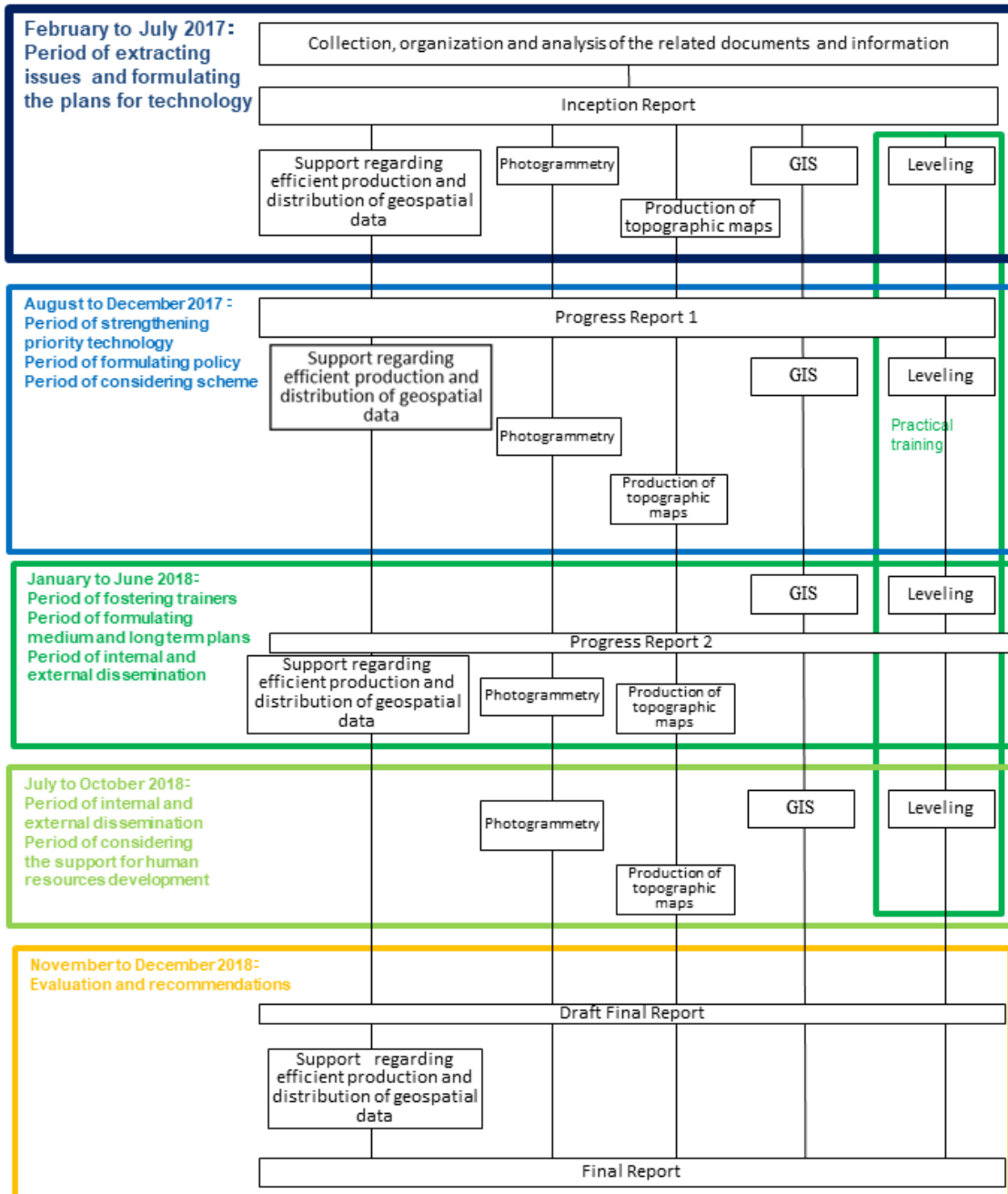
### 3.2.	Project Activity Implementation Details

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

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**[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
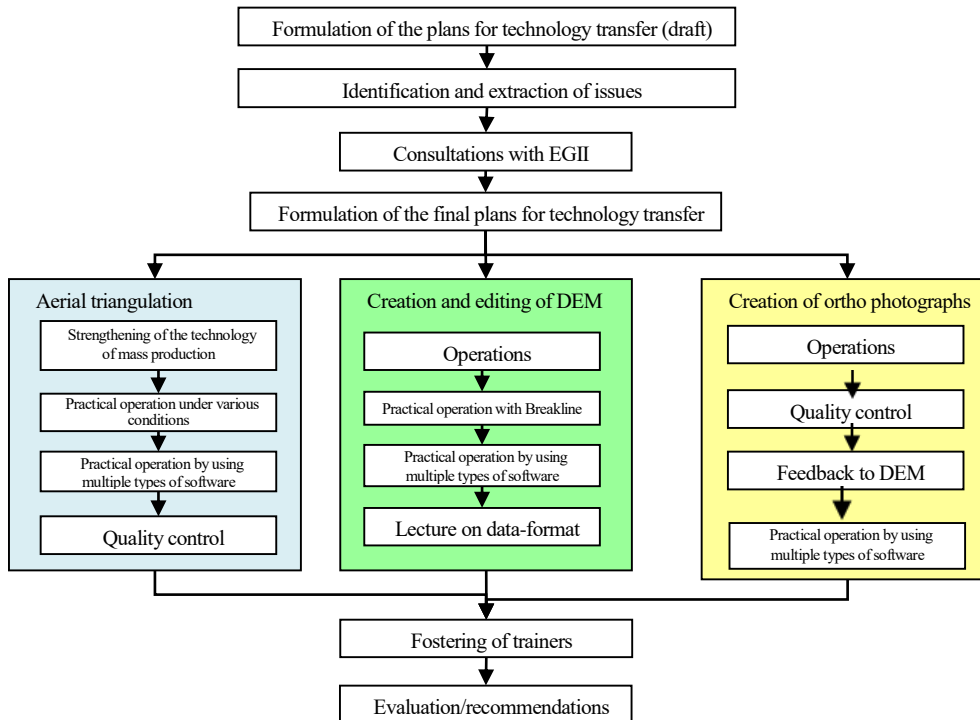
Figure 3   Work Flow of Technology Transfer for Photogrammetry

(2) Implementation schedule of technology transfer

Table 12　　Technology transfer schedule

Period	Overall		Aerial Triangulation	Creation/Editing of DEM	Creation of Ortho Photography
			Details		
August to December 2017	Period for strengthening technology with overriding priority	Operations optimization	The format of "the Result of Control Points Survey" (control point description) shall be created. The efficiency for observation of control points shall be promoted. Parameters for automatic observation of tie points shall be set depending on topography and images. The strengthening the technology for mass production will be made including the improvement of the efficiency of the adjustment calculation in which different software are combined.	The efficiency in the processing capacity of PC and software as well as the division of operation area and allocation of operators depending on conditions shall be promoted. The Project Team will implement the technology transfer that enables efficient acquisition of Break line so that DEM with incorrect values or complex shapes can be represented. The Project Team will support the effort for understanding of the effective Data Format regarding the data processing conducted among different software.	The Project Team will support the effort for understanding the ways for acquiring appropriate mosaic line. The Project Team will transfer the applied technology regarding the removal of clouds and haze. The efficiency for cutting out per map sheet shall be promoted. The Project Team will eliminate the possibility that there may arise bottlenecks in operations when different software is combined.
		Quality control	The efficiency of error detection and correction by combining different software shall be promoted, and the ability for troubleshooting will be strengthened.	The Project Team will support the effort for the ways to accurately identify error points in DEM and correct them efficiently, through the inspection of ortho.	The Project Team will support building the system where the feedback from the inspection of ortho photographs will help updating DEM.
January to June 2018	Period for fostering trainers		The Project Team will implement training for EGII staff who already participated in technology transfer so that their skill can reach the level that they can give lectures for the EGII staff who do not have any experience of participating in technology transfer.		
July to October 2018	Period for internal and external dissemination		The Project Team will support the effort of experienced experts for providing technical training for the experts at elementary level.		
November 2018	Evaluation/recommendations		The Project Team will evaluate the results of the technology transfer, and make recommendations for the long-term development of national geospatial information.		

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(3)   Status of technology transfer implementation

Technology transfer implementation status as follows.

Table 13   Implemented Technology transfer for photogrammetry

	Period	Theme	Works
1st training	Week 1 (9-14 May)	Equipment Management	Inspection of equipment operating conditions, License installation Study on DEM editing work and interviews with the operators
	Week 2 (15-21 May)	Work efficiency (status identification)	Preparation for DEM cut out by map sheet (Finding a solution to the issue of being unable to link an output file name and a map sheet number in the operation for cutting out by map sheet using INPHO Software); DEM cut out by map sheet training, Index creation training (of map sheets, principal points of photographs and progress sharing); Training on DEM editing by map sheet (review of the conventional method)
	Week 3 (22- 28 May)	Work efficiency (status identification)	DEM editing by map sheet (study of an appropriate method based on a comparison from reviewing the conventional method) training, Discussion with Director Ayele on the strategy; Study and recommendation of a practical DEM editing method (preparation of Work Instructions)
	Week 4 (29 May - 4 June)	Work efficiency (recommendation, demonstration)	Preparation for the demonstration of the DEM editing method recommended by the Project Team; Demonstration of the DEM editing method recommended by the Project Team; Technology transfer for schedule control (schedule control and setting levels of difficulty of work using Microsoft Excel, setting man-hours, reconfirmation of work schedules, etc.); Quantitative evaluation of performance improvements, setting new targets; Sorting issues and creation of shared understanding of issues to be solved
2nd 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
3rd training	Week 1 (12-18 Feb.)	Preparation	Preparation for technology transfer Updating of equipment and validation of operation Consultation regarding technology transfer plan
	Week 2 (19-25 Feb.)	Trainer training, ToT training	Aerial triangulation theory (Work flow, input data, parameters, adjustment calculations and margin of error)
			Practice in aerial triangulation (Working from the manual, adjustment calculations)
	Week 3 (26 Feb. - 4 Mar.)	Trainer training, ToT training	Practice in aerial triangulation (Automatic processing work, operation and comparison of multiple software programs, accuracy control in aerial triangulation)
			DEM and ortho theory (Work flow, relationship between DEM and ortho images, parameters, distinctive features of DEM（DTM/DSM）and ortho images)
	Week 4 (5 - 12 Mar.)	Trainer training, ToT training	Basic practice in DEM (DEM creation)
			Practice in ortho (Production of ortho images, production of ortho mosaic images)
			Applied practice in DEM (DEM editing, accuracy control in DEM and ortho images)
4th training	Week 1 (16-20 May)	Preparation	Preparation for technology transfer Consultation regarding technology transfer plan
	Week 2 (21-25 May)	Trainer training, ToT training	Photogrammetry work planning training, Ortho image production training (mosaic, image editing, cut line, embedment), DEM editing OJT, EGII internal training support
	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

(4)   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.

