Kingdom of Bhutan
National Land Commission Secretariat (NLCS)

PROJECT ON DEVELOPMENT OF NATIONAL GEO-SPATIAL DATA IN BHUTAN

Final Report

November 2017

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

PASCO CORPORATION

EI
JR
17-113

Currency exchange rate

Currency unit: Bhutan Ngultrum (BTN)

1 Bhutan Ngultrum = 1.77 yen (designated by JICA as of November 2017)

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Abbreviations

1	ADB	Asian Development Bank	16	GSI	Geospatial Information Authority of Japan
2	ALOS	Advanced Land Observing Satellite	17	IT	Information Technology
3	CAD	Computer Aided Design	18	JCC	Joint Coordination Committee
4	CGISC	Centre for GIS Coordination	19	M/M	Minutes of Meeting
5	CORS	Continuously Operating Reference Station	20	NLCS	National Land Commission Secretariat
6	DTM	Digital Terrain Model	21	NSDI	National Spatial Data Infrastructure
7	DEM	Digital Elevation Model	22	Nu	Ngultrum
8	G.I.	Geographic Information	23	NLC	National Land Commission
9	DPS	Data Production Specification	24	OJT	On the Job Training
10	GIS	Geographical Information System	25	QC	Quality Control
11	GNSS	Global Navigation Satellite System	26	RGOB	Royal Government of Bhutan
12	GCP	Ground Control Point	27	RMSE	Root Mean Squared Error
13	GDP	Gross Domestic Product	28	SPOT	Satellite Pour l'Observation de la Terre
14	GPS	Global Positioning System	29	SATREPS	Science and Technology Research Partnership for Sustainable Development
15	GRS	Geodetic Reference System	30	UML	Unified Modeling Language
16	GSD	Ground Sample Distance			

Chapter 1. Outline of Project

1-1. Background and History of Project

This technical cooperation project was implemented in the following areas in response to a request from the Government of the Kingdom of Bhutan:

- Creation of 1/25,000 digital topographic maps to be used as basic information for the development of farmland, etc.
- Formulation of a plan for the development and operation of National Spatial Data Infrastructure (NSDI)
- Transfer of the technologies used in the digital topographic mapping to the National Land Commission Secretariat (NLCS), the national surveying institution of the Government of Bhutan.

Table 1 describes the background of the request for this technical cooperation of the Government of Bhutan.

Table. 1 Background of the Project

Item		Status
Topography	Location/topography	Bhutan is a landlocked country located on the eastern edge of the Himalayas and bordered by China to the north and India to the south.
	Land use	Most of the land in Bhutan is in the mountains and farmland accounts for 3% of the land.
Economy and industry	GDP growth rate	8.6% (in 2012, source: statistical data of the Government of Bhutan)
	Industrial composition	GDP Primary industry: 17.0%, secondary industry: 39.3%, tertiary industry: 43.7%
		Percentage of people engaged by industry: agriculture: 60.2%
	Issue	The primary industry including agriculture has to be improved for the reduction of poverty and the reduction of the outflow of foreign currency for food import.
Policy	11th Five-year Plan (2013 – 2018)	The plan aims at improving the food self-sufficiency with the increase in rice production. The government intends to take measures for farmland development and improve agricultural techniques in the priority area on gentle slopes in the south of the country where many poor people live.
	Economic development policy	Opportunities for foreign investment are to be created by facilitating the development of the manufacturing industry targeting the market in India with the development of a special economic zone in the south.
Geospatial information	Topographic maps	Topographic maps are basic information required for the development of farmland and infrastructure.
		The 1/50,000 topographic maps created in the 1960's with assistance from the Government of India were partially updated in 1990.
		The accuracy of the data on the 1/50,000 maps alone is not sufficient for the planning and management of various projects.
	Policy on map specifications and information sharing	Geospatial information has not been created or managed efficiently because of the lack of a clearly defined policy.

1-2. Project Purpose and Outputs

(1) Overall Goal, Project purpose, Outputs

< Overall goal >

Digital topographic maps will be prepared and maintained by NLCS and used for agriculture and infrastructure planning.

< Project Purpose >

1/25,000 digital topographic maps covering the southern region (9,870km^2) of Bhutan will be developed using satellite images, and the technology transfer for the development of the NSDI and digital topographic maps will contribute to the formulation of agricultural and infrastructure development programs.

< Outputs >

- **1: 1/25,000 digital topographic maps of the southern region (9,870km^2) of Bhutan**
- **2: Technology transfer in 1/25,000 digital topographic mapping to the NLCS**
- **3: NSDI development based on the model case of 1/25,000 digital topographic mapping**

(2) Project Purpose, Project Outputs and Definition of NSDI Development

It is very important to define "NSDI Development" clearly for the planning of activities for the achievement of the Project Purpose and evaluation of the outputs of the activities because it is one of the Outputs of the project and its achievement is closely related to the achievement of the other Outputs.

Therefore, the Study Team (hereinafter "the Team") conducted a study on the current state of the hardware and software development for the creation and use of geospatial information in Bhutan and had discussion on the development of NSDI with NLCS. Then the Team prepared an outline design of the activities for "NSDI development," a purpose of the implementation of this Project, and related their outputs to the Project Outputs, as described below Table, using the results of the study and discussion and implemented the Project in accordance with the design.

The activities mentioned below were implemented in this Project in order to present a model case of the use of the 1/25,000 digital topographic maps in each of Activities (1) – (4) mentioned in the table below, which is to serve as foundation for the continuous development of NSDI led by NLCS. The Team held meetings and seminars to discuss and share the outputs of the activities with the stakeholders.

Table. 2 Activities for NSDI Development

Item	Purpose	Practical Activities in the Project	Relevant Output
1) Development of geospatial information	Geospatial information is developed.	1/25,000 digital topographic mapping of the southern region	Output 1
2) Establishment of a system for the maintenance and management of geospatial information	Technology and documents required for the maintenance and management of geospatial information are developed.	Development of the technology and system, quality/process control, maintenance of equipment for the creation and updating of the 1/25,000 digital topographic maps of the southern region	Output 2
	A study is conducted on data models and formats and the results of the study are shared among the stakeholders.	Preparation of the drafts of the work specifications and product specifications to be used in the 1/25,000 digital topographic mapping of the southern region	Output 3
3) Establishment of a system for geospatial information sharing	Measures to prevent duplication in the creation of geospatial information are discussed and shared. A rule and policy on data sharing are discussed and shared. A policy and a mechanism for data sharing among the stakeholders in the government are discussed and shared.	Description of the duplication prevention measures and data sharing rule in the work specifications Development of a model case of information sharing with 1/25,000 digital topographic maps Discussion with NLCS (on the sharing of the data managed by NLCS) and discussion with data providers (CGISC member organizations) on a data policy	Output 3
4) Establishment of a system for the use of geospatial information	A policy on the data sales is discussed and shared. Studies and discussions on data use models are conducted among the stakeholders in the government. A policy, system and data for public data browsing are discussed and shared.	Development of model cases of information dissemination and use with 1/25,000 digital topographic maps Organizing seminars	Output 3
		Recommendation on model cases of the use of 1/25,000 digital topographic maps in the formulation of an “agriculture development plan” or an “infrastructure development plan” (GIS Sample models)	Achievement of the Project Purpose

1-3. Project Target

(1) Project Period

The project was implemented in two phases, the first year and second year, in the 33-month period between February 2015 and November 2017.

(2) Scope of Work

An area of approx. 11,000 km^2 in the southern region where many agricultural activities and dam and road construction projects are implemented and flooding and earthquakes occur frequently was selected as the target area of this project based on the needs of the expected main users of geospatial information in the agriculture and infrastructure development sectors. A 1,130 km^2 area situated in the eastern part of the target area (marked with the blue lines in the figure below) was designated as a pilot area where NLSC staff were to practice the technology for digital topographic mapping transferred to them in this Project. Therefore, the Team provided limited outputs of this Project, *i.e.,* satellite images and output of the aerial triangulation of this area, to them as input for their pilot work.

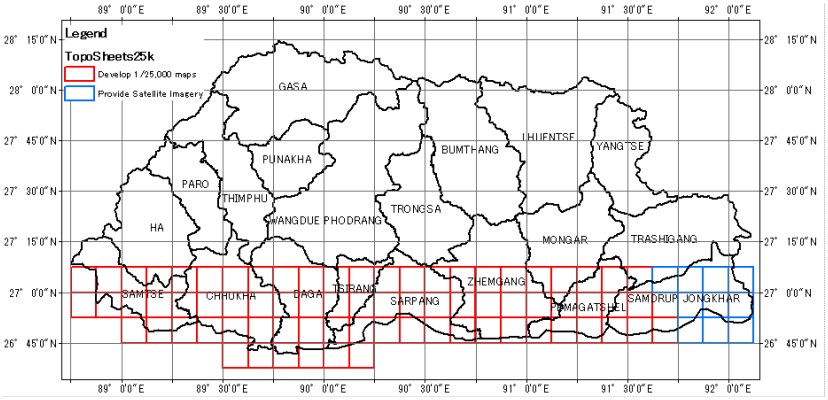


Figure. 1 Target Area of the Project

(3) Counterpart Agency and Present Status

NLCS is the counter part of the project and is the national surveying institution of Bhutan.

Major activities and services of NLCS are followings.

- Implement survey works as foundation for all "Survey works" in Bhutan
- Establish and manage points and their information as positional standard of land
- Establish and manage "Base map" and "Thematic map" as foundation for all "Geospatial Information" in Bhutan
- Manage, regulate, administer "ownership", "use", "transaction" of land

NLCS Organization

The organigram of NLCS is shown below.

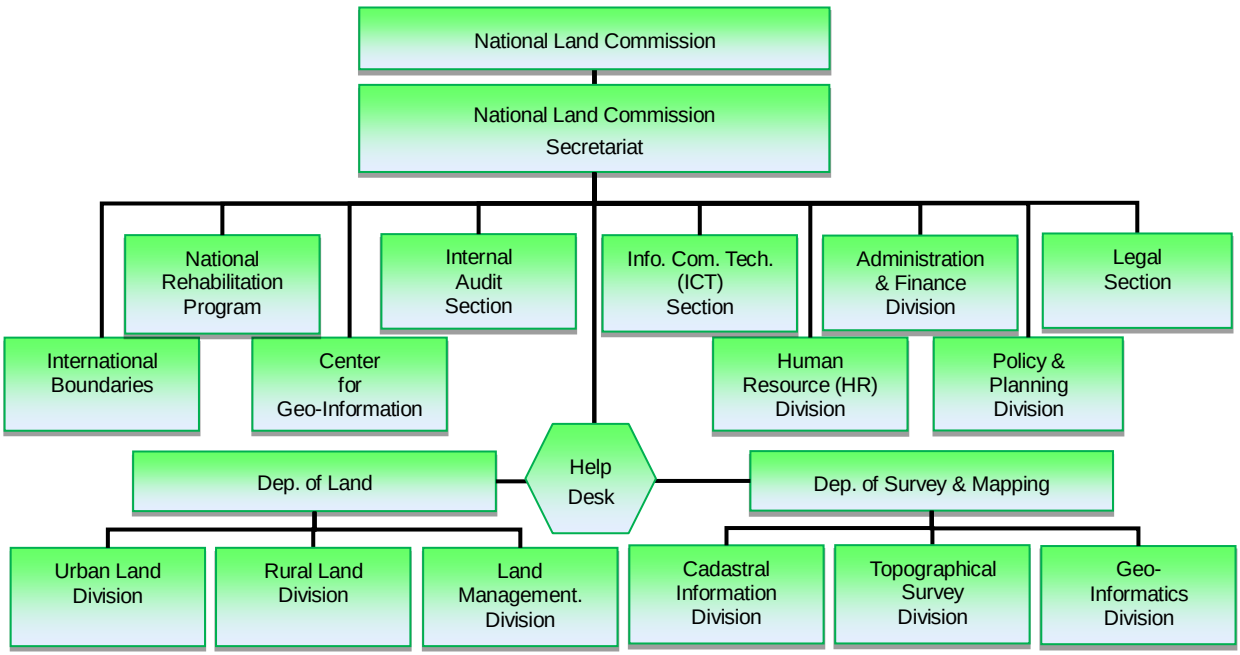


Figure. 2 Organigram of the NLCS

The table below shows the breakdown of the personnel of NLCS. The largest numbers of personnel are working in the department engaged in the creation of geospatial information in the headquarters.

Surveying engineers and surveyors are assigned to all the departments and divisions in NLCS. Surveying engineers have acquired their qualification in training in Australia and India and surveyors have acquired their qualification from the universities and technical colleges in India and Bhutan and NLCS.

Table. 3 Personnel of the NLCS

Section Name		Number of personnel			
		Total	Surveying engineers	Surveyors	Others
Administrative Part (57 pers.)	Secretariat Office National Rehabilitation Program Policy & Planning Division Internal Audit Section ICT Section Human Resource Section Legal Division Adm. & Finance Division Customer Care Archiving Section CGISC	57	9	3	44
Department of Land Administration & Management (45 pers.)	Director's Office	2			2
	Land Management Division	7	1	1	5
	Land Registration Division (Urban)	11	1	1	9
	Land Registration Division (Rural)	25	1		24
Department of Survey and Mapping (86 pers.)	Director's Office	2			2
	Cadastral Information Division	35	12	23	
	Topographical Survey Division	24	11	13	
	GeoInformatics Division	25	7	18	
Sub-total		**188**	**43**	**59**	**86**
Survey assistants		53			53
Drivers		32			32
Total		**273**	**43**	**59**	**171**
Offices in the designated cities		37	2	10	25
District offices		166	6	29	131
Grand total		**476**	**51**	**98**	**327**

The table below shows the breakdown of the budget of NLCS. Although the budget allocation to NLCS was reduced in 2015/16 from 2014/15, the allocation to the Department of Survey and Mapping engaged in the creation of geospatial information was increased.

"GeoInformatics Division" is responsible for the sales of topographic maps. The largest sales of the geospatial information in recent years were recorded in 2013-2014 because of the high demand for topographic maps in the planning of the construction of a hydroelectric power station at the time. "Topographic maps - A4-clipped," which have been sold the most, are mainly used in the classes at school.

Because large-scale infrastructure development projects including those for the construction of power supply facilities, hydropower stations and roads are expected to be implemented continuously in Bhutan, the need for geospatial information is expected to be high. However, notification to the users of the availability of digital topographic data will be required.