Table 14   Technology transfer participants

Train er	Task		
	Enhance Productivity	**Fostering of trainers, training of experts**	**Quality control**
	JICA Project Team	**Ms. Senait Seyoun Ms. Beza Haile**	**JICA Project Team**
1	Yewbdar Fikre Silassie	Aklilu Assefa Hake	Yewbdar Fikre Silassie
2	Beza Haile	Natnael Ketema Tadasse	Beza Haile
3	Senait Seyoun	Dawit Desalegn Tola	Senait Seyoun
4	Tsedale Mehari		Beltech Zewde (QS)
5			Balainesh Begashaw (QS)
6			Tegene Wedajeneh (QS)

(5)   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.

Table 15   Technology transfer result (AT)

operator	Accuracy control operation	Operation level			
		Trainer	**Operator**	**Assistant Operator**	**Basic**
1	✓	✓			
2	✓	✓			
3	✓		✓		
4				✓	
5	✓			✓	
6	✓				✓
7	✓				✓
8					✓
9					✓

Note: "Operator Operation Level": A person at this level can produce marketable products.

"Assistant Operator Operation Level": A person at this level can produce marketable products with assistance of an expert at the level of "Operator Operation Level." A person at this level requires repeated practice of AT to attain "Operator Operation Level."

"Basic Operation Level": A person at this level needs to improve the productivity of the work and quality of the output in OJT to attain "Assistant Operator Operation Level" and "Operator Operation Level" in future.

2) DEM generation and editing

JICA expert has supported the ongoing internal contract project through the 1st to 3rd technology transfer.

EGII is at the present time engaged in the execution of an order for a large-scale (4 blocks of 4,500 km² 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 16   Technology transfer detail of DEM generation & editing

Original setup	Issues	Content of proposals and technology transfer implemented	Results
・One operator was in charge of working and managing one block. ・One block is one work unit. ・The work period was long (several years). ・4 operators were maximum assigned due to limit in equipment. ・Subsequent work begins only after the whole work set is completed.	・Equipment are outnumbering the operators. ・There is little/no awareness of tracking progress over the short term (per day, per week, per month). ・The lack of milestones makes it difficult to set targets. ・The large amount of data causes software freezes and lengthens processing times. ・There are fluctuations in quality within the same block and between blocks.	・Split one block into 1/10,000-scale sheets (approx. 250 sheets per block). ・Before starting work print out the relevant data so that those involved can confirm the content and points to be rectified. ・Draw up a progress chart (per day) and a progress index.	・Daily targets were made clear. ・It became possible to draw up a concrete work plan. ・The ability to have an appropriate level of quality throughout the job has reduced excess work. ・Quality control can be implemented in parallel and with shared responsibility. ・Appropriately-timed feedback on quality control is possible.

Example of Dividing a Sheet	Work progress control (daily) with the progress sheet
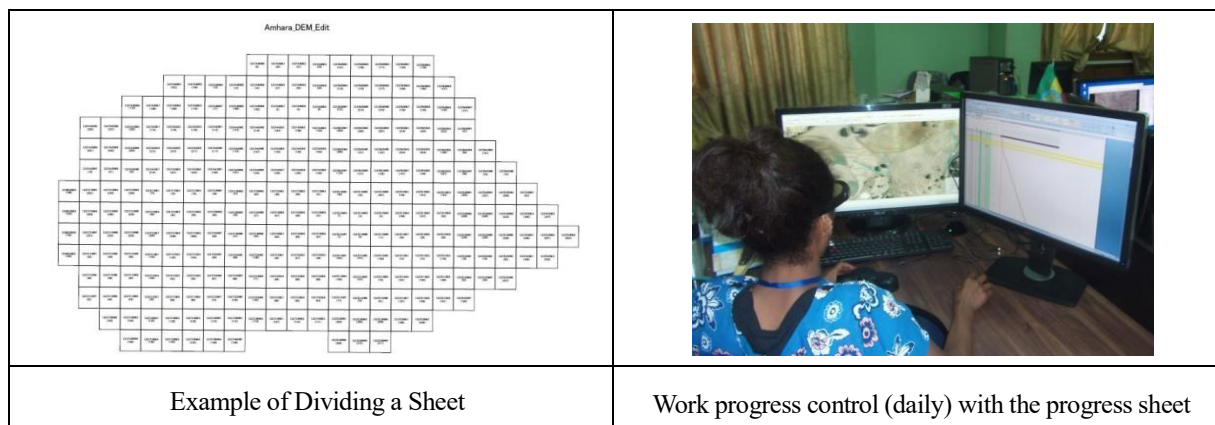
Figure 4   Work Progress Control

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.
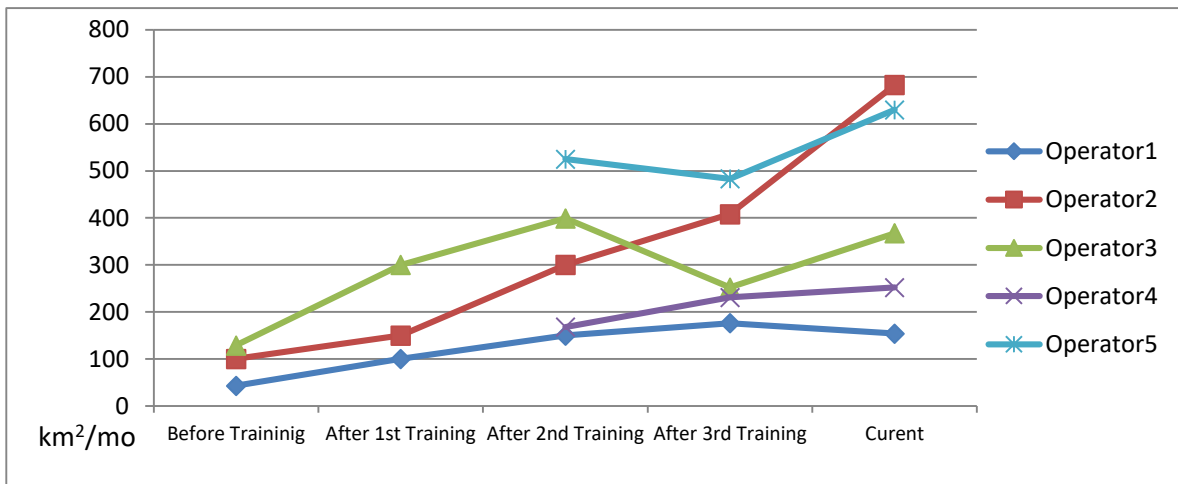
Figure 5   Productivity Transition

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 400km2/month, 3 with 80km2/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.

Table 17   Technology transfer result (DEM generation & editing)

operator	Accuracy control operation	Operation level		Productivity (km2/MM)	
		Trainer	Operator	Value	Achievement
1	✓	✓		154	> 80
2	✓	✓		683	> 400
3	✓		✓	368	> appx. 400
4	✓		✓	252	> 80
5	✓		✓	630	> 400
6				48	
7				80	> 80
8				64	

    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 28,000km2 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

Table 18   Technology transfer result (ortho production)

operator	Accuracy control operation	Operation level		
		Trainer	Operator	Assistant Operator
1	✓	✓	✓	
2	✓	✓	✓	
3	✓		✓	
4	✓			✓
5	✓			✓
6	✓			✓
7	✓			✓

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.

Photogrammetry theory	Stereo observation
Comparing multiple photogrammetry software programs (INPHO)	Comparing multiple photogrammetry software programs (ORIMA)
Updating of DEM	Quality control (QC)

Figure 6   Scenes from the technology transfer

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.
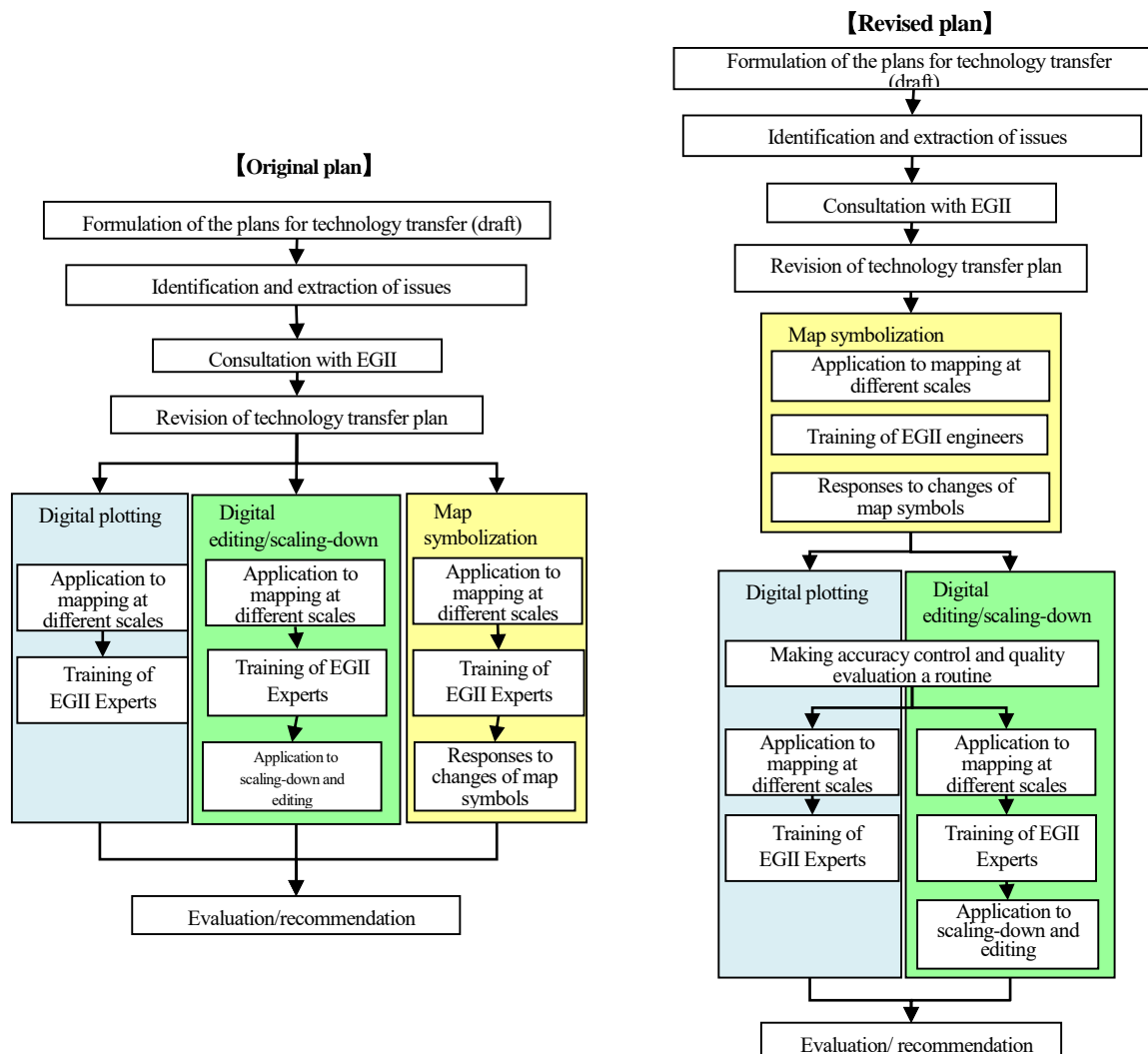
Figure 7   Flowchart for technology transfer of topographic map production

(2)   Implementation schedule of technology transfer

Table 19   Technology Transfer schedule for Topographic Mapping

Period	Details			
	Overall	**Digital Plotting**	**Digital Editing Generalization**	**Map Symbolization**
From June 2017	Consultations and review on the plans for technology transfer Support for upgrading of skills in digital plotting Support for upgrading of skills in digital plotting Study on the current practice of accuracy control and quality evaluation and inclusion of them in the subjects of the technology transfer	・The Project Team will consult with EGII on the plans for the technology transfer for digital plotting and reach an agreement with EGII	・The Project Team will consult with EGII on the plans for the technology transfer for digital editing and reach an agreement with EGII.	・The Project Team will consult with EGII on the plans for the technology transfer for map symbolization and reach an agreement with EGII. ・The Project Team will implement the technology transfer for the production of 1:5,000 map symbol catalogs.
From December 2017	Technology transfer on accuracy control and quality evaluation Assistance for the improvement of the technical capacity for map symbolization	・Technology transfer on accuracy control and quality evaluation in digital plotting	・Technology transfer on accuracy control and quality evaluation in digital editing	・The Project Team will implement the technology transfer for the production of 1:5,000 map symbol catalogs. ・The Project Team will transfer the technology (at the level of training-of-trainers) to an experienced EGII expert while implementing 1/5,000 mapping of Addis Ababa. ・The team will support the experienced expert in the provision of technical training to inexperienced experts for 1/10,000 mapping of an unmapped area of EGII.
From June 2018	Monitoring of technical training for map symbolization, digital plotting and digital editing in EGII	・The Project Team will transfer the technology (at the level of training-of-trainers) to an experienced EGII expert while implementing 1/5,000 mapping of Addis Ababa. ・The team will support the experienced expert in the provision of technical training to inexperienced experts for 1/10,000 mapping. ・Monitoring will be conducted on the status of technical training on digital plotting.	・The Project Team will transfer the technology (at the level of training-of-trainers) to an experienced EGII expert while implementing 1/5,000 mapping of Addis Ababa. ・The team will support the experienced expert in the provision of technical training to inexperienced experts for 1/10,000 mapping. ・Monitoring will be conducted on the status of technical training on digital editing.	・The Project Team will monitor the progress of the technical training for map symbolization.

Period	Details			
	Overall	Digital Plotting	Digital Editing Generalization	Map Symbolization
From September 2018	Conversion of the existing format of symbols into other format, preparation, evaluation, and recommendations of symbol catalogs	・ The Project Team will implement the technology transfer for the preparation of the symbol catalogs for the scales of 1:50,000. ・ The Project Team will implement the technology transfer for the generalization from the scales of 1:10,000 and 1:25,000 to the scale of 1:50,000. Since the topographic maps with scale of 1:50,000 have been developed in the format of ArcGIS, this generalization shall be conducted by using ArcGIS. ・ The Project Team will implement the technology transfer for converting the symbol catalogs for the scales of 1:10,000 and 1: 25,000 produced in MicroStation format into the symbol catalogs produced in ArcGIS format. The Project Team will conduct evaluation and make recommendations on "the mastery of the technology corresponding to the needs for mapping at different scales", "the effort of the experienced experts in EGII for fostering the experts at elementary level" and "the skills for scaling-down and editing corresponding to the needs of different scales", "the conversion of the format of symbols into other format".		

(3)   Status of implementation of technology transfer

Table 20   Implemented Technology Transfer for Topographic Mapping

	Period	Theme	Works
1st training	Week 1 (19th – 23rd June)	Discussion on technology transfer planning	General meeting with the Director and team leaders to elucidate the state of planning the technology transfer 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	Interview with the Q/C Section of the Orthophoto Team and inspection of their work and work place Interview with the Photogrammetry Team and inspection of their work and work place Confirmation that Q/C was not implemented systematically in EGII and that only memos and oral instructions were used 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 Introduction of a sophisticated map refining and representation method Preparation of training materials for the technology transfer on Q/C, quality evaluation and preparation of product specifications Preparation of the accuracy control sheet
	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 two Q/C methods, accuracy control (control of a manufacturing process by a manufacturer) and quality evaluation (evaluation of the final products by a third party independent of production method) Explanation of the outline of the preparation of data product specifications essential for conducting the quality evaluation Explanation of the outline of the process of introducing accuracy control in the practical Q/C Confirmation of the tasks to be tackled (by C/Ps and experts, respectively) in the next dispatch of the Project Team to Ethiopia

	Period	Theme	Works
2nd training	Week 1 (20th – 25th November)	Preparation, interviews, etc.	Briefing with EGII (Schedule & content) Training in digital plotting (for the inexperienced): questionnaire, basic theory, stereo training Preparation for conversion of map symbols from CAD to GIS Interview with experts working on 1/50,000 digitization
	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 Updating of materials relating to quality control 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	Practice in map symbolization and discussion on the specifications of 1/50,000-scale topographic map Conversion of map symbols from CAD to GIS Lectures on quality control of topographic maps Training in digital plotting (Experienced experts → the inexperienced): Basic exercises (Training in the basics of feature drawing)
	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^2)
3rd 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 Confirming existing issues and methods to solve
	Week 3 (7/23-7/27)	Quality control	Quality management with ArcGIS Data Reviewer Lecture about data reviewer and accuracy control Adopting Data reviewer to actual work with project data
	Week 4 (7/30 - 8/3)	Update work regulation	Updating work regulation (quality control, 25,000scale and 50,000scale)
4th training	Week 1 (9/4 - 9/7)	Preparation	Preparation and 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 (from EGII trainer to trainee)
	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 Final evaluation

(4)   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.

Table 21   Participants in the technology transfer

		Task		
		Fostering of trainers/training of experts	**Digital plotting**	**Quality control & evaluation**
Trai ner		**Ms. Beza Haile**	**JICA Project Team**	**JICA Project Team**
1		Aklilu Assefa Hake	Kassaye Hailu	Aster Tiruneh
2		Natnael Ketema Tadasse		Yewbdar Firre Silassie
3		Dawit Desalegn Tola		Beza Haile
4		Asebech Negatu Ayichelet		Senait Seyoun
5				Beltech Zewde(QS)
6				Balainesh Begashaw(QS)
7				Tegene Wedajench(QS)

(5)   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 22   Results of technology transfer (Symbolization)

Item	Issues	Proposals and implementation status	Results
Map sybolization	• EGII plans to develop production technology and a production line using ArcGIS. • They have a strong desire for technology transfer in map symbolization for the preparation of topographical maps using ArcGIS.	• Technology transfer in symbolization using ArcGIS for 1/50,000-scale topographical maps (Creation of map symbols and marginal information) • Map symbol creation using the free software InkScape and practice in conversion to ArcGIS	• Development of a map symbolization manual for ArcGIS • Development of a 1/10,000-scale symbol catalog (Transition from CAD to ArcGIS) • Development of marginal data (ArcGIS) for 1/10,000-scale printed topographical maps
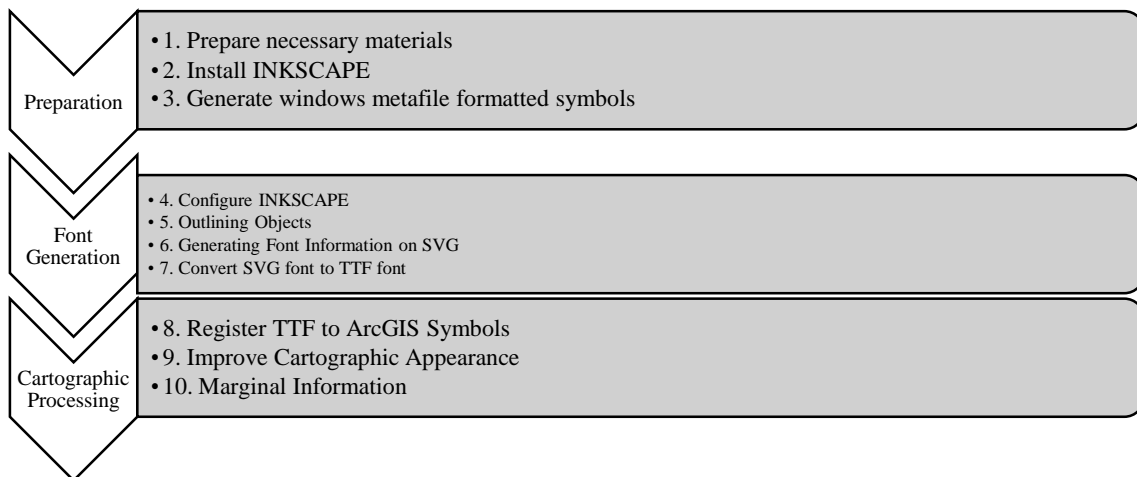
Figure 8   Map Symbolization Procedure Using ArcGIS

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.