Table. 4 Budget of NLCS (Bhutan Ngultrum : Nu)

Section		2014 - 2015	2015 - 2016
Administrative Part		128,022,000	90,263,000
Department of Land Administration & Management		33,197,000	24,653,000
Department of Survey and Mapping	**Total of the department**	82,255,000	93,787,000
	Cadastral Information Division	26,466,000	44,228,000
	Topographical Survey Division	37,879,000	30,293,000
	Geo Informatics Division	17,910,000	19,266,000
Cadastral Re-Survey Project		149,994,000	44,021,000
Total		**393,468,000**	**252,724,000**

Table. 5 NLCS Sales performance of Geospatial Information (Unit: number of sheets, Nu)

Geospatial Information		2013 - 2014			2014 - 2015			2015 - 2016		
		sheet		Sales (Nu)	sheet		Sales (Nu)	sheet		Sales (Nu)
		Free	Not Free		Free	Not free		Free	Not Free	
1/50,000	1960 edition	23	176	10,560	2	76	4,560		28	1,680
	1990's edition	23	221	18,785	4	83	6,970		116	9,860
Satellite /Wall Map		38	25	10,000	0	16	6,400		7	2,800
Printing of maps / Images & Drawing		0	95	23,900	0	2	1,200		0	0
Thematic Map		51	9	720	16	6	480		15	2,380
Soft Copy			1set	146,083		1set	25,915		0	0
Topo Map A4 clipped (Educational Purpose)			1,352	13,520		3,989	39,890		1,806	18,060
Total				**223,568**			**85,415**			**34,780**

Capacity of NLCS

The table below summarizes the capacity of NLCS at the beginning of the project.

Table. 6 Capacity of NLCS

Item		Equipment, materials and capacity that NLCS had at the beginning of the project		Project output
Creation, maintenance and management of geospatial information	Control point survey	Total stations: 168 units GNSS receivers: 6 units (all in operation) Digital levels: 2 units	The total stations have often been used in the cadastral work. Number of staff of Topographical Survey Division with experience in GNSS surveying and leveling: approx. 3	Procurement of 4 digital levels Technology transfer
	Digital aerial photogrammetry (aerial triangulation and digital plotting)	NLCS has licensed software for photogrammetry procured in the past. Operational PCs: 3 units	(Triangulation with aerial photographs) 54% of the staff of Topographical Survey Division had experience in triangulation with aerial photographs. Few had experience in stereo plotting with aerial photographs.	Procurement of 1 digital photogrammetry system and 7 stereo plotters Technology transfer
			(Triangulation with satellite imagery) 31% of the staff of Topographical Survey Division had experience in triangulation with satellite imagery (in several projects for aerial triangulation of an area of approx. 500 km^2). Few had experience in stereo plotting with satellite imagery.	
	Field identification/ completion	Handheld GPS receiver: none Digital camera: none	54% of the staff of Topographical Survey Division had experience in field identification/completion (only with aerial photographs).	Procurement of 8 handheld GPS receivers and 8 digital cameras Technology transfer
	Digital editing and map symbolization	Operational PC: none	75% of the staff of Mapping Division had experience in digital editing and map symbolization.	Procurement of 1 digital photogrammetry system and 7 digital plotters Technology transfer
	Use of GIS application	ArcGIS with annual contract. No license limitation applies in the contract period.	88% of the staff of Mapping Division had experience in using GIS applications.	Technology transfer required for creation of GIS sample models and the structuration
	Geospatial information	NLCS owned reference stations and class 0 – 2 control points, benchmarks and gravity base stations	The reference stations were not continuously in operation. Many benchmarks had been lost.	Use of those stations in the technology transfer in control point survey and creation of a registry for their management
		1/50,000 topographic map sheets that covered approx. 90% of the land of the country were available. (20 of them were updated in the 1990's.) 8 sheets of 1/25,000 topographic maps had been created.	The topographic maps were mainly distributed in the form of the sales of printed maps.	Creation of 1/25,000 digital topographic maps of the southern region
		NLCS owned high-resolution satellite images of major cities they had acquired by themselves.	NLCS was using the orthophotos that they had created from the satellite images.	See the outputs of the technology transfer in control point survey and aerial triangulation.
		Data model or format had not been developed.	No staff had experience in developing data models or formats.	Development of the Product Specifications (draft) including the description of the data models and formats

		No manual for topographic mapping or document for data quality control or equipment operation was available.	No staff had experience in the preparation of such documents.	Development of the manual and documents in the technology transfer
Sharing and use of geospatial information	Establishment of rule	The Copyright Act and the Land Act had been enacted and is in force. The Survey Manual had been developed and is in use (mainly in the cadastral work). The Work Specifications had not been developed.	No staff had experience in developing work specifications.	Development of the work specifications including the description of a rule to prevent duplication and a data sharing policy
	Policy and mechanism of data sharing	A coordinating organization, CGISC, had been established.	CGISC held regular meetings to discuss problems in and plans for data sharing.	Dispatch of "Project Consultation Team" to Bhutan, an interview survey at CGISC by the team
		The Geo-Portal Service began in October 2014.	CGISC had formulated the G.I. policy (draft).	Discussion on the data sharing policy among the stakeholders in the government and description of the policy in the work specifications
		A medium- to long-term plan had not been developed.	No staff had experience in developing a medium- to long-term plan.	A study and discussion on a medium- to long-term plan
	Promotional activities for ordinary users	Geospatial information was available for browsing on Geo-portal.	Insufficient promotional activities	Competition of ideas for smartphone application Development of the "topographic map viewer" and its use on Web
Financial capacity		The budget of NLCS for fiscal year 2014/15 was 316,113,000 Nu (equivalent to 170 million yen).	The focus of funding was shifting from re-surveying of cadastral data to nationwide digital topographic mapping.	Evaluation and recommendations

(4) Final Outputs

Table. 7 Outputs, etc.

Item			Quantity	Remarks
(1) Work Reports		Inception Report	5 copies in Japanese (summary) 15 copies in English	10 English copies to the Government of Bhutan
		Progress Report 1		
		Progress Report 2		
		Interim Report		
		Draft Final Report		
		Final Report	5 copies in Japanese (summary) 20 copies in English	
(2) Output for Technical Cooperation	Manuals	1/25,000 digital topographic maps	2 sets	1 set to the Government of Bhutan
		1/25,000 digital topographic map QC	2 sets	
		Operational management of equipment	2 sets	
(3) Other Reports	Survey results	Field topographic surveying outputs	1 set	
		Aerial triangulation outputs	1 set	
	Digital data files	1/25,000 topographic map data	2 sets	
		1/25,000 GIS fundamental data	2 sets	
		1/25,000 topographic map data (PDF)	2 sets	
		Orthophotos	2 sets	
		Product Specifications	2 sets	
	Others	Reports on quality control	1 set	
		Itemized list of equipment and materials procured for the study	1 set	
(4) Work reports			Monthly reports (submitted to JICA by 15th of the following month)	
(5) Collected materials		With lists of the collected materials sorted by specialty	Submitted to JICA	
(6) Publicity materials		1. Overview of the project activities and project implementation procedures	200 sets of English materials (printed on matt-coated paper) Electronic data of the materials (in any data format)	150 sets to the Government of Bhutan
		2. Scope of the project		
		3. General conditions of the project target area		
		4. Outputs and results of the project		
		5. Conclusions and recommendations		
(7) Collection of digital images		Description of digital images		MS Word format
		Digital Images	Approx. 20 images	JPEG format
(8) Other documents to be submitted		Minutes of meetings, etc.	Minutes of various meetings for reporting, explaining and discussing project activities with the Bhutanese side must be prepared and submitted to JICA immediately after such meetings.	
		Letters from/to the Government of Bhutan	Copies of the letters must be submitted to JICA immediately.	

Chapter 2. Evaluation and Recommendations for Project

2-1. Confirmation of Achievement

(1) Input

The input from the Japanese side, *i.e.* dispatch of experts, training in Japan and equipment (including the equipment for the topographic mapping) was appropriate both in quality and quantity and utilized effectively.

(2) Outputs

1/25,000 digital topographic maps of the southern region of Bhutan (9,870 km^2) are created.

The technology used in the 1/25,000 digital topographic mapping is transferred to NLCS.

Model cases of NSDI are created using the 1/25,000 digital topographic maps.

Output 1: Creation of 1/25,000 digital topographic maps

1/25,000 digital topographic maps of the southern region of Bhutan (9,870 km^2) were established.

Output 2: Technology transfer

Table 8 below shows the progress in the technology transfer. The outputs of the technology transfer and the results of the evaluation of the outputs are described in detail in Table 8.

To evaluate the outputs quantitatively, a level of achievement for each goal rated on a scale of 1 to 10 was multiplied by a weighting factor determined in advance for each goal in accordance of the relative importance of the goal and a total of the weighted achievement scores was used for the evaluation of the technology transfer in each mapping stage. The reasons for failing to obtain the full mark (100 points) (the problems to be solved after the completion of the project) are described briefly in "Explanation of the Evaluation Results" in the table below.

The goal of the technology transfer in this Project, "achieving the level of capacity required for the mapping of a pilot area independently" has been achieved or is expected to be achieved in all the stages in the mapping. However, it is considered that the participants of the technology transfer require more training such as repetitive exorcize, inhouse technology transfer, new technology acquisition for the digital topographic mapping of the entire country, updating of digital topographic data and creation of larger-scale maps required for the long-term project of developing NSDI in Bhutan.

Table. 8 Summary of the evaluation

Item	State of Progress	Outputs	Measures to be taken after the completion of the Project
Control point survey	Completed	The participants can prepare a work plan and perform the process and quality control independently at an appropriate speed in a condition different from this Project. They can act as a trainer to transfer the technology they have learned to other staff.	Improvement in the capacity to acquire sufficient budget and supply of materials for the implementation of work in accordance with a plan Acquisition of the technical capacity to conduct the survey in the middle and northern region where the accessibility to survey sites is significantly different from that in the southern region
Field identification/completion	Completed	The participants can prepare a work plan and perform the process and quality control independently at an appropriate speed. They can act as a trainer to transfer the technology they have learned to other staff.	Improvement in the capacity to acquire sufficient budget and supply of materials for the implementation of work in accordance with a plan Acquisition of the technical capacity to conduct the work concerned in the central and northern regions where the occurrence of features and the accessibility to survey sites are significantly different from those in the southern regions
Aerial triangulation	Completed	The participants can prepare a work plan and perform the process and quality control independently at an appropriate speed. They can act as a trainer to transfer the technology they have learned to other staff.	Acquisition of the capacity to respond to the cases where the quality of satellite images is poor, good quality data of control points cannot be obtained because of poor accessibility in the northern region, or the quality of the observation results is poor
Digital plotting	Pilot work in progress	The participants can have the ability to implement the pilot area work. Most of the participants can have the ability to implement the work with a stable level of quality and speed. They have training of "Contour line" generation by combinational method of "manual" and "semi-manual".	Improvement in the capacity and speed of the plotting to respond to the required schedule of nationwide topographic mapping establishment Improvement of ability to urban area mapping level from the pilot area level (sparsely inhabited area). Study of adequate "Contour line" generation method to realize nationwide "Topo map" establishment Ability of Large scale mapping
Digital editing/ digital completion/ map symbolization	completed up to before the pilot work	The participants can have the ability to implement the pilot area work.	Training to have ability of implementation for intricate area as urban area level
Data structuration/ GIS data analysis	completed up to before the pilot work	The participants can have the ability to implement the pilot area work.	Training to have ability of implementation for intricate area as urban area level
	Creation of GIS sample models in progress	The participants understand the technology of GIS analysis about "Arable potential area detection model", "Landslide risk detection model", "Farm road planning model"	Study of GIS analysis models using Geospatial Information and Parameters derived from daily business of each participant

Table. 9 Overall Evaluation of and Level of Achievement in Technology Transfer

Item		Goal	Level of Achievement		Rating (score)/100	
			Score/ on a scale of 1 to 10	Weighting factor (fixed)	By goal	Total
Control point survey	1	The level at which participants can understand the theory and SPEC.	10	1.3	13.0	99.3
	2	The level at which participants can operate required equipment	10	1.3	13.0	
	3	The level at which participants can perform the work in correct procedures	10	1.2	12.0	
	4	The level at which participants can perform the basic work with satisfactory quality and at a sufficient speed	10	1.1	11.0	
	5	The level at which participants can perform the basic work with QC	10	1.0	10.0	
	6	The level at which participants can perform the basic work with process control	10	0.9	9.0	
	7	The level at which participants can perform similar work independently	10	0.9	9.0	
	8	The level at which participants can give instruction on the learned technology to other staff	10	0.8	8.0	
	9	The level at which participants can perform similar work with satisfactory quality and at a sufficient speed	10	0.8	8.0	
	10	The level at which participants can perform the work in different conditions	9	0.7	7.0	
Field identification/ Completion	1	The level at which a participant can understand the theory and SPEC.	10	1.3	13.0	93.2
	2	The level at which a participant can operate required equipment	10	1.3	13.0	
	3	The level at which a participant can perform the work in correct procedures	10	1.2	12.0	
	4	The level at which a participant can perform the basic work with satisfactory quality and at a sufficient speed	10	1.1	11.0	
	5	The level at which a participant can perform the basic work with QC	10	1.0	10.0	
	6	The level at which a participant can perform the basic work with process control	10	0.9	9.0	
	7	The level at which a participant can perform similar work independently	9	0.9	8.1	
	8	The level at which a participant can give instruction on the learned technology to other staff	9	0.8	7.2	
	9	The level at which a participant can perform similar work with satisfactory quality and at a sufficient speed	8	0.8	6.4	
	10	The level at which a participant can perform the work in different conditions	5	0.7	3.5	
AT	1	The level at which a participant can understand the theory and SPEC.	10	1.3	13.0	94.7
	2	The level at which a participant can operate required equipment	10	1.3	13.0	
	3	The level at which a participant can perform the work in correct procedures	10	1.2	12.0	
	4	The level at which a participant can perform the basic work with satisfactory quality and at a sufficient speed	10	1.1	11.0	
	5	The level at which a participant can perform the basic work with QC	10	1.0	10.0	
	6	The level at which a participant can perform the basic work with process control	10	0.9	9.0	
	7	The level at which a participant can perform similar work independently	10	0.9	9.0	
	8	The level at which a participant can give instruction on the learned technology to other staff	8	0.8	6.4	
	9	The level at which a participant can perform similar work with satisfactory quality and at a sufficient speed	8	0.8	6.4	
	10	The level at which a participant can perform the work in different conditions	7	0.7	4.9	
Digital plotting	1	The level at which a participant can understand the theory and SPEC.	10	1.3	13.0	87.9
	2	The level at which a participant can operate required equipment	10	1.3	13.0	
	3	The level at which a participant can perform the work in correct procedures	10	1.2	12.0	
	4	The level at which a participant can perform the basic work with satisfactory quality and at a sufficient speed	10	1.1	11.0	
	5	The level at which a participant can perform the basic work with QC	9	1.0	9.0	
	6	The level at which a participant can perform the basic work with process control	8	0.9	7.2	
	7	The level at which a participant can perform similar work independently	8	0.9	7.2	
	8	The level at which a participant can give instruction on the learned technology to other staff	8	0.8	6.4	
	9	The level at which a participant can perform similar work with satisfactory quality and at a sufficient speed	7	0.8	5.6	
	10	The level at which a participant can perform the work in different conditions	5	0.7	3.5	

Digital editing/ digital completion/map symbolization	1	The level at which a participant can understand the theory and SPEC.	10	1.3	13.0	86.7
	2	The level at which a participant can operate required equipment	10	1.3	13.0	
	3	The level at which a participant can perform the work in correct procedures	10	1.2	12.0	
	4	The level at which a participant can perform the basic work with satisfactory quality and at a sufficient speed	9	1.1	9.9	
	5	The level at which a participant can perform the basic work with QC	9	1.0	9.0	
	6	The level at which a participant can perform the basic work with process control	8	0.9	7.2	
	7	The level at which a participant can perform similar work independently	8	0.9	7.2	
	8	The level at which a participant can give instruction on the learned technology to other staff	7	0.8	5.6	
	9	The level at which a participant can perform similar work with satisfactory quality and at a sufficient speed	7	0.8	5.6	
	10	The level at which a participant can perform the work in different conditions	6	0.7	4.2	
Data structuration/GIS analysis	1	The level at which a participant can understand the theory and SPEC.	10	1.3	13.0	81.4
	2	The level at which a participant can operate required equipment	10	1.3	13.0	
	3	The level at which a participant can perform the work in correct procedures	10	1.2	12.0	
	4	The level at which a participant can perform the basic work with satisfactory quality and at a sufficient speed	8	1.1	8.8	
	5	The level at which a participant can perform the basic work with QC	8	1.0	8.0	
	6	The level at which a participant can perform the basic work with process control	8	0.9	7.2	
	7	The level at which a participant can perform similar work independently	7	0.9	6.3	
	8	The level at which a participant can give instruction on the learned technology to other staff	6	0.8	4.8	
	9	The level at which a participant can perform similar work with satisfactory quality and at a sufficient speed	6	0.8	4.8	
	10	The level at which a participant can perform the work in different conditions	5	0.7	3.5	

※The weighting factors were set based on the "priority for the achievement" assumed in the original plan. (Larger weighting points indicate that the priority of achieving the level concerned is high.) The scores in the table are average scores of all the participants.