Figure 9   1/10,000 Symbol catalog (ArcGIS)

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 23   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)	・Conceptual lectures, creation of materials ・Introduction of accuracy control methods ・Introduction of quality evaluation
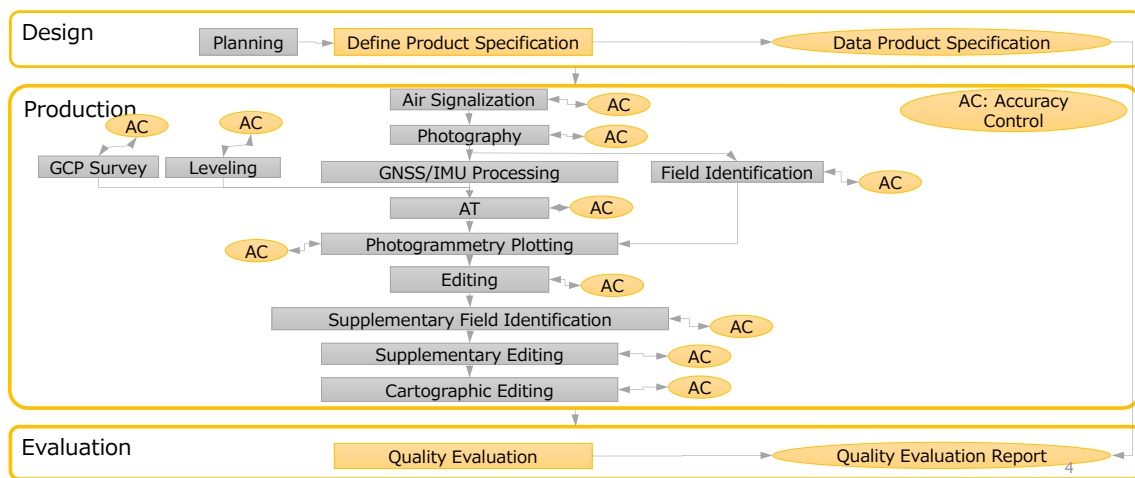
Figure 10   Relationship between Accuracy Control (AC) and Quality Evaluation

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. Accuracy control is to check if the accuracy pre-determined in accordance with the conditions, such as the applicable surveying method and reduction scale, is achieved. Unless prescribed limiting values are met in each process, the work cannot proceed to the next process and the error of the final surveying result can be specified by the error propagation of each process. Accuracy control enables prompt and easy work management if the surveying work is carried out by using an established surveying method and equipment. However, if a new technology or equipment emerges, it is difficult to perform accuracy control before the method of using such technology or equipment or the accuracy evaluation of such method is established.

On the other hand, quality evaluation is to assess the quality of the final product, such as its accuracy, regardless of the surveying method or the equipment used, and as such, it is possible to apply new method or equipment. If satellite images are utilized in digital topographic mapping, quality evaluation is essential since any work regulations or operation specifications of Japan do not cover the method of using satellite images. Quality evaluation is based on ISO19100 Geographic Information and in Japan, the bylaw of the Public Survey Work Regulations provides for quality evaluation.

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. The concept of quality evaluation, definition of quality, evaluation procedure, etc. are standardized. Quality evaluation as prescribed in the bylaw of the Public Survey Work Regulations in Japan is also based on the same standard. 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. Since quality evaluation is performed in accordance with quality requirements, as a premise of the introduction of quality evaluation, a product specification sheet, which explains the product including its quality requirements, must be developed in planning the operations.

Figure 11   Upgraded Accuracy Control Sheet

Lecture on quality evaluation	Quality evaluation demonstration
Study of the current status of accuracy control	Quality evaluation exercises

Figure 12   Technology Transfer for Accuracy Control and Quality Evaluation

3)   Topographic mapping

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

Table 24   Results of Technology Transfer

Item	Issues	Proposals and implementation status	Results
Topographic mapping	・Fostering of experts ・Creating technology transfer manuals, etc.	・Fostering of stereo plotting experts	・Acquisition of basic skills ・Clarification of issues and priority items for training of inexperienced experts

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.

Table 25   Evaluation of the Exercise Results

Item	Subject	Evaluation by period		
		Week 1	Week 2	Week 3
Stereoscopy	Stereoscopy and moving cursor to target feature	All the three participants had problems	2 participants: Understood 1 participant: Had problems	3 participants: Understood
Road	Appropriate height	Paved road: ×	Paved road: △ Unpaved road: ×	All roads: ○
	Appropriate reading	Paved road: ○ Unpaved road: △	Paved road: ○ Unpaved road: △	Paved/unpaved: ○ Walkway: ×
	Appropriate drawing (shape)	Paved road: △ Unpaved road: ×	All roads: △	All roads: △
	Understanding of reduced scale		Paved road: ○ Other roads: ×	All roads: △
River/other linear features	Appropriate height	×	△	○
	Appropriate reading	△	○	○
	Appropriate drawing (shape)	×	△	○
	Understanding of reduced scale	×	×	△
Building	Appropriate height	×	△	○
	Appropriate drawing (shape)	△	○	○
Vegetation	Vegetation community		△	△
	Appropriate reading		△	○
	Appropriate drawing (shape)		△	○
	Understanding of reduced scale		△	△
Isolated elevation point	Convex or concave		×	△
	Steep slope		△	○
	Gentle slope/flat land		×	△
Contour	Steep slope (without trees)		×	○
	Steep slope (with trees)		×	×
	Gentle slope/flat land		×	△
	Gentle slope/flat land /residential land			×

○: good, △: standard, ×: need practice

Plotting training by experienced EGII staff	Results of pilot exercises (in red) (approx. 5 km^2) in the 1/10,000-scale map
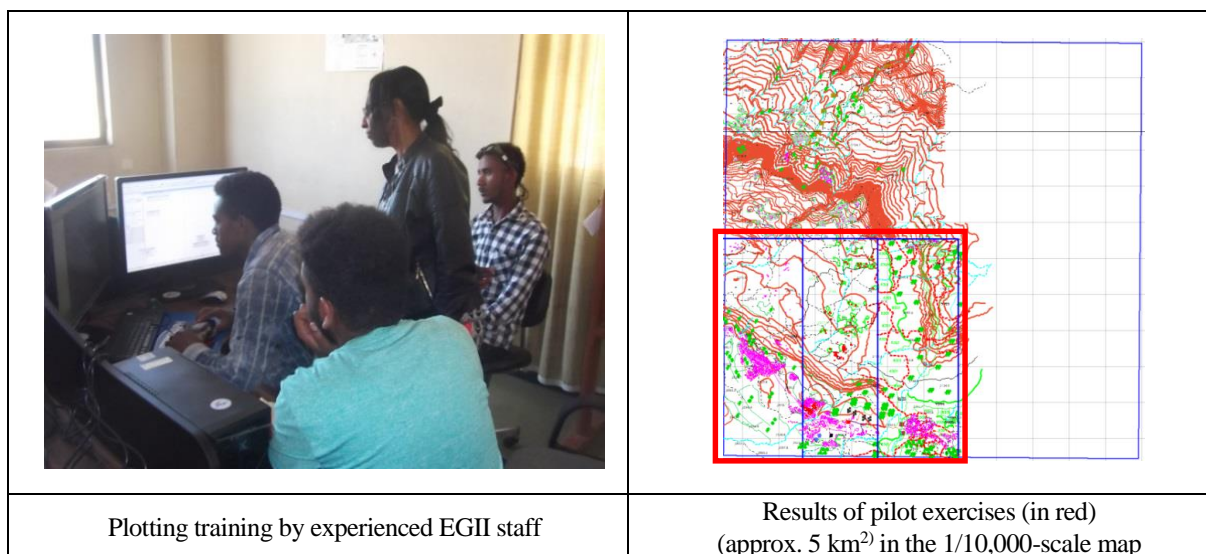
Figure 13   Scenes from the Technology Transfer for Topographic Mapping

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 26   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.

```
Formulation of the plans for technology transfer (draft)
                        ↓
        Identification and extraction of issues
                        ↓
                 Analysis of issue
                        ↓
       Formulation of the plans for fostering trainers
                        ↓
          Creation of the curriculum for training
                        ↓
           Creation of training reference material
                        ↓
                 Fostering of trainers
                        ↓
       Fostering of the experts in other organizations
                        ↓
               Evaluation/recommendations
```
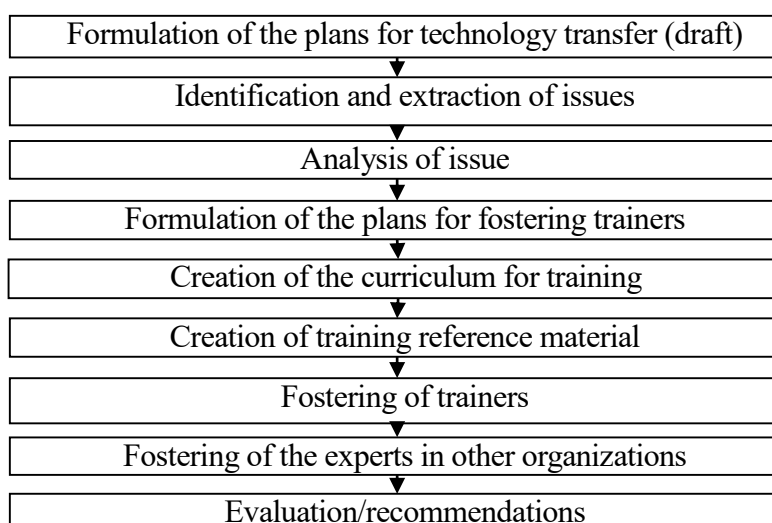
Figure 14   Work Flow of Technology Transfer for GIS Technology

(2) Implementation schedule of technology transfer

Table 27   Technology Transfer schedule for GIS Technology

Period	Details	
	Overall	**Description**
August to December 2017	Period for creating the curriculum for education	The Project Team will consult with EGII on the plans for the technology transfer and create the curriculum for education. The Project Team will consult with EGII and make a decision, regarding the external organizations targeted as beneficiaries of technology transfer.
	Period for training reference material	The details of training reference material ・The method for converting topographic maps data into GIS database ・The method for designating and converting coordinates projection ・The method for detecting data errors by using topology rules ・The method for correcting data errors ・The method for representing the data of topographic maps ・The method for overlay with thematic data ・The method for analysis by using thematic data ・The method for utilizing the data of topographic maps ・Automation of data processing through ArcGIS Model Builder ・The data for practical training and exercises for each of the above item shall be prepared.
January to June 2018	Period for fostering trainers in EGII	The Project Team will implement the training for fostering the experts in EGII to enable them to implement technology transfer for the experts in other organizations, in accordance with "the curriculum for training" and by using "training reference material" and the data for practical training and exercises, and will strengthen GIS technology in EGII.
July to October	Period for internal and external dissemination	With view to increasing the number of GIS users and the organizations using GIS, the Project Team will provide the case examples of GIS data utilization as the data for exercises. EGII trainers will actually implement the effort for fostering experts in other organizations, by using the training reference material produced.
November to December 2018	Evaluation/recommendations	The Project Team will conduct evaluation and make recommendations regarding the curriculum, training reference material and practical training, exercises and the technology transfer conducted by EGII staffs.

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

Table 28   Implemented Technology Transfer for GIS

Period		Theme	Works
1st training	Week 1 (5 - 9 June)	Preparation Tool development and technology transfer	Re-inspection of the operating conditions of the equipment Updating the OS of the server and the GIS machinery Inspection of the operating conditions of the network, server and SQL database Discussion on technology transfer planning and selection of participants Development/exercises of aerial photography planning tool (cost calculation using produced data, parameter modification methods, operation practice of tools)
	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 Inclusion of solutions to the identified issues in the next training Selection of training participants and mapping tasks to be used in the training 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	Discussion on the content of next training (with division manager of the Mapping Directorate and division manager of the GIS & Remote Sensing Directorate) Interviews with team leaders of the Remote Sensing & GIS Directorate (expected participants of the next training) 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	Final confirmation of the next training contents Acquisition of sample data for the next training Representation of true north on maps, rotation of neatlines and production of maps Development and exercises of a tool to automatically create offset neatlines Discussion on quantitative evaluation method of the mapping capacity of the staff
2nd 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 Record of workflow by ModelBuilder and exercises Automatic processing of LAS and DTM data by ModelBuilder
3rd 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 (setup of a training room at EGII, selection of user organizations and participants) Preparation for GIS seminar (venue arrangement, material preparation, selection of guests)
	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 and final preparation for GIS seminar
	Week 4 (26 Feb. - 2 Mar..)	GIS seminar	Implementation of GIS seminar and evaluation
4th training	Week 1 (7/23-7/27)	Preparation	GIS workshop (training room, trainee selection, text book preparation) GIS seminar (Venue, presentation, attendant selection)
	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

(4)　　　　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.

Table 29　　　　Participants in the technology transfer

Trainer	1st training JICA Project Team	2nd training JICA Project Team	3rd training EGII JICA Project Team	3rd training User Organizations Yohanis (EGII) Yebelay (EGII) Kassaye (EGII) Aster (EGII)
1	Aster Tiruneh (Mapping Directorate, Digital Photogrammetry Team)	Aster Tiruneh (Mapping Directorate, Digital Photogrammetry Team)	19 experts participated from EGII	11 experts participated from 9 organizations other than EGII
2	Ahmed Hamid (Mapping Directorate, Digital Photogrammetry Team)	Ahmed Hamid (Mapping Directorate, Digital Photogrammetry Team)		
3	Kasaye Hailu (Mapping Directorate, Digital Cartography Team)	Mezgebu Chala (Mapping Directorate, Digital Cartography Team)		
4	Beza Haile (Mapping Directorate, Digital Orthophoto Team)	Belete Tafese (Mapping Directorate, Digital Photogrammetry Team)		
5	Isreal G. Meskel (Remote Sensing and GIS Directorate, GIS and Thematic Team)	Zena Lingerih (Mapping Directorate, Digital Photogrammetry Team)		
6	Chalachew Simon (Remote Sensing and GIS Directorate, Remote Sensing Team)	Tigist Wubshet (Mapping Directorate, Digital Cartography Team)		
7	Yosef H. Mariam (Remote Sensing and GIS Directorate, Map revision and Updating Team)	Yosef H. Mariam (Remote Sensing and GIS Directorate, Map revision and Updating Team)		
8		Sime Ayano (Remote Sensing and GIS Directorate, Map revision and Updating Team)		
9		Lemi Ilala (Remote Sensing and GIS Directorate, GIS Team)		
10		Belainesh Begashaw (Quality & Standard Directorate, Quality Control Team)		

(5)   Technology transfer results & evaluation (1ˢᵗ and 2ⁿᵈ 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 1ˢᵗ 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.

Table 30   Results of Technology Transfer (GIS)

Issues		Proposals and selection of implementation content	Implementation of technology transfer
Strengthening of raster processing skill	Georeferencing (spatial correction)	Workflow restructuring and creation of quality control rules and their implementation are necessary.	Georeferencing of raster dataset
	Processing of large-scale raster	Optimization of operations to cut out unnecessary part	Processing of raster data and use of tool
		Efficient management, indication and search of large-volume raster by understanding and using mosaic dataset	Creation and use of mosaic dataset
		Understanding of efficient projection transformation method	Spatial adjustment transformations
Strengthening of vector processing skill	Reshaping	Understanding of reshaping tools for lines/polygons	Editing of apexes and segments of objects Editing of polylines and polygon objects
	Data conversion	Structuring polygon data from multiple polyline data	Data conversion by data conversion tool
DEM/contour	Development of acquisition specifications/data specifications	Reduction of disconnection errors by effective utilization of snapping function	Setting of work environment on ArcMap
		Reduction of attribute errors between neatlines by standardizing the setting of attributes	
		Data size reduction by reducing excessive smoothing (smooth lines)	
	Applied data processing	Structuring large-scale DTM surface/creation of contours	Creation and use of TIN
		Processing of LAS files generated from DTM creation process of photogrammetry	Processing and use of LAS files
		Structuring wide-range 3D surface from multiple LAS files	Creation and use of terrain dataset
Topology (topological properties) tool	Error detection and correction	Reduction of errors by editing shared geometry by understanding and using map topology tool	Editing of shared geometry of lines and polygons by map topology
		Edge matching processing between neatlines	Edge matching between neatlines
		Structuring geodata base topology, detection and correction of errors by topology	Utilization of overlay analysis tools

Issues		Proposals and selection of implementation content	Implementation of technology transfer
Data saving	Automatic saving option	Setting of an option for automatic saving of changes	
	Back-up	Avoidance of data loss (caused by power outage) by developing a data back-up structure	
Others			Creation and editing of annotation Optimization of data processing and analysis by using ModelBuilder

In the 2nd 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 31   Evaluation of Technology Transfer (GIS)

Training participants	Evaluation (point)
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
Average	**3.8**

(6)   Technology transfer results & evaluation (1st 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 contents of GIS workshop are as follows:

1-1)   Removal of geometric distortion from vector data (rubber sheeting)

1-2)   Editing by spatial adjustment transformation function

1-3)   Tools for creating polygons

1-4)   Advanced data editing functions (7 functions)

2-1)   Edge matching of neatline data (3 functions)

2-2)   Detection and correction of errors by application of topology rules

2-3)   Tools enabling the detection of disconnection errors of polylines

3-1)   Spatial analysis tools for polygons (7 functions)

3-2)   Data processing/extraction/measurement tools (7 functions)

4-1)   Basics of tool combination flow design function (ModelBuilder)

4-2)   Automated data processing by use of ModelBuilder

4-3)   Analysis of land use changes by using ModelBuilder with satellite images

4-4) Risk analysis of building inundation caused by flood damage by using ModelBuilder with DEM data

5-1) Method of spatial correction (georeferencing) of scanned maps (raster images)

5-2) 3D display and output of orthophotos and DEM by ArcScene

5-3) Management of printed maps by automated output of multiple neatlines (Data Driven Pages)

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.

Table 32   Participants in the Technology Transfer (1st GIS Workshop)

	Training of EGII trainers/ training of experts			Training of experts from user organizations	
	Belonging to/Post		**Name**	**Belonging to**	**Name**
1	Training, Research & Development	Researcher & Trainer	Yohannes Azanaw (trainer)	Addis Ababa Integrated Urban Land Information Management Agency	Beley Agajie
2			Yebelay Gonfa (trainer)	Ministry of Agriculture and Natural Resources, Land Administration and Use Directorate	Anteneh Wegenie
3	Mapping Directorate	Cartography Team Leader	Kassaye Hailu (trainer)	Ethiopian Road Authority	Wegderes Tena
4		Photogrammetry Team Leader	Aster Tiruneh (trainer)	Ethiopian Road Authority	Tefare Fayise
5		Photogrammetry Expert	Belete Tafesse	Oromia Integrated Urban Land Information System Coordination Project Office	Zewdu Shegena
6		Photogrammetry Expert	Zena Lingerih	Ministry of Forest, Environment and Climate Change	Buzayehu Alemu
7		Orthophoto Team Leader	Beza Haile	Development Bank of Ethiopia	Melaku Teshome
8		Map Update Team Leader	Sime Ayano	Geological Survey of Ethiopia	Tariku Kebede
9		Cartography Expert	Yelikal Chane Nega	Geological Survey of Ethiopia	Tsehaye Boyale
10			Tewodros Kasahum	Oromia Rural Land Administration Bureau	Dawite W. Maryam
11	Remote Sensing & GIS Directorate	GIS Team Leader	Shimelis Tadese	Ministry of Water Irrigation and Electricity	Tiruwork Tadege
12		Remote Sensing Team Leader	Ahmed Hamid		
13		GIS Expert	Amanuel Kamsa		
14			Lemi Elala		
15			Dinku Shiferaw		
16	QC Directorate	QC Expert	Belaynesh Begashaw		
17	Survey, Experting Directorate	Survey Computation Team Leader	Hymanot Desalegn		
18	IT Directorate	IT Expert	Helen Tesfaye		
19			Tsehey Beyene		

| Fostering EGII trainers | Training of experts from user organizations |

Figure 15   Scenes from the 1st GIS Workshop

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 33   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
	Average	**2.7**	**3.9**	**2.2**	**4.1**

(7)   Technology transfer results & evaluation (GIS seminar)

On the 27th 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)