Output 3: Development of NSDI

The output assumed in the original plan is considered to have been achieved. (See Table below.)

The measures to be taken in future are described in "2-4. Recommendations."

Table. 10 Activities for NSDI Development and Outputs of the Activities

Item	Purpose	Activity/output	Progress in Achievement
1) Development of geospatial information	1/25,000 digital topographic mapping of the southern region	Digital topographic maps	The maps have been created.
2) Establishment of a system for the maintenance and management of geospatial information	Development of the technology and system, quality/process control, maintenance of equipment for the creation and updating of the 1/25,000 digital topographic maps of the southern region	A study on a "medium- and long-term plan (draft)" with NLCS Development of various technical manuals and manuals for quality control and equipment management	Common understanding of the "medium- and long-term plan (draft)" has been formed between the Team and NLCS through the study and discussion on the plan. Various manuals have been developed.
	Preparation of the work specifications and product specifications to be used in the 1/25,000 digital topographic mapping of the southern region	Development of the work specifications (draft) and product specifications (draft)	The specifications have been developed.
3) Establishment of a system for geospatial information sharing	Description of the duplication prevention measures and data sharing rule in the work specifications Development of a model case of information sharing with 1/25,000 digital topographic maps Coordination with NLCS (for the sharing of the data managed by NLCS) Coordination concerning data policies with data providers (CGISC member organizations)	Common understanding of the importance of sharing geospatial information among the stakeholders formed in the consultation by the "Project Consultation Team" Recommendations of the consultation team on the data sharing policy (free distribution of raster data to users in the private sector and free distribution of all the digital data to governmental organizations)	Reference materials for the development of rules for the prevention of the duplication in the creation of geospatial information and data sharing among the stakeholders have been prepared. A basic policy on the sharing of geospatial information has been developed.
4) Establishment of a system for the use of geospatial information	Development of model cases of information dissemination and use with 1/25,000 digital topographic maps Organizing seminars	An open competition of ideas of smartphone applications of "1/50,000 and 1/25,000 topographic map browsing viewer" on the Web Seminars	Data and a system for public browsing have been developed and the measures have been taken to promote the use of the data and the system.
	Proposals for model cases of the use of 1/25,000 digital topographic maps in the formulation of an "agriculture development plan" or an "infrastructure development plan" (GIS Sample models)	"1/50,000 and 1/25,000 topographic map browsing viewer" and a GIS sample model for the formulation of "agriculture development plan" were created and used in the technology transfer.	Practical examples of data use among government officials were presented.

(3) Progress in Achievement of Project Purpose

＜Project Purpose＞

1/25,000 digital topographic maps covering the southern region (9,870 km^2) of Bhutan will be developed using satellite images, and the technology transfer for the development of the NSDI and digital topographic maps will contribute to the formulation of agriculture and infrastructure development plans.

Table below shows the outline of the plans for "infrastructure development" and "agriculture development" of the CGISC member organizations and the organizations interviewed in this Project in which the digital topographic maps are expected to be used during and after the implementation of this project. Organizations in the following table, who understood the usability of "Geospatial information" through the seminar and Technology transfer in the project, requested NLCS the outputs of the project and they have already been shared the data.

Based on these findings, the Team considers that the digital topographic maps created and the technology for the creation, updating, management and use of the maps transferred in this Project facilitates the formulation of such plans as agriculture and infrastructure development plans and that, thus, the project purpose were achieved with the use of the maps and the technology.

Table. 11 Expected Use of Geospatial Information by concerning Organizations

Organization	Use of the 1/25,000 topographic map data	Remarks
Bhutan Power Corporation (BPC)	The data will be used in facility management and environmental impact assessment of infrastructure development projects.	Outputs have been shared Utilization for infrastructure field
Department of Hydropower and Power Systems	The department has formulated several projects for dam construction in the southern region, to which budget has not been allocated. The data will be used for the selection of dam sites (in a feasibility study) once the budget has been allocated to those projects.	Utilization for infrastructure field
Department of Road	The department has formulated several construction projects of national highways, tunnels and bridges in the southern region, to which budget has not been allocated. The data will be used for the selection of the construction sites (in a feasibility study) once the budget has been allocated to those projects.	
National soil service center	The center has a plan to create 1/50,000 soil maps of the entire country by 2020. The soil maps will be used for the planning in the agriculture sector with the topographic maps. The center are interested in the idea of nationwide "Agricultural potential area detection" using Geospatial Information and GIS	Utilization for agricultural field
Department of Agriculture	A plan for the construction of agricultural roads in each gewog is formulated every five years. The development of the viewer is expected to enable the use of topographic maps, which have not been used until now.	Utilization for infrastructure / agricultural field
Ugyen Wangchuk Institute of Conservation and Environment	Study of "Natural habitat of rare animals"	Outputs have been requested
Samtse Prefecture	Sorting of projects and areas for "12th Five-Year Development Plan"	Outputs have been shared
Department of Works and Human Settlement	"Project for Formulation of Comprehensive Development Plan for Bhutan" with JICA	
JICA Consultant	Study of "Glacier Lake Outburst Flood"	
SATREPS	The data will be used for the "Active Fault" Mapping in the evaluation of "Earthquake Hazard".	Outputs have been requested
National Land Use Zoning Project	The data will be used for the effective zoning work	Will be used by NLCS

2-2. Results of Evaluation

The project was evaluated on the following five criteria, (1) relevance, (2) effectiveness, (3) efficiency, (4) impact and (5) sustainability.

(1) Relevancy

The relevance of the project is considered high because of the following reasons.

1) The Japanese assistance programs are formulated in accordance with the Japan's "Country Assistance Policy" for Bhutan.
2) The Government of Bhutan is studying the implementation of the "12th Five-Year Development Plan (in preparation)" for the period beginning in July 2018. It will be mentioned in this Plan that the development of "geospatial information," which will be available for common use among the ministries and agencies responsible for the planning, implementation and evaluation of projects, is in progress with Japanese assistance.
3) The need to develop geospatial information of the international standard of an entire country as basic information is recognized internationally in the "Sustainable Development Goals (SDGs)" because the analysis of the information produces an indicator for the monitoring of sustainable development of the country and the information is required for objective comparison between countries in the achievement of country-specific sustainable development goals. The project contributes as the part of effort for the national base establishment.

(2) Effectiveness

The effectiveness of the project is considered high because of the following reason:

1) The outputs of the project such as "Establishment of Geospatial Information", "Technology Transfer to NLCS", "Establishment of NSDI" were achieved the Project Purpose.
2) The Publicity to notice that NLCS is the major organization who manage, regulate, implement basic works and records for all geospatial information of Bhutan and their ability and presence succeeded through the consultation by "GSI Consultation Team", seminar and technology transfer mainly organized by NLCS.
3) After exemplifying of "Data sharing" model such as Web base "Topographic base map viewer", the importance and effectiveness of data sharing concerning national development plan managed by each organization based on geospatial information were disseminated.
4) Requests of the outputs of the project from some of organization for the purpose of various "development plan" show some accomplishments exceeded the "Project purpose".

(3) Efficiency

The facts mentioned below prove the appropriateness of the input in quality, quantity and timing. Therefore, the efficiency of the project is considered high.

1) The commencement of this Project coincided with that of the operation of "Geo-portal" and the discussion on a "G.I. policy" in Bhutan. When the implementation of the project commenced, the national cadastral survey of NLCS was in the final stage and NLCS was shifting the focus of its work to "topographic mapping of the entire country."
2) A plan for field work that took accessibility in the mapping area into consideration was prepared and implemented in this Project. The concurrent implementation of "Field Identification" and "Field Completion" made significant effectiveness.
3) The technology transfer was implemented with a plan that did not require the use of too many different types of software. The equipment NLCS owned including the server and Geo-portal was utilized effectively in the technology transfer. As a consequence, the technology transfer was implemented not by forcing the use of the methodology used in Japan but by modifying the contents to make them appropriate for the current work environment of the C/P organization and the capacity of its staff.
4) In addition, an environment in which users all over the world can browse the geospatial information of Bhutan was developed cost-effectively with such a measure as the use of open source applications and free software in the development of a viewer.

(4) Impact

Negative impact of the Project has not been found so far. The three facts mentioned below have already been identified as positive impact of the Project.

1) The number of the engineers who participated in the technology transfer was larger than expected. The quantity of the work performed by the participants in the pilot work was also larger than expected.
2) The "1/50,000 and 1/25,000 topographic map viewer" developed in this Project has already been uploaded on the website of NLCS and is available for browsing.
3) The members of CGISC have been sending inquiries on the use of the Project outputs after the completion of the Project. NLCS is preparing procedures for the data use using the mechanisms and reference materials proposed in the project.
4) After the "Final seminar", Samtse prefecture requested NLCS the 1/25,000 digital topographic map (GIS data) of the project for the purpose of sorting of projects and areas for "12th Five-Year Development Plan".

(5) Sustainability

The facts mentioned below make expectation of the sustainability about data-establishment, data-updation, data-sharing and data-utilization of geospatial information by NLCS and concerning organizations.

The expectation for the creation of 1/25,000 topographic maps of the central and northern regions of Bhutan is high because such maps are not available. NLCS has expressed interest in creating such maps. The creation of the maps of the central region is expected to increase the use of geospatial information because the demand for such maps is particularly high. The system to provide data to users is being established as exemplified by the establishment of the Geo-portal.

Although the participants of the technology transfer in this project have improved their technical capacity to the level at which they can create topographic maps independently, they have to continue improving the speed of the work. Therefore, they need additional support to complete the topographic mapping of the entire country during the implementation period of the There is also a need to improve the hardware and software for the mapping.

1) Through the technology transfer, 5 engineers were trained to establish and update middle scale digital map with the level of stable speed and quality on the condition of similar area as pilot work. For realizable sustainability, “Capacity expanding of Operators, Hardware and Software”, “Improvement of work performance to adequate level of needs for nationwide topomap establishment”, “Establishment of QC scheme to guarantee the quality as commercial products” shall be required in the future.
2) In addition to the existing resources such as “CGISC” and “Geo-portal”, the backbone of “data-sharing and data-utilization” was prepared by the actions “Geospatial Information”, “Consultation of GIS team”, “Topographic base map viewer”, “GIS utilization models”. Formulation of practical structure shall be expected to operate realistically NSDI in the future.
3) The “Geospatial Information” are counted to be cross-sectional foundation through plans from each governmental organization for “12th Five-Year Development Plan.” and contribute efficiency and harmonization in case of implementation of the plan. Some of organizations have requested outputs of the project for the purpose of above use.
4) It will also be necessary to raise the revenue for the continuous updating and printing of topographic maps with the sales of geospatial information and other means. The establishment of a fee-based system for the distribution of digital topographic data will require a rule on data duplication and measures against unauthorized use of the data, in particular.

2-3. Conclusion of Evaluation

The results of the evaluation of this Project in each stage of its implementation and on the five criteria mentioned above suggest that the Project Purpose has been achieved within the project implementation period.

2-4. Recommendations

Recommendations on the measures required to maintain and increase the impact of the Project after its completion are described in the following to facilitate the achievement of the Overall Goal of the Project, "Digital topographic maps will be prepared and maintained by NLCS and used for agriculture and infrastructure planning."

(1) Capacity Development for the Expected Digital Topographic Mapping of the Entire Country

As mentioned above, the skills (especially the speed of the work) of the engineers of NLCS will have to be improved further if the creation of 1/25,000 digital topographic maps of the entire country, one of the major tasks of NLCS, is to be completed within a period demanded by their users. As the need for large-scale digital topographic maps of urban areas is expected to increase, NLCS is expected to need technical assistance in the creation of such large-scale maps and the use of graphic reduction for the improvement of the efficiency of 1/25,000 digital topographic mapping.

Five staff members of the C/P organization were the main beneficiaries of the transfer of the technology used in laboratory in this project. They will have to transfer the technology they have learned in this Project to other staff members to establish a system to create digital topographic maps in large quantity. The human resources, hardware and software for the digital topographic mapping will also have to be improved for the same purpose.

Discussion on the concepts to be used in the preparation of a "medium- to long-term plan" of NLCS was held in this Project. NLCS will need to formulate such a plan including the development of a plan for the NSDI development and the rules on the NSDI in compliance with the "12th Five-Year Development Plan."

(2) Establishment of a Mechanism for Distributing Digital Data with Fees

NLCS intends to provide the geospatial information free of charge to governmental organizations. Meanwhile, although NLCS intends to provide raster data free of charge to users in the private sector, there will be a charge for vector data.

NLCS and CGISC have a G.I. policy (draft) on the information distribution. They will need to have discussion on the policy including the discussion on the sales prices of digital (vector) data and amendment to the policy for the sale of such data.

Addition of applications and data downloading functions to the existing user-friendly data-distribution tool, "Geo-portal," is recommended on the assumption that the Internet environment in Bhutan is to be improved in future.

(3) Development of a Mechanism for Data Sharing

A simple system for the sharing of a wide variety of information, including 1) purpose of data creation, 2) data specifications (contents, accuracy, etc.), 3) data creator and 4) the year of data creation, between data creators and data users will be required to realize effective and efficient creation and use of geospatial data, the main purpose of the development and operation of NSDI.

Establishment and operation of such an information sharing system will require additional efforts to develop mechanisms and an environment, such as those for the creation of common understanding and standardization of the rule on data sharing (including the development of applications) and outsourcing, among the organizations creating and using geospatial information both in the public and private sectors.

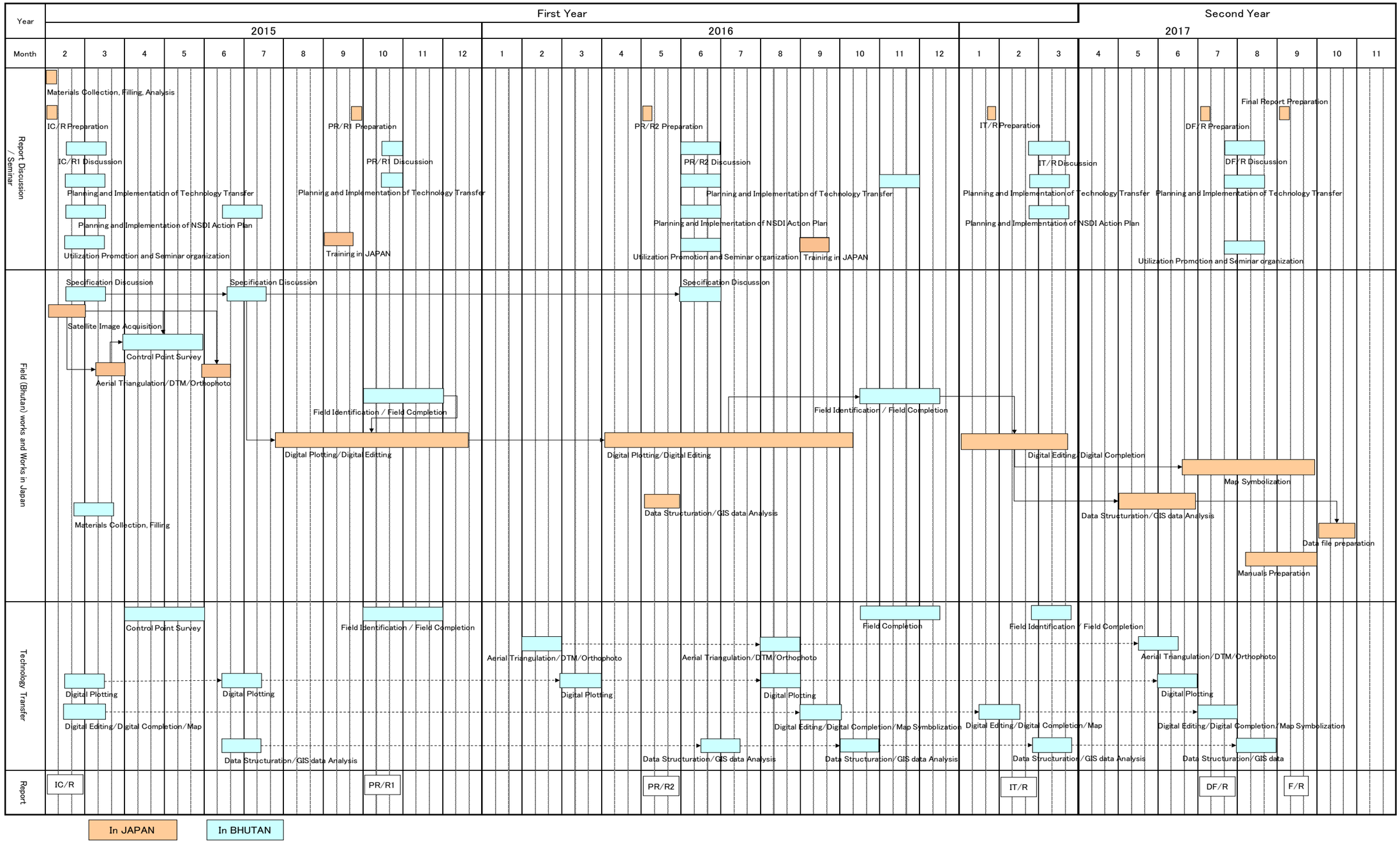
(4) Development of "Survey Act"

For the establishment of Geospatial Information and the promotion and dissemination of Data-sharing and Data-utilization, development of "Survey Act" are essential. As statements in the act, "Strengthen of NLCS authority", "Qualification system of Surveyor", "Deduplication of survey result" etc, are desired.

Chapter 3. Establishment of Digital Topographic Map

3-1. Scheme of Work

Table. 12 Work Flow



3-2. Contents and Progress of Work

[1] Discussion on specifications 《Work in Bhutan》

In order to develop the 1/25,000-scale topographic maps, discussions were held with the NLCS on the following specifications (including survey standards and annotations). The final edition was prepared after addition and amendment from Field Identification and technology transfer.

Table. 13 Agenda for Specifications Discussions

	Item	Description
1	Work Specifications	The work of developing the digital topographic maps in this Project was in accordance with the Survey International Specifications (for Base Maps) (December 2006, JICA). Work Specifications (draft), 1/25,000 Topographic Map Symbols (draft), Product Specifications (draft) and Marginal Design (draft) were prepared in this Project.
2	Survey standards	Geodetic system: Drukref03 Reference ellipsoid: GRS1980 (a = 6,378,137.000m; 1/f = 298.257222101) Elevation reference: Existing benchmarks installed in Bhutan
3	Indication of copyrights	The indication method and content of copyright ownership of the topographic maps was decided through discussions (by the NLCS, JICA, JICA Bhutan Office, and JICA Study Team).

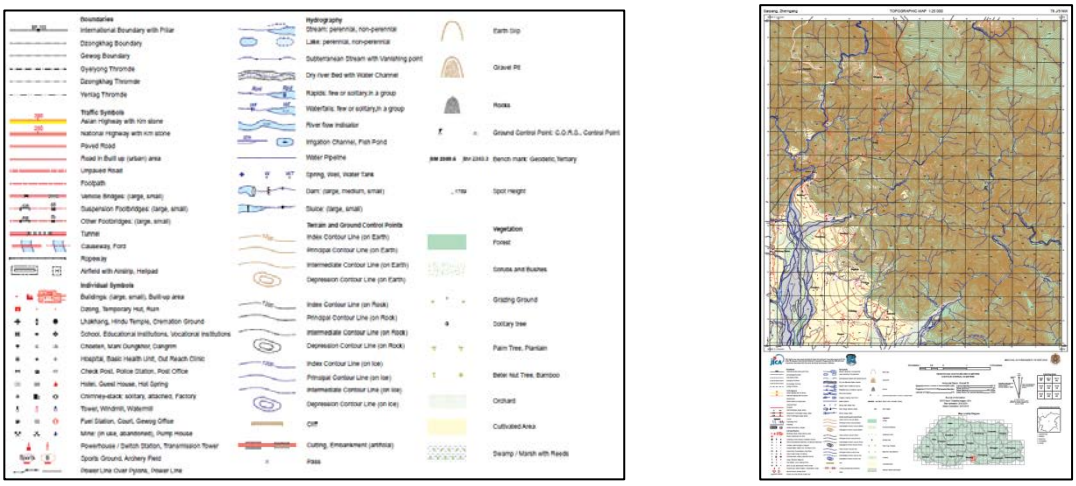


Figure. 3 Map symbol catalogue and Map Print Design

[2] Acquisition of satellite images 《Work in Japan》

Satellite images covering the target area of this Project (11,000km^2) as shown in Section 1-3 (2) were acquired to ensure that the 1/25,000 digital topographic maps to be developed in this Project meet the accuracy as specified in the Survey International Specifications (for Base Maps) (December 2006, JICA). New satellite images were purchased to replace the existing images of areas in the pilot area where significant change has taken place since they were taken and those with large cloud cover.

Table. 14 Specifications of Target Satellite Images

	Item	Description
1	Type of satellite	SPOT6 / SPOT7
2	Time of photography	After November 2014
3	Ground resolution	Panchromatic (black/white): 1.5m Multi-spectrum (color): 6m Pan-sharpened: 1.5m
4	Stereo	Provided
5	Cloud volume	Less than 10%
6	Format	DIMAP V2 format (JPEG 2000 or GeoTIFF)

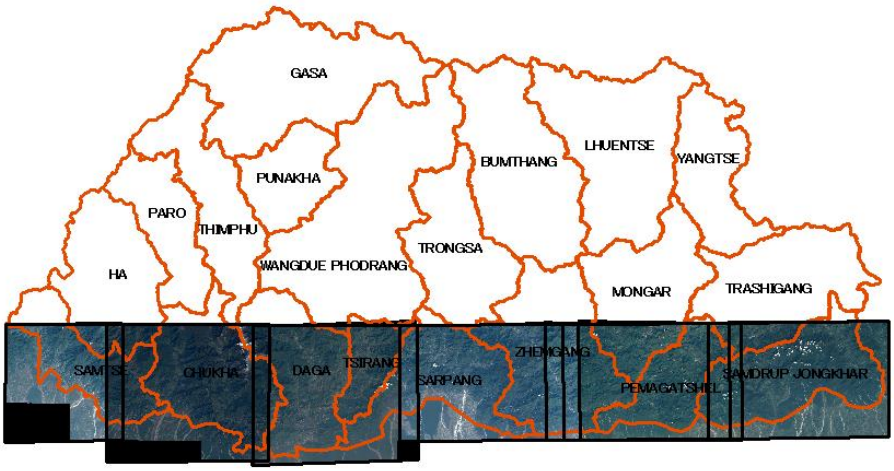


Figure. 4 Status of Satellite Image Acquisition

[3] Control point survey 《Work in Bhutan》

The control point survey was executed through technology transfer to NLCS staff in the form of OJT under the guidance of two members of the Team. The work was implemented with much attention to safety and along to efficient plan which utilized existing materials such as existing geodetic points (0 order, 1st order, 2nd order) and existing survey results.

Table. 15 Control Point Survey Work

	Item	Method	Work Volume	Equipment	Remarks
1	GNSS observation	Static positioning	9 points	GNSS receiver: 4 units	All result was satisfied its tolerance. All result was satisfied its tolerance. All result was satisfied its tolerance.
2	Leveling	Direct leveling	24 points Total length: Approx. 5km (two-way leveling)	Digital level: 4 units	
		GNSS leveling	2 points	GNSS receiver: 4 units	
3	Analysis of survey results	Network analysis	9 points	GNSS analysis software Laptop PC	All result was satisfied its tolerance.

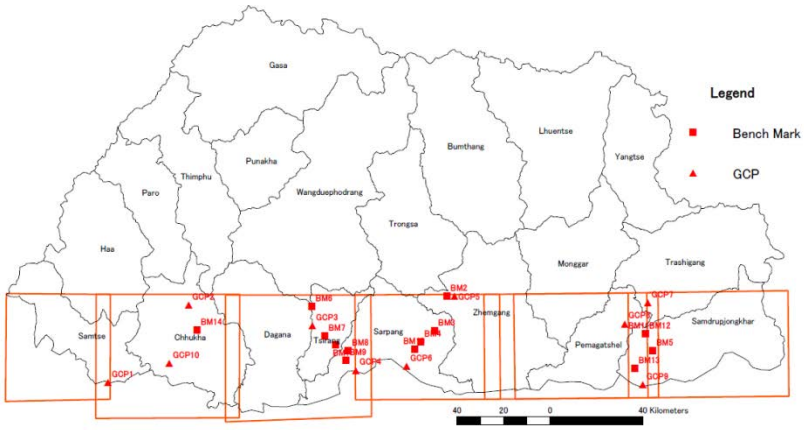


Figure. 5 Allocation of Control Points

[4] Aerial triangulation / DTM / creation of orthophotos 《Work in Japan / Work in Bhutan》

The aerial triangulation survey using the satellite images acquired in the work [2] and the result of Control Point Survey [3] was executed.

In the aerial triangulation survey using satellite images, the images of the entire project area (11,000km^2) were processed as a block in Japan because better accuracy was expected from processing images as a block than processing them by scene. It was confirmed that the standard deviations and maximums of the residuals of the horizontal positions and elevation values obtained in the aerial triangulation were within the range of tolerance for the 1/25,000 topographic mapping.

Technology transfer also was implemented for the entire project area.

Table. 16 Aerial Triangulation / DTM / Orthophoto Work

	Item	Contents	Remarks		
1	Ground control point (GCP)	24 points (14 vertical points)	Tolerance		Result
			Tolerance (horizontal)	Standard deviation	5.0m
				Maximum	10.0m
			Tolerance (elevation)	Standard deviation	5.0m
				Maximum	10.0m
2	Tie point	6 points or more per scene	Allowable residual range	Standard deviation	1.5m
				Maximum	3.0m
3	Adjustment method	Bundle adjustment			
4	DEM	50m Mesh			
5	Orthophoto	GSD: 1.5m	1/25,000 Map sheet base		

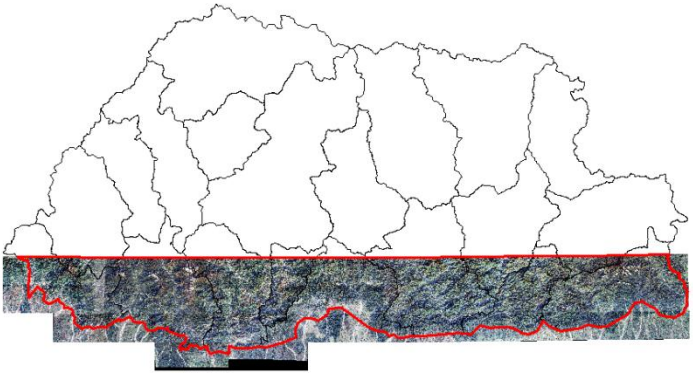


Figure. 6 Generated Orthophoto

[5] Field identification and field completion 《Work in Bhutan》

The field identification and field completion detailed in Table below was implemented as OJT-based technology transfer to the staff of NLCS under the instruction of two Team members. The field identification/completion in the areas where the Team members were restricted to enter by JICA for security reasons (the shaded areas on the map in Fig. 7) was performed by the NLCS staff alone, while the schedule of their work was controlled by the Team members from outside.