Table 34   Organizations Participating in the Seminar and Number of Participants

	Organizations	Number
1	The Oromia National Regional Government	1
2	Addis Ababa Integrated Urban Land Information Management Agency	1
3	Ethiopian Airport Authority	1
4	Ministry of Agriculture and Natural Resources	1
5	Ministry of Mining and Natural Gas	1
6	Ministry of Forest Environment and Climate Change	1
7	Ministry of Water and Electricity	1
8	Ministry of Finance and Economic Development	1
9	National Planning Commission	1
10	Ethiopian Mapping Agency	11
11	JICA/JICA Project Team	5
	Total	**25**
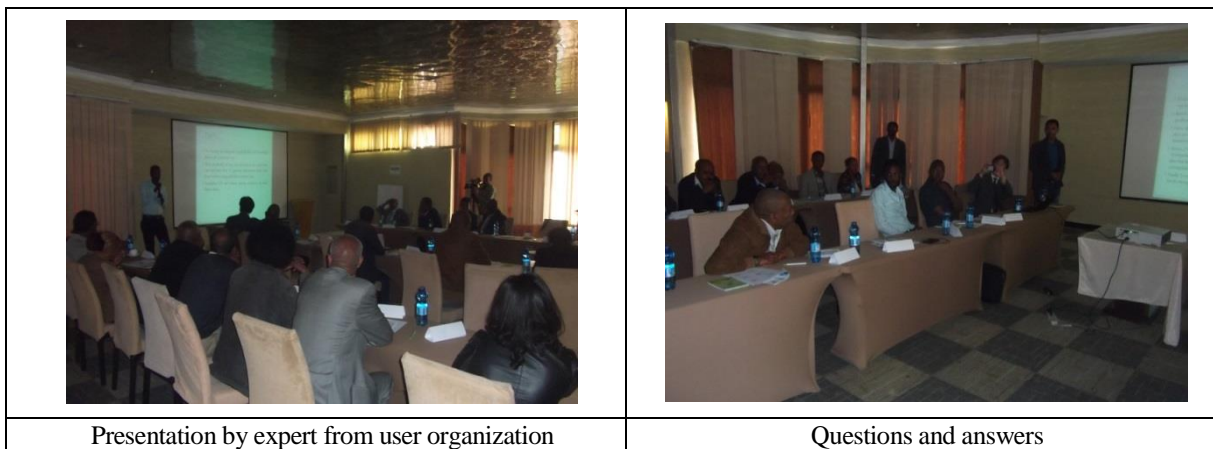
Presentation by expert from user organization	Questions and answers

Figure 16   Scenes from the Seminar

(8)   Technology transfer results & evaluation (2nd GIS workshop)

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

    1-1)   Generate Edge match Links
    1-2)   Edge match Features
    1-3)   Generate Rubbersheet Links
    1-4)   Rubbersheet Features
    1-5)   Transform Features
    1-6)   Transfer Attributes
    2-1)   Create TIN
    2-2)   Create Terrain
    2-3)   Create Las Dataset
    2-4)   Create Contours from TIN, Terrain and Las Dataset
    3-1)   What is raster data?
    3-2)   Create raster from polygon
    3-3)   Clip Raster
    3-4)   Resample Raster
    3-5)   Split Raster
    3-6)   Mosaic to New Raster
    3-7)   Focal Statistics
    3-8)   Create Mosaic Dataset
    4-1)   Model Builder basics
    4-2)   Model Builder for automatic data processing
    4-3)   Model Builder for mass data auto processing with Iterate function
    4-4)   Model Builder for mosaic data set
    5-1)   Python basics
    5-2)   Python tools with ArcGIS
    5-3)   Python tools for mass data auto processing
    5-4)   Python tools for 2D to 3D contour auto conversion
    5-5)   Python tools for Personal Geodatabase to File   Geodatabase auto conversion

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.

Table 35   Attendance from EGII (2nd GIS workshop)

No	NAME	TITLE
1	Ahlam Yimam	Photogrammetry Expert
2	Ahmed Hamid	Remote Sensing TL
3	Amanuel Kamsa	GIS Expert
4	Aster Tiruneh	Photogrammetry TL
5	Belaynesh Begashaw	QC Expert
6	Beletech Zewdu	QC TL
7	Beza Haile	Orthophoto TL
8	Belete Tafesse	Photogrammetry Expert
9	Dawit Desalegn	Photogrammetry Expert
10	Derese Teshome	Software Programmer
11	Fekadu Aragie	Office Survey TL
12	Helen Tesfaye	System Administration
13	Hymanot Desalegn	Engineering survey
14	Kassaye Hailu	Cartography TL
15	Lemi Elala	GIS Expert
16	Shimelis Tadesse	GIS TL
17	Sime Ayano	Map Update TL
18	Tegenie Wedajeneh	QC Expert
19	Tewodros Kasahun	Cartography Expert
20	Tigist Woubeshet	Digital Cartography Expert
21	Tsehaye Beyene	System Administration
22	Yebelay Gonfa	Researcher & Trainer
23	Yelikal Chane Nega	Cartography Expert
24	Yohannes Azanaw	Researcher & Trainer
25	Yohahannis Ebestu	GIS and Remote Sensing
26	Zena Lingerih	Digital Photogrammetry Expert

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

Table 36   Attendance from User organizations (2nd GIS workshop)

No	NAME	TITLE	ORGANIZATION
1	Anteneh Wegenie	GIS Expert	Ministry of Agriculture and Livestock Resource
2	Ephrem Negatu	Sewer Infrastructure Information center, Head	Addis Ababa Water and Sewerage Authority
3	Gedamu Yenasew	Remote Sensing Expert	Ministry of Environment Forest and Climate Change
4	Misganaw Wubetu	Geo Spatial Analyst	Ministry OF National Defense (MONO)
5	Mulualem Kere	GIS Expert	Ethiopian Road Authority
6	Robal Asamenow	Hydro Geologist	Geological Survey of Ethiopia
7	Samuel Hailu	RS and GIS Senior Expert	Geological Survey of Ethiopia
8	Semu Melese	Infrastructure Information Coordinator	Addis Ababa Water and Sewerage Authority
9	Tewodros Tesfaye	Geo Spatial Analyst	Ministry OF National Defense (MONO)
10	Tiruwork Tadege	GIS Expert	Ministry of Water Irrigation and Electricity
11	Yewbdar Mulatu	Geologist	Ministry of Mines Petroleum and Natural Gas
12	Zelalem Ketema	Sewer Line Connection Sub Process Leader	Addis Ababa Water and Sewerage Authority

| EGII TOT workshop | USER workshop |

Figure 17   Scenes from the 2nd 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 37   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
Average		**2.4**	**3.9**	**2.2**	**4.1**

(9)   **Technology transfer results & evaluation (2nd GIS seminar)**

  The 2nd 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)

Table 38   Participating in the Seminar

	Organizations	Number
1	Addis Ababa Integrated Urban land Management Center	2
2	Addis Ababa Water and Sewerage Authority	3
3	Ethiopian Road Authority	2
4	Geological Survey of Ethiopia	1
5	Ministry of Defense	1
6	Ministry of Forest, Environment and Climate Change	1
7	Ministry of Mining and Natural Gas	1
8	Ministry of Transport	1
9	Ministry of Water Irrigation and Electricity	1
10	Ethiopian Mapping Agency	12
11	JICA/JICA Project Team	4
	Total	**29**

Presentation from EGII	Presentation from USER

Figure 18   Scenes from the 2nd 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.
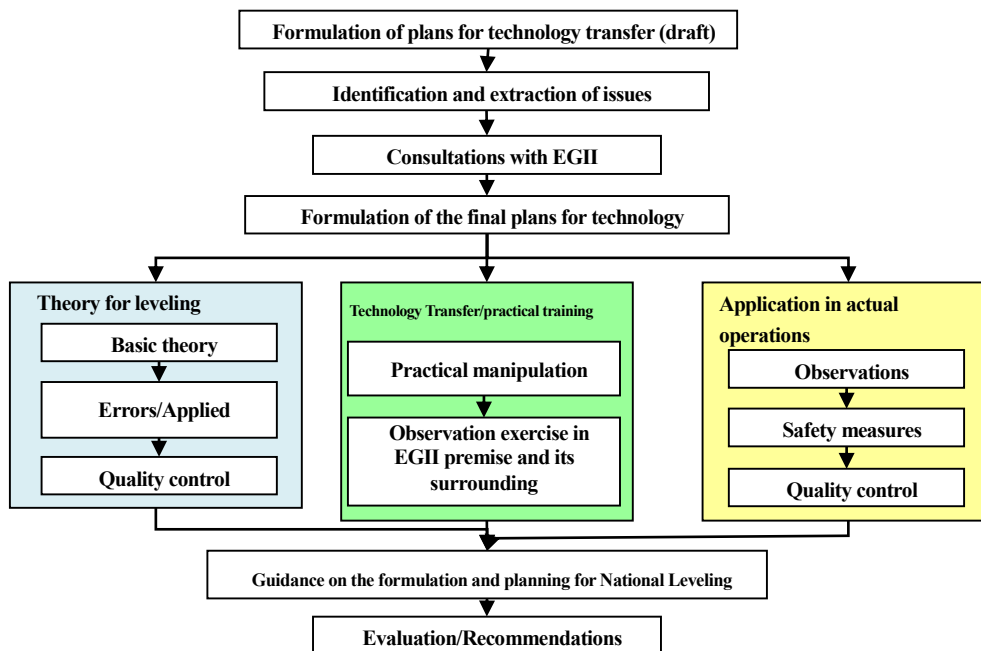
Figure 19 Work Flow of Technology Transfer for Leveling

(2) Implementation schedule of technology transfer

Table 39 Technology Transfer schedule for Leveling

Period	Details	
	Overall	**Description**
August to December 2017	Curriculum/texts	The Project Team will create curriculum and teaching materials.
	Theory on leveling Technology transfer/practical training	The Project Team will implement the technology transfer regarding the theory on leveling and the theory of errors in accordance with "the curriculum for training" and by using the "reference material" to be created. The Project Team will implement the technology transfer regarding instrument handling, care, operation and the observation and computation method and safety measures through practical training. The technology transfer and practical training will mainly be implemented within the EGII premise and the surrounding area.
January to April 2018	Technology transfer/Practical Work I	The first order leveling between the zero-order control points that range from Addis Ababa to its neighboring area will be implemented, and skills of EGII staffs in leveling will be established and improved. The method for safety measures will be acquired.
May to September 2018	Technology transfer/Practical Work II	The first order leveling between the zero-order control points that range from Addis Ababa to its neighboring area will be implemented, and the management skill of overall operations will be improved. Guidance on the method for quality control will also be given.
October to December 2018	Evaluation/recommendations	The Project Team will provide guidance regarding the method for Network Adjustment Calculation required for leveling network and the creation of master plan for National Leveling Network. The Project Team will conduct overall evaluations and make recommendations on the project planning for the future.

(3)　Status of implementation of technology transfer

To date the following technology transfer has been implemented.