Table. 17 Field Identification / Field Completion Work

Work Time		Item		Description	Equipment	Remarks
1	1st Oct – Nov 2015	Eastern Area	Field Identification	Collection of information where the satellite images are difficult or impossible to interpret, and information such as administrative boundaries and names	Orthophoto / Printed plotted manuscript maps (approx. 35 sheets) Digital camera: 8 units Handy GPS: 8 units	2 members × 8 groups Red area in Figure7
2			Field Completion	Survey of the points which are deemed to be doubtful and rechecking in the plotting work, and any secular changes after acquisition of the satellite images		
3	2nd Oct – Nov 2016	Western Area	Field Identification	Collection of information where the satellite images are difficult or impossible to interpret, and information such as administrative boundaries and names	Orthophoto / Printed plotted manuscript maps (approx. 40 sheets) Digital camera: 8 units Handy GPS: 8 units	2 members × 8 groups Blue area in Figure7
4			Field Completion	Survey of the points which are deemed to be doubtful and rechecking in the plotting work, and any secular changes after acquisition of the satellite images		

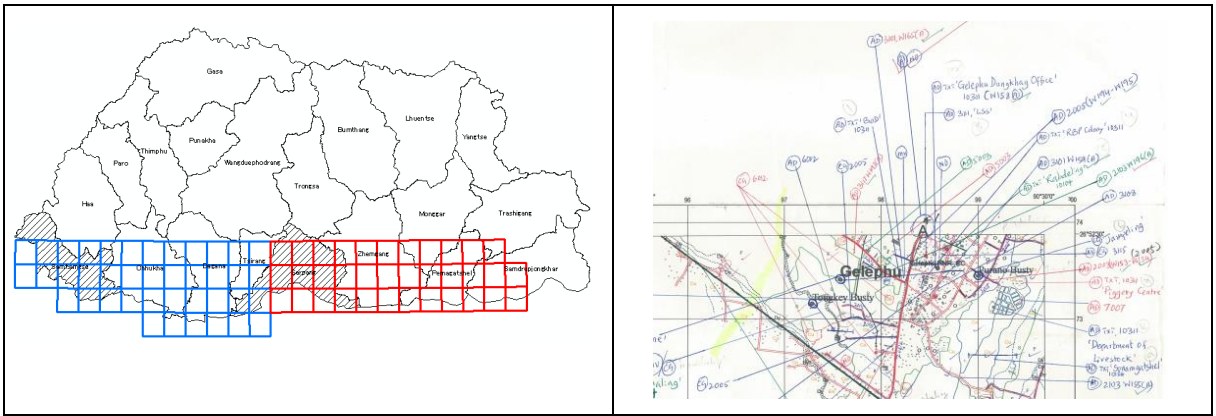


Figure. 7 Field Identification / Completion (Left: Work Area, Right: Field Completion result)

Table. 18 Field Identification and Field Completion Work

	Item	Content
1	Questions from plot operators	Confirmation survey and creation of responses to about 780 questions
2	Map inspection	Inspection by field comparison of plotted maps
3	Newly added features	Addition of features that have undergone secular changes and are difficult to interpret on satellite images (about 2,000 features)
4	Annotation information	Interview survey at the field administrative office (Gewog office) about the official names of villages, mountains, rivers, etc. (about 2,600 questions).

[6] Digital plotting/ digital editing 《Work in Japan / Work in Bhutan》

A stereo environment for satellite images was built by referring the external orientation elements obtained from Aerial Triangulation. And the topographic and planimetric features as specified in the 1/25,000 map symbol specifications as agreed upon in the discussions on the specifications in the work [1] were extracted from stereo interpretation of the satellite images and the field identification results in accordance with the data acquisition standards.

After completion of the digital plotting, the forms and logicality of the planimetric features were corrected in accordance with the data acquisition standards, and data cleaning including deletion of unnecessary data was performed. After that, administrative boundary data and annotation data were added to create the plotting manuscript map data. The items from the field completion were added to the data to produce the field completion map.

This work for the entire target area of 9,870 km^2 was executed in Japan and the work for the 1,130 km^2 area in the east was executed by the NLCS within the framework of the technology transfer (pilot work).

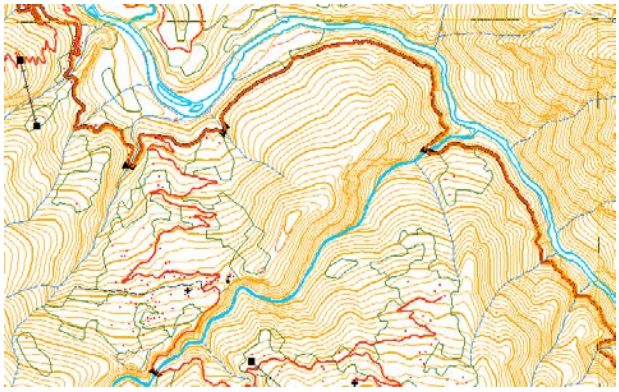


Figure. 8 Digital Plotting data

[Second Year: April 2017 to November 2017]

[7] Digital completion 《Work in Japan / Work in Bhutan》

About east area, the Plotted/Edited data was modified with the result of "Field Identification / Field Completion (implemented October – December 2015)". About west area, modification of "Field Identification / Field Completion (implemented October – December 2016)" was implemented.

This work was executed for the target area of 9,870 km^2 in this Project in Japan and the work for the 1,130 km^2 area in the east was executed by the NLCS within the framework of the technology transfer (pilot work).

[8] Map symbolization for topographic maps 《Work in Japan / Work in Bhutan》

The data for which digital completion was carried out were subject to map symbolization in accordance

with the map symbol specifications as agreed upon through the discussions on specifications in the work [1] so that the data can be used as easy-to-see topographic maps and printed output maps.

This work was executed for the target area of 9,870 km^2 in this Project in Japan and the work for the 1,130 km^2 area in the east was executed by the NLCS within the framework of the technology transfer (pilot work).

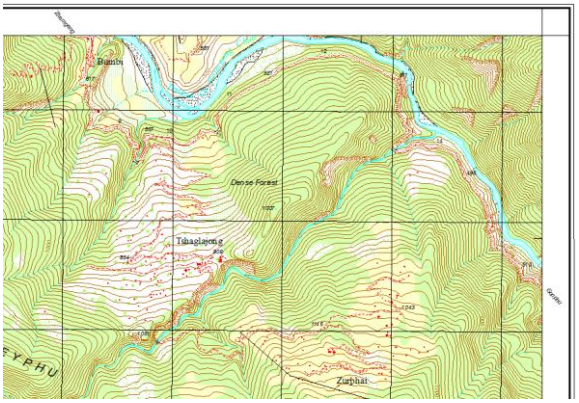


Figure. 9 Symbolized data (Sample)

[9] Digital data structuration / GIS data analysis 《Work in Japan / Work in Bhutan》

The topographic map data were be structured as data with phase relations so that it can be formatted for use with GIS software. The data specifications and file size were in accordance with the Product Specifications as agreed upon through the discussions on specifications in the work [1].

GIS sample models with high need for utilization were created based on the structured data and the materials collected from the related staff of the Centre for GIS Coordination (CGISC).

The Team developed Design Web Format "Topographic base map viewer" using "GSI Maps" open source code for the purpose of flee browsing and the browser is linked NLCS Web page (http://www.nlcs.gov.bt/topo_map/gsimaps/).

Table. 19 GIS Sample Model creation

	Sample model	Area concerned	Description
1	1/25,000 and 1/50,000 topographic map browsing viewer	Infrastructure development plan	Browsing of "1/25,000 and 1/50,000 topographic maps" and map sheet numbers, measurement/drawing, export of drawing data, display of the position of the operator on the Web
2	Arable potential area detection model	Infrastructure development plan	Analysis based on conditions such as "Shape of valleys ", "Distance from valley", "Angle of slopes"
3	Landslide risk detection model	Agriculture development planning	Analysis based on conditions such as "Temperature ", "Angle of slopes", "Water drainage", "Amount of insolation", "Cultivatable effectivity", "Accessibility"
4	Farm road planning model	Agriculture development planning	Detection of appropriate road network through the area detected in "Arable potential area detection model"

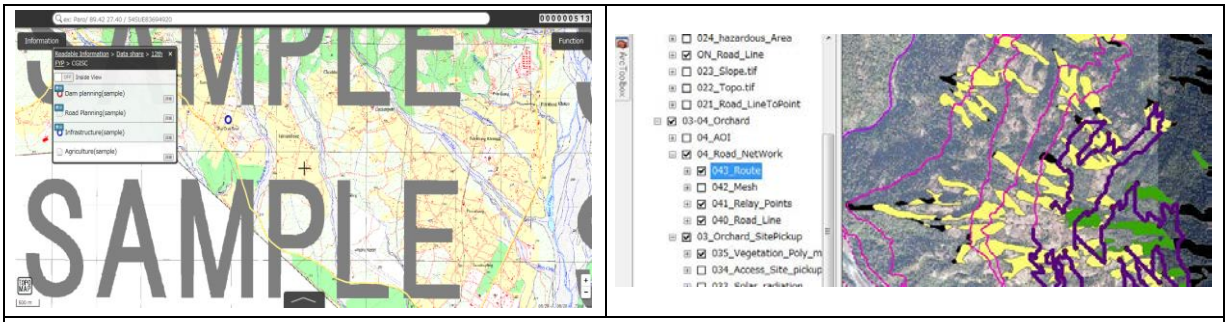


Figure. 10 GIS Sample Models (Left: Viewer, Right: Arable Land Identification Model)

[10] Creation of data files 《Work in Japan / Work in Bhutan》

As for the digital data of the created topographic maps and the GIS data, the data files were created in an appropriate format in accordance with the specifications as agreed upon through the discussions with the NLCS and the data were stored in a recording media (Hard disk).

Chapter 4. Technology Transfer

4-1. Concept of Technology Transfer

Technology Transfer was implemented along with following concept in each period of "Basic Stage", "Replication Period", "Pilot/Summary Period".

[Basic Stage: Understanding of theories, operations, specifications (2015 – First half of 2016)]

In this stage, the technology transfer was carried out by placing emphasis on familiarization with basic theories and basic operations of the equipment to be used. The theories were mainly taught by lectures and operation of the equipment was taught by exercises in the field work using the actual equipment.

Table. 20 Contents of Technology Transfer (Basic Period)

Item		Goal		Work	Evaluation Method / Indicator	Evaluation
1	Control point survey	Understanding of theories	Capable of control point selection work Capable of pricking work	Lectures (3 days) and OJT	Qualitative evaluation by questionnaire and the Team members	Level of Self operation by NLCS
			Able to understand the theory of eccentricity			
			Able to understand the theory of leveling surveys			
			Able to understand the theory of net adjustment			
		Understanding of operations	Able to operate at digital level	OJT	Operation test	
			Able to operate the network analysis software	Exercises (3 days)	Operation test	
2	Field identification/ Field completion	Understanding of theories	Able to understand the pre-interpretation work	Lectures (5 days) and OJT	Qualitative evaluation by questionnaire and the Team members	Level of Self operation by NLCS
			Able to understand the field identification work			
			Able to understand the field completion work	Lectures (5 days)		
		Understanding of operations	Able to operate the handy GPS	OJT		
3	Aerial triangulation	Understanding of theories	Able to understand the theory & the error concept as stated in the Work Specifications	Lectures (3 days)	Qualitative evaluation by questionnaire and the Team members	Well - understood
			Able to understand the theories on creation of DTM and orthophotos	Lectures		Level of implementation for basic work (DEM generation & modification)
		Understanding of operations	Able to operate the photogrammetry system	Exercises (10 days)	Operation test	Basic Manipulation was understood
4	Digital plotting	Understanding of theories	Able to understand the Work Specifications Able to understand the map specifications, and acquisition standards and procedures	Lectures (5 days)	Qualitative evaluation by questionnaire and the Team members	Specification and Map symbols were understood Basic level of acquisition for a series of feature

		Understanding of operations	Able to operate the stereo equipment Capable of basic operation of GIS software	Exercises (30 days)	Operation test	Basic Manipulation was understood
5	Digital editing/ Digital completion	Understanding of theories	Able to understand the methods of data error detection and correction, and the polygon creation method	Lectures (2 days)	Qualitative evaluation by questionnaire and the Team members	Well - understood
		Understanding of operations	Capable of error rejection and polygon creation by operating GIS software	Exercises (16 days)	Operation test	Basic Manipulation was understood
6	Map symbolization	Understanding of theories	Able to understand the Product Specifications Able to understand mapping theory Able to understand the map symbolization	Lectures (5 days)	Qualitative evaluation by questionnaire and the Team members	Well - understood
		Understanding of operations	Able to carry out the symbolization process using GIS software	Exercises (15 days)	Operation test	Basic Manipulation was understood
7	Data structuration	Understanding of theories	Able to understand the Product Specifications Able to understand the data structures	Lectures (13 days)	Qualitative evaluation by questionnaire and the Team members	Well - understood
		Understanding of operations	Able to carry out the basic analysis process using GIS software	Exercises (17 days)	Operation test	Basic Manipulation was understood

[Replication Period: Exercises, Quality / Process Control, Manuals (Second half of 2016)]

Table. 21 Contents of Technology Transfer (Replication Period)

Item		Goal		Work	Evaluation
1	Aerial triangulation	Exercises	Able to carry out aerial triangulation by manual process using aerial photos and satellite images	Exercises using the digital photogrammetry system	Level of Self operation by NLCS
			Able to create DTM and orthophotos	Exercises using the digital photogrammetry system	Level of Self operation by NLCS
		Quality control and process control	Capable of quality control in accordance with the Work Specifications and Product Specifications	Preparation of accuracy control table by NLCS	Work Specification and Product Specification were understood.
			Able to monitor productivity	Monitoring of ability to observe the control points and tie points	Streamlining of Observation
		Preparation of manuals	Able to prepare the aerial triangulation manual (work theory, operation of digital photogrammetry system), and digital photogrammetry system management manual	Preparation of manuals by NLCS and the Team	Level of operation according to the manual
2	Digital plotting	Exercises	Exercises within the scope of work in Japan: 340 km^2	Exercises using the stereo plotter	Understanding of General feature plus "Contour", "Contour & River", "Vegetation boundary"
		Quality control and process control	Able to implement quality control by comparison with the results in Japan	Preparation of inspection maps	
			Able to monitor productivity	Number of planimetric features acquired Volume of elevation data acquired	Level of Stable operation by NLCS

		Preparation of manuals	Able to prepare the digital plotting manual (work theory, stereo plotter operations) and stereo equipment management manual	Preparation of manuals by NLCS and the Team	Level of operation according to the manual
3	Digital editing/Digital completion	Exercises	Exercises within the scope of work in Japan 172km^2	Exercises using GIS software	Level of Self operation by NLCS
		Quality control and process control	Capable of quality control by monitoring the detected logical errors	Data cleaning and creation of topology	Level of Self operation by NLCS
			Able to monitor productivity	Number of detected errors and number of connections	Level of Stable operation by NLCS
		Preparation of manuals	Able to prepare the digital editing manual (work theory, error detector operations)	Preparation of manuals by NLCS and the Team	Level of operation according to the manual
4	Map symbolization	Exercises	Exercises within the scope of work in Japan 172km^2	Exercises using GIS software	Level of Self operation by NLCS
		Quality control and process control	Capable of quality control by inspection of printed maps	Preparation of inspection maps Preparation of accuracy control table	Level of Self operation by NLCS
			Able to monitor productivity	Work volume per unit area	Level of Stable operation by NLCS
		Preparation of manuals	Able to prepare the map symbolization manual (work theory, creation of symbols)	Preparation of manuals by NLCS and the Team	Level of operation according to the manual
5	Data structuration	Exercises	Exercises within the scope of work in Japan 172km^2	Exercises using GIS software	Level of Self operation by NLCS
		Quality control and process control	Capable of quality control by comparison with the Product Specifications	Inspection of GIS data structure	Level of Self operation by NLCS
			Able to monitor productivity	Work volume per unit area	Level of Stable operation by NLCS
		Preparation of manuals	Data structuration manual (work theory, creation of GIS data), and GIS software management manual	Preparation of manuals by NLCS and the Team	Level of operation according to the manual

[Pilot/Summary Period: Pilot Work, Technology Transfer Evaluation, Arrangement and Analysis of Achievement Levels (2017)]

Table. 22 Contents of Technology Transfer (Pilot/Summary Period)

Item		Goal	Work	Evaluation Method / Indicator	Evaluation
1	Field identification/ Field completion	All the participants in the technology transfer can conduct the work at the same level	Pilot area	Satisfaction of work tolerance on each work from preparation of field Map, through Field reconnaissance, Planning, Process / QC to result filing.	Satisfied the goal
2	Aerial triangulation	Capable of aerial triangulation by automatic processing using aerial photos and satellite images	project area	Personal skills in terms of understanding of work, equipment operation, quality and speed by comparison with target values	Satisfied the goal
		Able to create DTMs and orthophotos in the pilot area	Pilot area	Personal skills in terms of understanding of work, equipment operation, quality and speed by comparison with target values	Satisfied the goal
		4 engineers can conduct the work	Tests	More than 4 engineers meet the criteria	Satisfied the goal
3	Digital plotting	Able to conduct the work in the pilot area	Pilot area	Personal skills in terms of understanding of work, equipment operation, quality and speed	Satisfied the goal
		5 engineers can conduct the work at an error rate of less than 20% for 2.5 month/sheet.	Tests	More than 3 engineers meet the criteria	Satisfied the goal
4	Digital editing/ Digital completion	Able to conduct the work in the pilot area	Pilot area	Personal skills in terms of understanding of work, equipment operation, quality and speed	Satisfied the goal
		5 engineers can conduct the work at an error rate of less than 20% for 1.0 month/sheet.	Tests	More than 3 engineers meet the criteria	Satisfied the goal
5	Map symbolization	Able to conduct the work in the pilot area	Pilot area	Personal skills in terms of understanding of work, equipment operation, quality and speed	Satisfied the goal
		5 engineers can conduct the work at an error rate of less than 20% for 1.0 month/sheet.	Tests	More than 3 engineers meet the criteria	Satisfied the goal
6	Data structuration	Able to conduct the work in the pilot area	Pilot area	Personal skills in terms of understanding of work, equipment operation, quality and speed	Satisfied the goal
		5 engineers can conduct the work at an error rate of less than 20% for 0.5 month/sheet.	Tests	More than 3 engineers meet the criteria	Just below the goal in speed, others almost satisfied the goal
7	Work Schedule	Able to prepare and discuss a medium- to long-term project plan	Discussion and compilation of a draft	A study and discussion was conducted on the qualitative evaluation of the formulated long-term plan	Got Ability to schedule of Tentative plan

4-2. Materials Utilized in Technology Transfer

The equipment and materials used for technology transfer were procured and handed over to NLCS.

Table. 23 Materials for Technology Transfer

Name of Material		Basic Configuration/ Specifications	Q'ty
1	Photogrammetric project management / stereoscopic software	ERDAS IMAGINE photogrammetry Base software ((aerial triangulation, creation of DTMs and Orthophotos) is configured)	1
2	Plotting and editing software (for creation of DEMs)	Automatic DTM editing add-on for ERDAS IMAGINE	1
3	Plotting and editing software (for editing of DEMs)	Manual DTM editing add-on for ERDAS IMAGINE	1
4	Plotting/editing linking software	Stereo work add-on in GIS environment for ERDAS IMAGINE (The stereo plotter is configured)	7
5	Uninterruptable Power Supply (UPS)	PC (8 units), printer (1 unit), map output equipment (1 unit) and data server (2 units)	12
6	Leveling instruments	Digital level, 2 sets of rods and tripods	4
7	Stereoscopic equipment	Stereoscopic monitor, stereoscopic glasses (3 sets) (Compatible to Material 1 and 4)	8
8	Plotting/editing equipment	Plotting/editing monitor, photogrammetric mouse, USB hardware key, plotting/ editing PC (Compatible to Material 1 and 4)	8
9	Digital camera	With GPS functions	5
10	Handy GPS	Internal memory 8GB or more recommended, compatible with MicroSD With 3-axis electronic compass	5
11	Map output equipment	A0-size plotter, consumables	1
12	Color laser printer	Printer, consumables	1
13	Data server	RAM: 1GB or more Memory: 512MB or more Tray: 4 trays with key HDD: 2TB or more (Incertable HDD for 2TB×4×2 units: 8 units in total)	2
14	LAN cable	10m or more (Compatible to Material 1, 4, 11, 12, 13)	14
15	Switching hub	Ports: 24 or more, compatible with IEEE802.1x	2
16	Anti-virus software	Compatible to Material 1, 4 ,18	9
17	Microsoft Office	Compatible to Material 1, 4 ,18	9
18	GNSS data analysis equipment	GNSS data analysis software, GNSS data analysis PC	1

Figure. 11 Materials for Technology Transfer

4-3. Contents of Technology Transfer

[11] Planning and implementation of the technology transfer 《Work in Bhutan》

1) The Technology Transfer was conducted based on the Technology Transfer Action Plan formulated through discussions with the NLCS while considering the problems with the NLCS, based on the schedule and concepts as shown in Figure below.

2) The technology transfer was implemented for the various processes of digital topographic mapping to the NLCS in accordance with the Action Plan as shown in Table below.

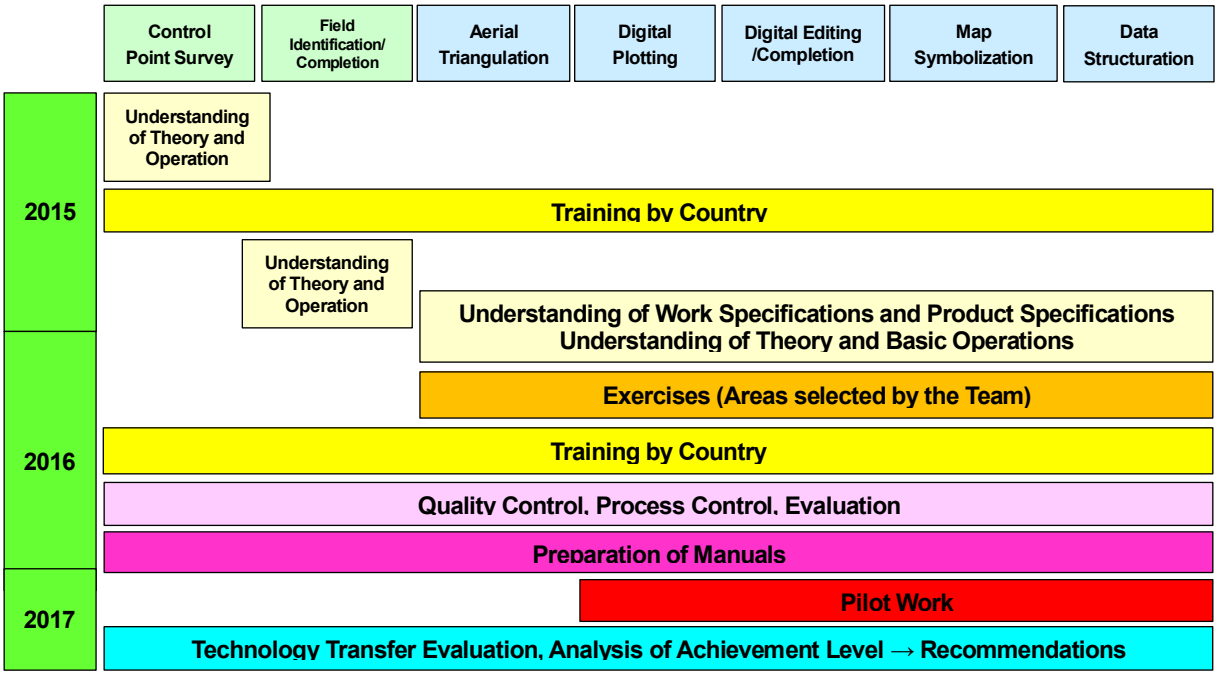


Figure. 12 Classifications and Schedule of Technology Transfer

Table. 24 Concept of Technology Transfer Action Plan

Item		Work Period				
		Understanding of Theory and Operation	Exercises	QC / Process Control Manuals	Pilot Work	Filing and Recommendations
1	Control point survey	By OJT in field work	Network analysis	Work Manual Operation Manual QC Manual Equipment Operation Manual		See chapter 3-4
2	Field identification/ Field completion	By OJT in field work	Arrangement and evaluation of results (through exercises in field completion)			
3	Aerial triangulation	Lectures (theory) Basic operations	Other satellite images Creation and editing of orthophotos /DTM			
4	Digital plotting	Lectures (theory) Basic operations	Exercises in areas selected by the Team depending on the conditions of the NLSC		Pilot area work and evaluation	
5	Digital editing/ Digital completion					
6	Map symbolization					
7	Data structuration GIS analysis	Lectures (theory) Basic operations			Pilot area work and evaluation Creation of GIS models	

[12] Technology transfer (Continued) 《Work in Bhutan》

The technology transfer to the NLCS in the various processes of digital topographic mapping was carried out in accordance with the Technology Transfer Action Plan as prepared or revised in the first year.

In this work, the effects and achievement level of the technology transfer through the pilot work, and the problems in terms of national development were extracted.

[13] Preparation of manuals 《Work in Bhutan》

Manuals related to the development and maintenance procedures for various types of data were prepared. The manuals are attached to the Draft Final Report.

Table. 25 Type and Contents for Manuals

	Manual	Contents	Considerations
1	1/25,000 Digital Topographic Mapping Manual	Documentation describing the theory and software operations for each work in accordance with the Work Specifications and Topographic Map Symbol Specifications (Work Manual and Operation Manual)	Applicable to work in other areas and updating work To be prepared jointly with the NLCS
2	1/25,000 Digital Topographic Map Quality Control Manual	Documentation describing practical working methods such as the evaluation method, compatible level and evaluation results for each work and process in accordance with the Product Specifications	The contents should define the criticality of detected errors and priority processes. The quality evaluation results should be easy for users to understand.
3	Equipment Operation and Maintenance Manual	Documentation describing the procedures for installing the hardware and software, the license registration procedure, and the maintenance procedures	Operation and maintenance after completion of this Project should be taken into consideration.

4-4. Results of Technology Transfer

Result of each training is following.

(1) Control Point Survey

The technology transfer for control point survey was conducted during April and May of 2015. Most of the engineers who participated in the technology transfer had experience in the installation and observation work of second order control point accompanying cadastral work, but the theory of work planning as well as the theory and technology of GNSS analysis/calculation, direct leveling, selection of ground control point for control point survey using satellite images and quality control had not been shared within the NLCS.

As described in the table 26, in the technology transfer of this work, explanation was given on work and manipulation as well as theories, including that of accuracy control, mainly through practical training by OJT. Also, assuming the actual work to be performed independently by the NLCS engineers in the future,

lectures focused on survey planning, calculation and quality control and exercises for actual planning and calculation were implemented.

Table. 26 Contents of the Technology transfer

Item	Contents		Training Type
Control Point Survey	Work	Point Selection and Pricking	OJT
		Leveling	OJT
		GNSS Observation	OJT
	Manipulation	Digital Level	OJT
		GNSS Receivers	OJT
		GNSS Analysis Software	Classroom lecture (1/2day) / Exercise(2days)
	Theory	Control Point Survey	Classroom lecture (1/3day)
		Leveling	Classroom lecture (1/2day)
		GNSS Survey	Classroom lecture (1/3day)
		Quality Control	Classroom lecture (1/3day)
	Exercise	GNSS Survey Plan	Classroom lecture (1/2day)/ Exercise(1/3day)
		GNSS Analysis/Network adjustment	Classroom lecture (1/2day)/ Exercise(1/3day)
		Calibration of Survey materials	Exercise(1/3day)
	Evaluation	Examination	Paper test

It was confirmed that as a result of the technology transfer, the NLCS engineers has reached the level at which they can carry out efficient planning and perform appropriate operations based on the plan with due consideration of safety. It was also confirmed that favorable results with no accuracy problem were obtained from the analysis and calculation results of GNSS survey. It is reported by the NLCS that they are still continuing the work daily using the GNSS analysis software on a daily basis.

On the last day of the technology transfer, a written exam (25 questions in total) was conducted to check the comprehension of the theory of control point through the OJT, lectures and exercises. As a result, out of 13 people who took the exam, 10 people showed the comprehension of 70% and the comprehension of 8 of them was 80% or higher. Questions that were answered incorrectly were revisited during the lecture after the exam to enhance their understanding.

Based on the above, it is considered that the NLCS engineers have reached the level at which they can perform work independently in accordance with their understanding of the actual work and theory of control point survey. However, the future challenge for them is to arrange their learnings on their own and develop plans and carry out work in consideration of quality control in GNSS survey, leveling, etc.

(2) Field Identification / Field Completion (East Area and West area)

1) Capacity of Trainees

Prior to the technology transfer, a questionnaire was conducted to grasp the field identification experience and understanding of the NLCS engineers. The experience of the 15 NLCS engineers who participated in this project regarding the technologies covered by this project was as follows.

Table. 27 Experience of Trainees (Before OJT)

Item	Experienced (more than 5 times)	Experienced (less than 5 times)	No Experience
Field Identification	47%	40%	13%

2) Policy and Contents of the Technology transfer

The technology transfer was implemented in three phases, first (in the east area), second (in the west area) and the third phase (in the pilot area), in accordance with the plan mentioned below.