Table 40　　Implemented Technology Transfer for Leveling

	Period	Theme	Works
1st 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 Practice of observation on the route, EMA. BM → St3 → St2 → St1 → St4 (in the out-bound direction), and processing the observation data Practice of observation on the route, St4 → St1 → St2 → St3 → EMA. BM (in the in-bound direction), and processing 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 (from EMA:BM_EMA to Addis Ababa University: BM_AAU) Practice of pacing: distance of approx. 3km (in the out-bound direction) BM_EMA→BM_AAU, BM_EMA→P1 (approx. 0.5km) Practice of pacing: distance of approx. 3km (in the out-bound direction) BM_EMA→BM_AAU, P1→P3 (approx. 1.5km)
	Week 4 (3rd – 7th July)	Exercises for observations	Leveling network planning, entry of acceptable range, practice of observation, P3→BM_AAU (approx. 1km) Practice of pacing: distance of approx. 3km (in the in-bound direction) BM_AAU→BM_EMA, BM_AAU→P2 (approx..1.5km) Verification of the output of the technology transfer and confirmation of the plan
2nd training	Week 1 (1st – 3rd November)	Exercises for observations	Selection of leveling route and benchmark: Addis Ababa – Dukem (30km southeast) Selection of leveling route and benchmark: Addis Ababa – Sendafa (40km northeast)
	Week 2 (6th – 10th November)	Exercises for observations	BM_EMA→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. Methods and procedures necessary for the observation are provided as necessary, including instructions to make the distance between the surveying level and the back sight and foresight leveling staff, to use an umbrella to prevent surveying level from being exposed to direct sunlight, etc.
	Week 3 (13th – 17th November)		BM_EMA→SBM.0 Continuing from the previous week, participants were instructed to take turns in making observations so that everyone could be familiar with the observation work. 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
3rd 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	Observation over the distance of BM_EMA→SBM.0 as with the previous exercise 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

	Week 1 (11 - 17 Jun.)	Preparation	Preparation and discussions for training plan	
4th training	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	

(4)   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 1st training could not attend the 2nd training, but the 2nd 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. 14 staffs were from the Geodetic survey team, 6 were from Large scale survey team and 2 from Engineering & survey data team.

Table 41   Participants in the Technology Transfer

	Name	1st	2nd	3rd	4th	Number
1	Fekadu Aragie	✓	✓	✓		3
2	Zewdu Mengesha	✓	✓		✓	3
3	Yared Agedaw	✓	✓	✓	✓	4
4	Masresha Mulugeta	✓	✓	✓	✓	4
5	Alelgne Ayana	✓			✓	2
6	Akalu Kassa	✓				1
7	Alemayehu Tadesse	✓		✓	✓	3
8	Negasa Merga	✓				1
9	Helifa Jemal	✓				1
10	Abiyan Hiluf	✓				1
11	Haymanot Desalegn	✓	✓	✓	✓	4
12	Tinsae Aklilu	✓			✓	2
13	Solomon Shiferaw	✓	✓	✓	✓	4
14	Mamaru Yihunie	✓	✓	✓	✓	4
15	Tumay Assefa		✓	✓		2
16	Abdulehadi Hamid		✓	✓	✓	3
17	Abel Hailemichael		✓	✓		2
18	Anemaw Bishaw		✓	✓	✓	3
19	Haileyesus Wagamyeleh		✓	✓	✓	3
20	Ayana Biratu		✓	✓		2
21	Getachew Biyazin			✓		1
22	Gizachew Nigussie			✓		1

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

Table 42　　　　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.

(5)　　　　Results of technology transfer

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

Table 43　　　　Results of Technology Transfer

	Issues	Content of proposals and technology transfer implemented	Results
1st	No experience in first order leveling	It was decided to start with the basics. 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.
2nd	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.
3rd	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).
4th	Enhance trainees' proficiency level	Continuous practice in SBM 0 to 1 (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 1st order leveling skill

1) 1st 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) 2nd 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) 3rd training

Considering the issues from the results of the Technology Transfer Phase 1 and 2, 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 as the previous training, 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). This training result proved that a satisfactory outcome could be obtained from observation conducted in accordance with the work regulation created in the previous phase.
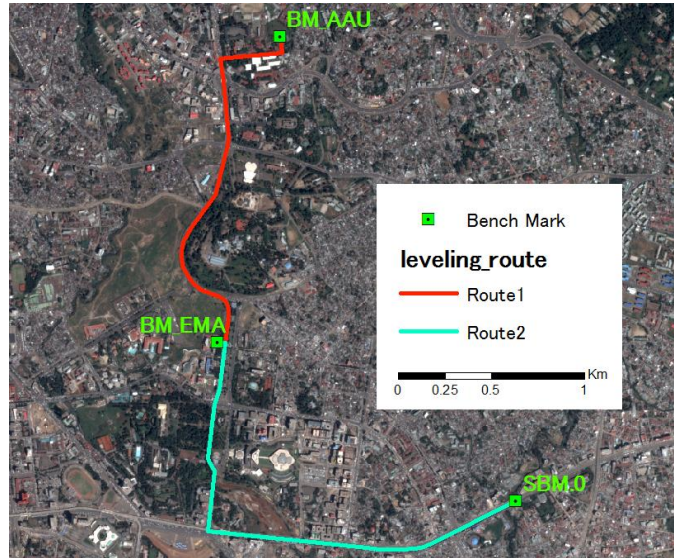
Figure 20   Work Area for the Technology Transfer for Leveling

4) 4th training

The project team has confirmed basic skill in almost all (12 out of 15) trainees, from the 1st to 3rd training. The 4th 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.

| Observation | Basic skill training |
| Data analysis training | Lecture |
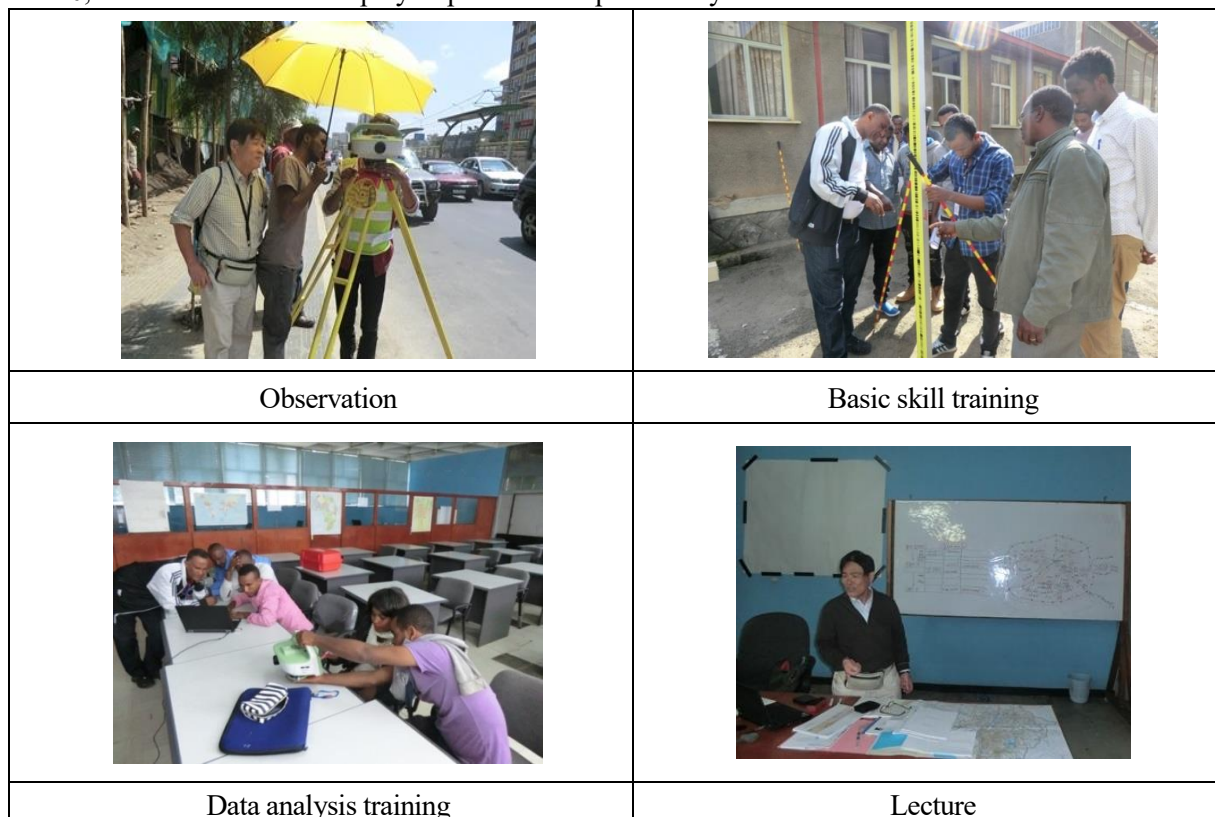
Figure 21   First order leveling training

In order to support EGII's future 1st 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.
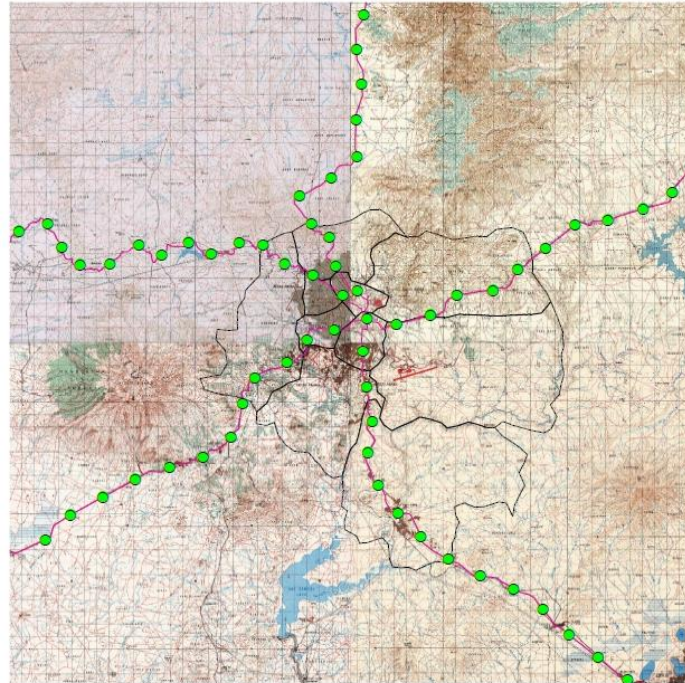
Figure 22   First order leveling route plan 1/50,000 (Addis Ababa)
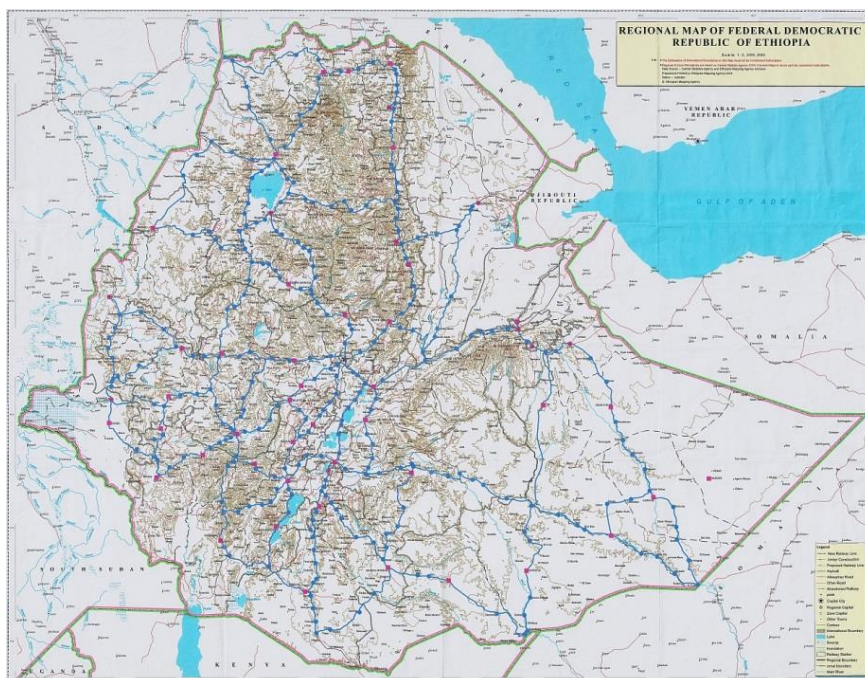
Figure 23   First order leveling route plan 1/2,000,000 (National)