Table. 28 Policy of the Technology Transfer

Phase	Purpose	Contents
1st (East area)	Improvement of the basic technical capacity (field verification, data acquisition and accuracy control) of the staff of NLCS with their experience and level of understanding taken into account	The participants took the preliminary test before taking the OJT. From the problems revealed in the results of the test, the OJT was implemented by focusing on trainees' understanding of this process in the mapping, acquisition of new information and work process control based on specific local conditions as points to be noted in the work and priority subjects of the technology transfer.
2nd (West area)	Independent planning, execution and control of the work by NLCS staff focused on the plan management (preparation of a plan and work, process and accuracy control)	Seven of the 15 NLCS staff who participated in Phase 2 had also participated in Phase 1. In accordance with their suggestion, they formed teams consisting of the staff with and without experience in the work concerned and each team prepared a work plan. The staff with experience transferred the technology they had learned in the first phase to those without experience and the contribution of the Team members in this technology transfer was kept minimum. The focus of the technical transfer was on the pending issues from the first phase (standardization, coordination and improvement of the efficiency of the work) and the improvement of the skills in work management (plan, process and accuracy control).
3rd (Pilot area)	Comprehensive evaluation of the work in the pilot area and recommendations to the participants for the implementation of field identification/completion by the NLCS staff based on the levels of their achievement in the technology transfer	The staff of NLCS performed all the work in the field identification, including planning/preparation, field work, work control/management, evaluation and organization of survey results, independently using their knowledge acquired through the technology transfer in Phases 1 and 2 without instruction from the Team members.

Table. 29 Contents of the Technology Transfer

Item	Contents		Training Type
Field Identification / Field Completion	Works	Preparation of Field Map	OJT.
		Preparation Materials	OJT.
		Work Planning	OJT.
		Team Arrangement	OJT.
		Reconnaissance	OJT, Classroom lecture.
	Field work	Field Identification / Field Completion	OJT, Classroom lecture.
		Equipment Manipulation	OJT, Classroom lecture.
		Technology Transfer to inexperienced technicians	OJT
	Result Correction	Quality Control and Error Correction	OJT.
		Digital result filing with GIS and Quality Control	OJT.
	Management	Accuracy and Process Control	OJT, Classroom lecture.

Following Table shows the problems found via the technology transfer in the first to third phases and the progress made in remedying the problems.

Table. 30 Progress in Remedying the Problems Found in the First, Second and Third Phases

	Contents		Points
1st and 2nd phases	Work Standardization	Variation in the acquisition level of annotations (extent of detail of the information to be acquired)	The participants conducted the work with the understanding of the map specifications and consideration to the scale of the topographic maps using the experience in the previous training and the feedback from the engineers who had participated in the technology transfer in digital plotting. Such work produced standardized outputs with reduced variation in the acquisition of surplus data among them.
	Communication	Efficient planning, travel and division of work	The participants worked more efficiently than they had in the East Area because they became able to prepare a plan with the topography, road conditions and travel times of a survey area taken into consideration.
		Information sharing	The participants managed to monitor the progress and operate the work with frequent communication between the work groups. They managed to modify plans flexibly in accordance with the changes in the road conditions.
		Individual management and overall management	The participants managed to control not only the progress, schedule and accuracy of the work of each group but also the entire work at appropriate time.
3rd phase	Planning	Identification of the issues to be verified in the field, preparation of maps, appropriate group formation and preparation of an efficient work plan	The participants managed to provide appropriate instruction to the surveyors and prepare appropriate field identification maps with clear understanding of the items required to be verified in the field for the implementation of both the field identification and the plotting. They also managed to prepare a work plan that included the team composition with the technical skills and personal relationship of individual participants taken into consideration and a system for cooperation among the teams required for the work in the area with poor accessibility.
	Management	Schedule management	They managed to control the activities of survey teams by performing the schedule management every day to complete the work within the limited period with satisfactory results.
	QC Filing	Verification of the consistency of the survey resultsdigitization of the feature and annotation information	The participants managed to inspect and correct the identification output in accordance with the standards (standards for the accuracy of positional information and information acquisition/sorting) and organize it in a way that makes it easy to use them in the subsequent editing work.
	Dissemination of Technology	Development of a training system for non-participants	A system in which training on the basic technologies consistent with the map specifications and regulation was developed.

Figure. 13 Technology Transfer (Left: Field work, Right: Digital input of result)

3) Evaluation and Recommendations

In the questionnaire inquiry conducted before the field identification/completion the participants seemed to show that they were slightly unsure about the acquisition of coordinates with handheld GPS receivers and the acquisition of annotations in their responses. However, the Team members confirmed that the participants had mastered a series of procedures to ensure accuracy of the survey results, including the operation of the handheld GPS receivers, the acquisition of coordinates and identification of locations on topographic maps, acquisition of annotation information and recording of the survey results in field books, and that the experienced participants had transferred technologies to the unexperienced participants in the evaluation of the work performed and the survey results produced by the NLCS staff in the OJT and tests, etc., conducted in the primary and secondary technology transfer.

The participants managed to perform the work at a sufficient pace, as they completed the work as planned, without delay. They understood and managed to practice the method to identify and correct defects in the verification of the survey results.

In addition, the outcomes obtained by the technology transfer in plotting and editing are highly significant, because, thanks to the technology transferred, the participants became able to recognize the items to be verified in the field from the viewpoint of the operator charged in the plotting and editing and to give appropriate instruction to other surveyors and inspect and correct the identification results appropriately. Based on the results of this capacity development, the Team concludes that the participants have understood the essential points of the field identification and acquired skills to perform it independently.

The Team has the following recommendations to the NLCS staff for the field identification to be carried out by them in future.

- The field work teams shall be notified of the points to be noted in the field work in

writing so that such matters as change in the work procedure and pre-determined rules should not be interpreted differently by the teams.

- Each worker is required to make a plan and preparation for the work carefully with the mental simulation of the practical work to prevent mistakes such as failure to distribute materials required in the field.

Table. 31 Evaluation of Technology transfer

Contents	1st	2nd	Contents	3rd (Goal) (Comprehensive evaluation)	Remarks
Works	Preparation of Field Map	△	△	◎	The Team members supported the participants in the work associated with the map representation. The participants acquired skills to perform field identification/completion independently by participating in the technology transfer for other processes and with the feedback from such technology transfer.
	Preparation Materials	△	△	◎	
	Work Planning	△	○	◎	
	Team Arrangement	○	◎	◎	
	Reconnaissance	○	◎	◎	
Field work	Field Identification / Field Completion	○	◎	◎	
	Equipment Manipulation	○	◎	◎	
	Technology Transfer to inexperienced technicians	△	○	◎	
Result Correction	Quality Control and Error Correction	○	○	◎	
	Digital result filing with GIS and Quality Control	△	○	◎	
Management	Accuracy and Process Control	△	○	◎	

△ : Implemented by the Team
○ : Implemented by NLCS with support of the Team
◎ : Implemented by NLCS without support of the Team

(3) Aerial Triangulation

1) Capacity of Trainees

Prior to technology transfer, a questionnaire was conducted to grasp the experience and comprehension of the NLCS engineers with respect to aerial triangulation. Since only one set of equipment was procured for Aerial Triangulation, it was decided that four engineers should participate in the technology transfer.

Table. 32 Experience of Trainees

Item	Participant A	Participant B	Participant C	Participant D
Years of experience in photogrammetry	Less than 3 years	Less than 3 years	Nil	Less than 3 years
Skill and knowledge of photogrammetry	Theory and practice	Theory only	Theory only	Theory and practice
Experience in digital photogrammetry	Yes	Yes	No	Yes
Experience of using the equipment in question (including old version)	Yes	Yes	No	Yes

2) Policy and Contents of the Technology transfer

Generally, aerial images or satellite images are used in Aerial Triangulation. Based on the fact that satellite images are used in this project and the hearing result that the NLCS is significantly unlikely to implement aerial triangulation using data other than satellite images in the future, it was decided that the technology transfer should focus on aerial triangulation using satellite images.

The technology transfer was carried out in the form of lectures and exercises covering the content shown in the table below, in which the objectives and actual operations of each item were explained and the software was operated.

Table. 33 Contents of the Technology transfer

Period	Contents		Training Type
1st Feb - March 2016	Theory (4 days)	1. Format of satellite images 2. Observation of control points 3. Automatic generation of Tie points 4. Check of control points & Tie points 5. Adjustment calculation 6. Accuracy control of AT 7. Creation of DEM 8. Editing of DEM 9. Accuracy control of DEM 10. Creation of orthophotos 11. Orthophoto accuracy control	Items necessary for aerial triangulation were explained, while using the photogrammetry software, in lectures and exercises.
		Theory of adjustment calculation and errors	Using the result of AT calculated in the exercises, items affecting the accuracy were explained in lectures and exercises.
		Stereo matching theory	lectures and exercises for automatic tie point observation by software in.
	Manipulation (10 days)	Manipulation of the Photogrammetric Software	Setting of Satellite Image project Observation of GCP/Auto generation of Tie-points Check of GCP & Tie-points/Block Adjustment
	Exercise(5 days)	Aerial triangulation exercise	The whole study area
	Evaluation (1 day)	Evaluation of comprehension of basic theory & Technology	Evaluation of comprehension of basic theory / basic manipulation of software
2nd Feb - March 2016	Theory/ Exercise (3 days)	Revision of previous Technology Transfer	Revision of Theory & Manipulation over Initial Setting, Data Import, GCP observation, Block Adjustment
	Theory/ Manipulation (11 days)	Lecture on the theory of the photogrammetry (DEM / orthophotos) Manipulation of the Photogrammetric Software	Generation & Modification of DEM/Orthophoto Accuracy control of DEMs
	Exercise(4 days)	Comprehension & Practice of the theory of DEM & Orthophoto	Comprehension of effect to Ortho from modification of DEM and Exercise of DEM modification feedback to Ortho updating
	Evaluation(1 day)	Evaluation of Exercise of AT	Evaluation of voluntary training of NLCS
3rd May - June 2017	Evaluation(3 days)	Evaluation of Exercise of AT	Exercise with the satellite stereo-pair images purchased anew because of large cloud cover and changes over time
	Exercise(10 days)	Exercise of DEM / Orthophoto Generation	Auto DEM generation and setting of parameters Orthophoto generation using satellite images and generated DEM
		Exercise of QC and Export of AT result	Evaluation of quality of Aerial Triangulation and preparation of Quality Control Table Import and orientation of the result of Aerial Triangulation into Stereo plotter
	Evaluation(3 days)	Quantitative Evaluation	Final evaluation of the pilot exercise

3) Evaluation and Recommendations

The engineers of NLCS have understood the basic theory of the photogrammetry and a series of work and basic operation of equipment in "aerial triangulation," "creation and editing of DEM" and "creation of orthophotos".

As a pilot training "Aerial Triangulation" for the purpose of application and evaluation were implemented , using additionally procured SPOT 6 stereo pair images to complete the areas where updation were required because of clouds and secular change.

In the exercise, they observed five new GCPs on an existing stereo model using existing one GCP, one BM and two check points and made block adjustment of the observation results. Then, the block file was exported to a stereo plotter and the accuracy of the data was examined with stereo plotting software. The outputs of the participants satisfied the standards.

The participants performed the work smoothly and completed it in approx. one hour in the exercise.

The NLCS engineers have acquired sufficient "aerial triangulation" skills at the level that they can use them in the actual work. They can also perform "aerial triangulation" with satellite images other than SPOT 6 or 7 used in this Project.

However, "Aerial Triangulation" is the most important process for establishment of Geospatial Information because this is the first photogrammetric process and makes all following outputs effect on the quality. Therefore in case of implementation of "Aerial Triangulation" for future massive projects, careful operation and thoroughgoing Quality Control and improvement of skill are required to realize it.

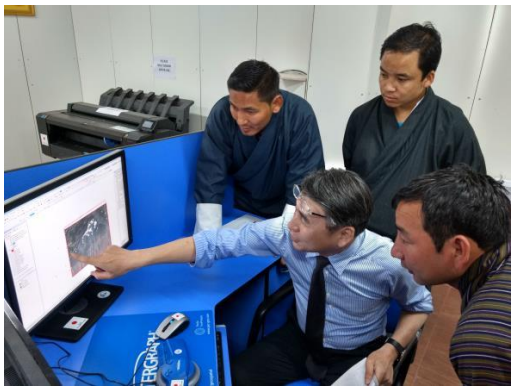


Figure. 14 Aerial Triangulation Technology Transfer

(4) Digital Plotting

1) Capacity of Trainees

There were maximum 20 trainees attended at the beginning of the training and almost of them had no experience and knowledge about Digital plotting except some knowledge about GIS and CAD. For this reason, the training started from the level of "Basic stereo measurement skill" then moved forward to next "Voluntary training" with selected 5 trainees considering effectivity.

Table. 34 Experience of Trainees and Impact of the Previous Technology Transfer

Item	With knowledge/experience	Without knowledge/experience
Knowledge of plotting	7	13
Experience in analogue plotting	3	17
Experience in digital plotting	2	18
Knowledge of GIS/CAD	ArcGIS: 18 / Other: 10	2
Data drawing	2	18

2) Policy and Contents of the Technology transfer

The training was implemented following the order of "Basic stereo measurement skill", "Voluntary training", "Pilot area Training".

In the "Voluntary training", 1/4 sheet selected as target were plotted by trainees and after the evaluation of the quality of the result, error correction was implemented through the filing and lecture about errors which were required modification. As the result of training, although following issues were detected, finally almost of the issues were resolved in the "Pilot training".

- The acquisition of contour lines were too much detailed compared to 1/25,000 scale standard.
- Shapes of many rivers (valleys) represented with contours were not accurate enough.
- Failure to acquire topography and features including vegetation and other boundaries and precipices and the use of inefficient data acquisition methods in the polygon generation were observed in the training.

In case of nationwide topographic map establishment, contour line plotting work with the method, which uses stereo digitizing of all contour line one by one, is not appropriate because it is expected consuming enormous time. Accordingly, the Teams included proposition and validation of a method which will be able to increase the feasibility of establishment for a limited period of time.

Pilot area is following.