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.
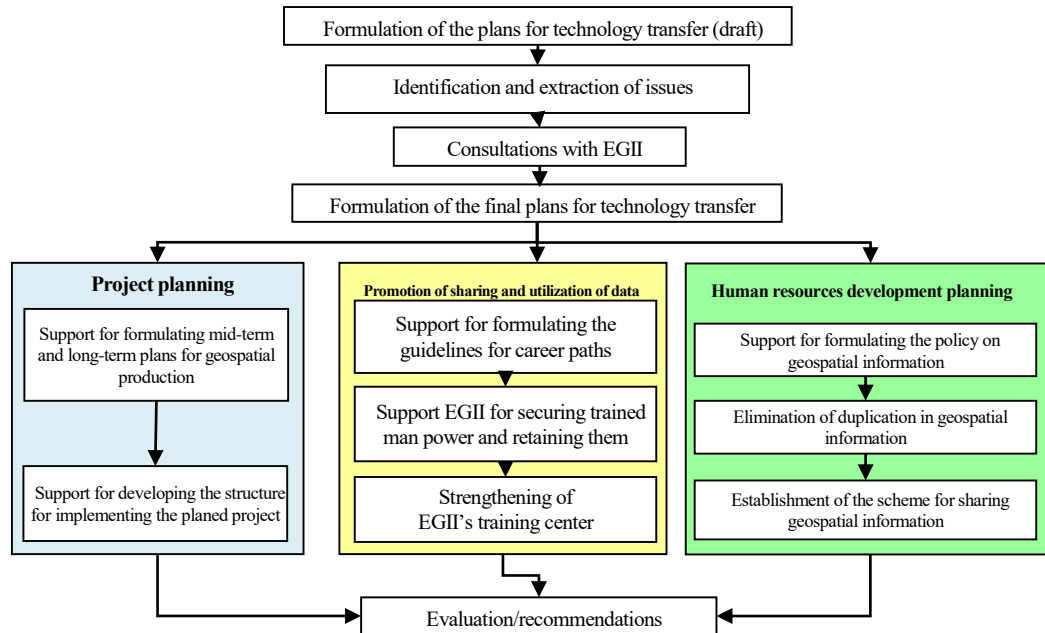
Figure 24   Work Flow for the Management and Operation of Geospatial Information

(2)   Implementation schedule of technology transfer

Table 44   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	2nd 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 2nd survey results to documents	Final discussions to finalize the draft documents

(3)   1ˢᵗ and 2ⁿᵈ 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 45   EGII Budget transition

Fiscal year（Upper: Ethiopian calendar, lower: western calendar）	Budget (ETB)	Expenditure (ETB)	Execution ratio (%)
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 stuff members where 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)　　　1st and 2nd survey result

The survey result and actions are sorted as follows.

Table 46　　　Issues and Planned Activities

Items	Issues	Planned Activities
Organizational project plans	• Long term plan does not existing • GI production plans and budgeting are not stable • Rules and regulations for GI production are not existing	• Create a long-term plan and use as budgeting • Create GI policy for standardized GI production
Data sharing & utilization promotion, reduction of work duplication	• IT policy needs an update to suite the situation • Internal data management is inappropriate • Data sharing and utilization is not promoted in the country • There is duplication in survey / GI work within organizations	• Update the IT Policy with data storage optimization • Establish relationship with user/donor organizations from seminars and trainings • Revise the survey regulation to reduce survey work duplication
Human resource	• Turnover is a big issue • Carrier planning is not existing • Training facility should be improved	• Create a carrier path guideline • Inputs to optimize the training and facility

The following members have been involved in the discussion to create the documents.

Table 47　　　Members of discussion

Member	Title
Mr. Ayele Teka	Director of Mapping Directorate
Mr. Kerlos Latebo	Director of Quality and Control Directorate
Mr. Gebrekiros Haile	Director of Surveying Directorate
Mr. Teferi Waktola	Director of Planning Directorate
Ms. Mebrate Samuel	Director of RS & GIS Directorate
Mr. Gezahegn G. Meskel	Director of Training, Research & Development Directorate

(5)   Technology transfer results

Table 48   list of outputs and its contents

Results	Organizational Operation	Human resource	Data utilization and sharing Reduce work duplication
Formulation of a long-term plan	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
Update of EGII Survey Regulation	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
Updating of Survey Work Regulation	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
Symbol Regulation	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
GI Policy	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
IT Policy	Reviewing and updating the contents in order to enhance efficiency and sufficiency		Raise IT literacy, enhance and simplify data management / sharing mind
Data storage procedure	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
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 49   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 50   Approval process

Document level	Approval process		Application duration	Progress
Proclamation	1.	To Planning Commission	4 months	N/A
	2.	To council of Minister		
	3.	To house of people's Representatives		
	4.	To the president office for signature		
Regulation	1.	To Planning Commission	3 months	Under evaluation in EGII technical committee
	2.	To council of Minister		
	3.	To the prime minister office for signature		
Directive	1.	Document preparation by assigned Committee	2 months	
	2.	To the Management committee of EGII for Approval		
	3.	To the DG of EGII office for signature		
Manual	1.	Preparation by respective Directorate	1 month	
	2.	To the Technical Committee of EGII for approval		
	3.	To the Director of Quality and standard for signature		

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 51   List of Materials and Equipment

Name of Materials and Equipment	Specification/Roles	Quantities	Procured by
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 1st 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 52　　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	Production of topographic maps	【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
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.

Deputy Project Manager/Photogrammetry
Akira Ota

Production of topographic maps
Keiji Yamada

GIS
Wentao Che

Project Manager/Support for organization structure 1
Akira Suzuki

Leveling
Masakuni Nakayama

Support for the Organization Structure 2/Coordination of operations
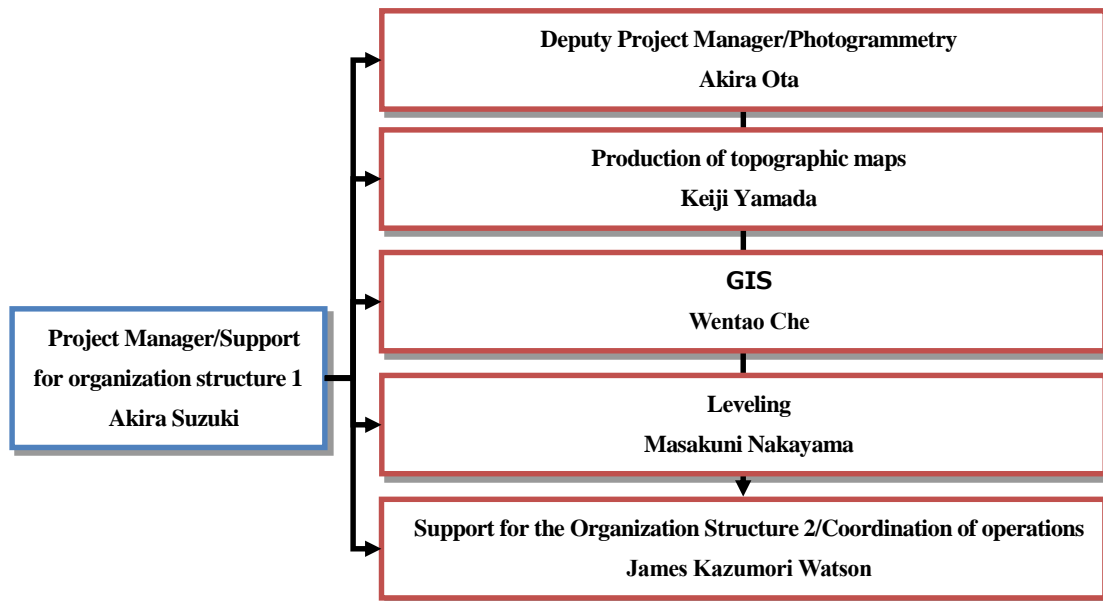**James Kazumori Watson**

Figure 25   Project Implementation Structure

5.3. Staffing Schedule

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

Table 53   The staffing schedule

	ROLE	NAME	AFFILIATE	Grade	2017 2	3	4	5	6	7	8	9	10	11	12	2018 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL ETH	JPN
WORK IN ETHIOPIA	Project Manager / Organization Structure support1	Akira SUZUKI	PASCO Corp.	2	12				18					30									30				30	4.00	
	Deputy Project Manager / Photogrammetry	Akira OTA	PASCO Corp.	3				30						30		30		30										4.00	
	Topographic map production	Kohei ISOBE	Kokusai Kogyo Co., Ltd.	3					30					30							24	36						4.00	
	GIS	Wentao CHE	Kokusai Kogyo Co., Ltd.	3					30				30		30						30							4.00	
	Leveling	Masakuni NAKAYAMA	PASCO Corp.	3					30				30		30				30									4.00	
	Organization Structure support2 / Coordinator	James K. WATSON	PASCO Corp.	5									15									25			20			2.00	
																									Total work in Ethiopia	**22.00**	
WORK IN JAPAN	Project Manager / Organization Structure support1	Akira SUZUKI	PASCO Corp.	2	2						2						2									2		2		0.50
																								Total work in Japan		**0.50**
	Reporting				ICR △						△ PGR1						△ PGR2								△ DFR	△ FR		
																								Total work	**22.50**	

LEGEND ▬ Work in Ethiopia
         ☐ Work in Japan