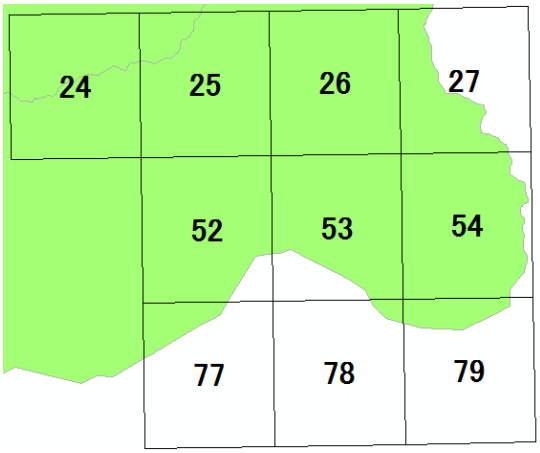


Figure. 15 Pilot area and work ID of the pilot sheets

Table. 35 Contents of the Technology transfer

Period	Contents		Training Type
1st July - August 2015	Manipulation (20 days)	Basic Manipulation of Software	Exercise of manipulation for IMAGINE Photogrammetry and ArcGIS (Stereo Analyst)
2nd March - April 2016	Manipulation (2 days)	Stereo Model Generation by using LPS	Exercise (Stereo Models generation after importing Block file from IMAGINE Photogrammetry into Stereo Analyst)
		Quality control of the generated stereo models	Exercise (The participants performed the quality control of the stereo models generated with Stereo Analyst and compiled the results of the exercise in a list.)
	Theory (5 days)	Map Symbol Catalogue comprehension	Classroom lecture (A Team member examined the map symbol catalogue comprehensively with the participants of the technology transfer to evaluate their understanding of the catalogue and data acquisition standards.)
		Data Acquisition Standard comprehension	Classroom lecture/exercise (A Team member explained the data acquisition procedure in the plotting. Data of linear objects (*e.g.* roads and rivers), structures (*e.g.* buildings), vegetation (*e.g.* farmland, forest and vegetation boundaries) and topography (*e.g.* contour lines and elevation points) are usually acquired in this order in the plotting. The Team member explained the acquisition of each type of data.)
		Data Acquisition Procedure comprehension	Classroom lecture / Exercise
		Scale comprehension (Adequate method to 1/25,000)	Classroom lecture / Exercise
	Exercise (28 days)	Planimetric feature interpretation (basic)	Exercise over selected area (1/4 sheet) by the Team
		Contour drawing (basic)	
	Evaluation (1 day)	Qualitative Evaluation	Hearing
3rd August - Sep 2016	Evaluation (5 days)	Evaluation of previous exercise	Evaluation of Plotting exercise over selected area by the Team
	Theory (3 days)	Feedback of the result of exercise evaluation	Review of 3D acquisition for Contour lines & Rivers Data acquisition method of boundary data including "Digital Editing" aspect
	Exercise (2 days)	Creation & Import of Symbol Creation of Line Style	Exercise of Symbol creation (of point and line data) & Data conversion using ArcGIS & Inkscape (Free design tool)
	Exercise (8 days)	Plotting exercise including feedback of voluntary training.	Plotting exercise in the area which has complicated administrative / vegetation boundaries

4th July - August 2017	Evaluation (2 days)	Evaluation of the output of the pilot exercise	Inspection and evaluation of the plotting data generated independently by C/Ps
		Study for effective acquisition method of Contour line plotting	Verification and comparison between 2 methods (1:stereo digitizing of all of the contour lines, 2: semi-auto contour generation by Index contours and modification)
	Exercise (13 days)	Exercise of the quality control and correction of edge matching between map sheets	Correction of the edge matching between the map sheets created in the pilot exercise
	Evaluation (2 days)	Quantitative evaluation (final evaluation of the output of pilot exercise)	Final evaluation of the output of the pilot exercise

3) Evaluation and Recommendations

The errors and their contents found from the review of the pilot work were as follows:

These errors occurred from insufficient understanding of subsequent works or errors itself. Therefore, the feedbacks from the evaluation of subsequent works and completed map, the result of the technology transfer for QC are expected to reduce errors in the corresponding works hereafter. In this regard, for some of challenging such as QC work of previous steps, management of "Adjoin works" to neighbouring map sheets, improvement of Contour line quality in the difficulty area for stereo plotting, continually repetitive practice and improvement of skill for management aspect shall be required.

Table. 36 Evaluation technology Transfer (Errors)

Issue of Quality		Reason / Part	Challenging
Data errors	Duplication of Vegetation line and Footpath	Inadequate Quality Control of the result of Field Identification	Thoroughgoing of work preparation
Contour lines	Areas with unstable accuracy of altitude	In the areas where are covered by forests and shadow of mountain	Study of a method for effective combination of conventional way and semi-auto way
Label Points	Lack of label points for polygon generation	The area whose shape is complicated	Feedback for effectiveness from following process as "Digital Editing", "Data Structuration", "Map symbolization"
Tying between map sheets	Inadequate tying result	Handling order for the tying work among map sheets was not clear.	Improvement of management skill for work coordination among operators and work processing

Table. 37 Evaluation technology Transfer (Quality)

Pilot sheet ID	Number of error (sheet base)									
	24	25	26	27	52	53	54	77	78	79
Area (km²) / Type of error	172	172	172	73	159	143	157	24	5	25
Total of error (sheet base)	135	185	278	139	177	166	149	57	26	147
Total of error /sheet	135	185	278	325	191	200	163	409	894	1011
Average of error / sheet										379
Average of error /sheet (Japan)										58

On the performance front, regarding the planimetric plotting, the trainees could work at the same speed as Japanese operator in the area with the same condition as pilot area.

Regarding the contour line plotting, trainees improved their performance and quality from the last training, however the work takes 2 -3 times longer than Japanese operators do.

To achieve feasible level of nationwide topographic map establishment, the study "Reasonable Contour line acquisition" by a combination of "manual method" and "semi-manual and modification method" in addition to continuously repetitive training are effective.

As "Reasonable Contour line acquisition", an example was practiced.

Table. 38 Change in Performance before and after Technology Transfer

Trainees	Planimetric Plotting			Contour line Plotting		
	Voluntary Training	Pilot Training	Japan Operator	Voluntary Training	Pilot Training	Japan Operator
A	7 - 10 days	About 6 days	4 days	About 60 days	About 50 days	15 days
B	5 - 7 days	About 4 days		About 40 days	About 35 days	
C	5 - 7 days	About 4 days		About 40 days	About 35 days	
D	7 - 10 days	About 6 days		About 60 days	About 50 days	
E	5 - 7 days	About 5 days		About 40 days	About 35 days	
Average (Planimetric and Contour line)				2.8 months	2.3 months	1.0 months

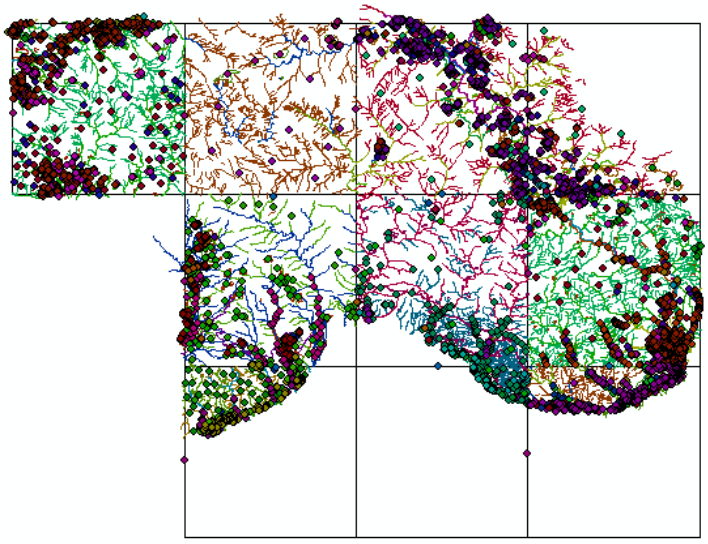


Figure. 16 Output of the Independent Training (interim output: contour lines not shown)

As one of the reasonable contour line acquisition methods, the Team proposed a method (semi-auto method, herein after "Method 2") to have contour lined modified principal contour lines (interval: 20m) generated from Index contour lines (interval: 100m) automatically, and practiced this method in the 3 test areas within the pilot area. The size of each test area was 17km^2 (1/10 map sheet) and compared the result to the conventional method (herein after "Method 1").

The result of the comparison shows that the more the area is mountainous, the more the time-shortening effect by "method 2". In the mountainous test area, the contour lines generated less than half the time compared to the conventional method.

About the accuracy quality, the vertexes which compose the contour lines of "Method 1" seem to touch on the ground in the uncovered area, whereas the vertexes of the contour lines of "Method 2" partially floated or below the ground level. However, there were no big elevational difference exceeding the tolerance between "Method 1" and "Method 2".

About the visual quality, the result of the comparison between the two methods, "Method 1" gives an impression of "Real though not natural", whereas "Method 2" gives an impression of "Good proportion but bit emphasized representation". It is difficult to determine which method is better.

From the aspect of time, for the reason that "Method 2" will have remarkable advantage in the mountainous area, it is effective to study and find appropriate combination of "Conventional method" and "Semi-automatic method" upon characteristics such as area and terrain.

Table. 39 Study and Comparison of Contour line acquisition method

Test Area 17km^2 Each (Relative Elevation)		Required Time: (Estimated days / sheet)					
		Method 2					Method 1 Conventional (/17km^2)
		Index Contour plotting (/17km^2)	Breakline plotting (/17km^2)	Spot Height plotting (/17km^2)	Check Correction (/17km^2)	Total (/17km^2)	
1	Valley: (1,600m)	2.5 hours	4.0 hours	0.5hours	3.0hours	10.0hours (20days/sheet)	12.5hours (25days/sheet)
2	Arable area: (1,600m)	2.5 hours	3.0 hours	1.0hours	2.0hours	8.0hours (16days/sheet)	10.0hours (40days/sheet)
3	Mountainous area: (1,800m)	6.5 hours	3.0 hours	0.1hours	4.0hours	13.6hours (20days/sheet)	32.5hours (65days/sheet)
Average required days		3.7 hours	3.3 hours	0.5 hours	3.0hours	10.5hours (19days/sheet)	18.3hours (43days/sheet)

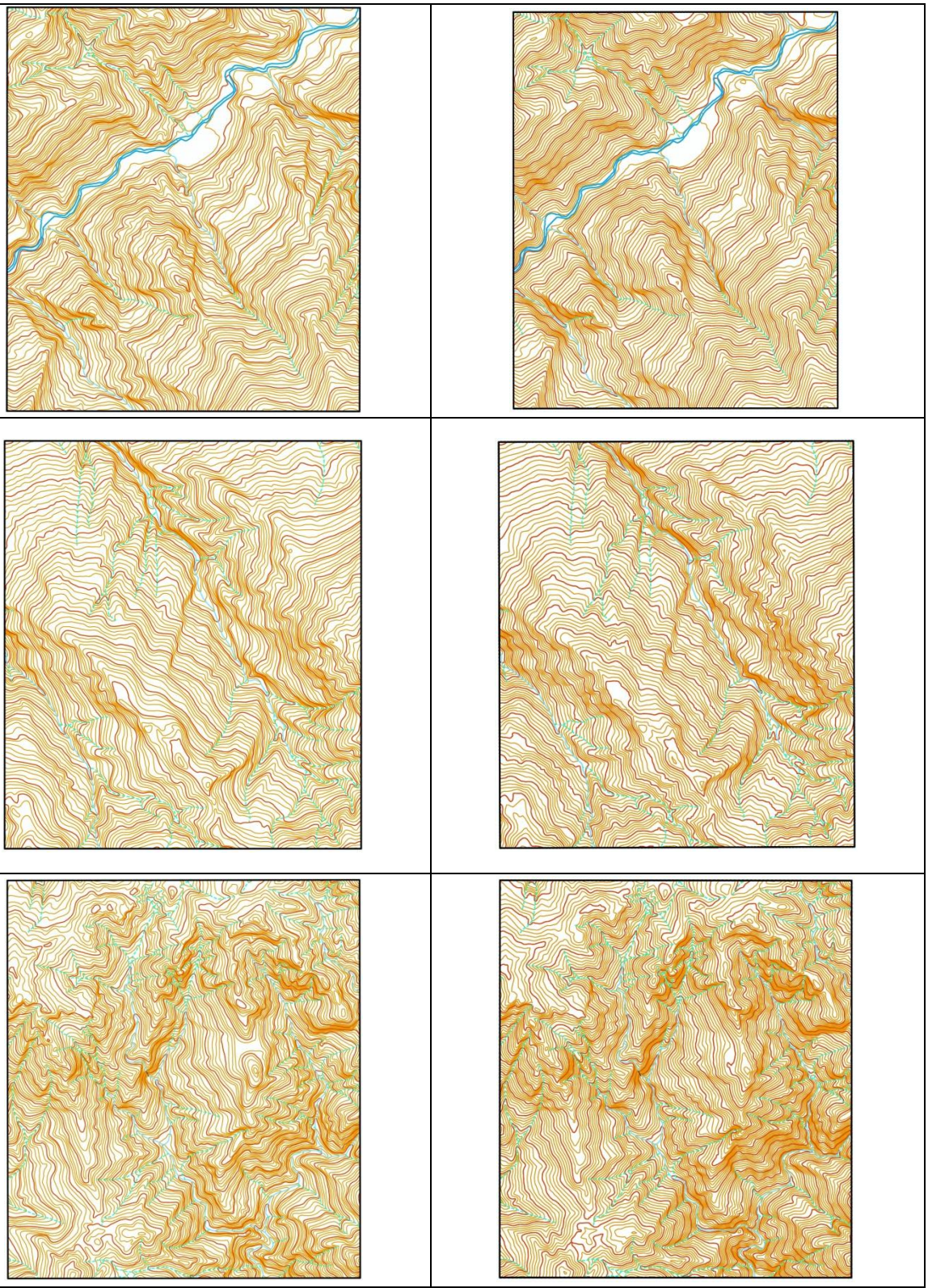


Figure. 17 Comparison of Conotur creation method (Left: method1, Right: method2)

(5) Digital Editing / Data completion / Map symbolization

1) Capacity of Trainees

Staff of the Topographical Survey Division (TSD) and the Geoinformatics Division (GID) participated in the technology transfer in "Digital editing/completion". 6 trainees from TSD have attended through "Aerial Triangulation", "Digital Plotting", "Digital Editing / Completion", "Data Structuration" before.

On the training of "Map symbolization", 5 trainees from TSD and 6 trainees from GID besides some of the interns whom the NLCS recruited for the purpose of increasing employees to improve its productivity of digital topographic map attended (16 trainees in total). There was no experienced trainee in the attendants.

Table. 40 Experience of Trainees

Item		With knowledge/experience	Without knowledge/experience
Digital editing/ completion	Knowledge of plotting	5	0
	Knowledge of Contour line Editing	1	4
	Knowledge of Annotation	0	5
	Knowledge of data Cleaning	0	5
	Knowledge of Polygon Creation	2	3
Map symbolizati on	Concept of map symbolization	0	16
	Basic software operation	0	16
	Advanced software operation	0	16
	Map design	0	16
	Map output	0	16

2) Policy and Contents of the Technology transfer

In the 1st Technology Transfer, the technologies used in the digital editing/data completion were transferred. The purpose of the technology transfer in the digital editing was for the participants to fully understand the method to detect and correct logical errors in the data created in the digital plotting and the method to incorporate the results of the field survey appropriately in the topographic map data.

In practice, the participants practiced a series of work in the digital editing/data completion, *i.e.* the inspection and correction of contours, input of annotation and boundary data, check and correction of intersection for features, data cleaning, creation of polygon data, edge matching and quality control. The technology transfer on all the above-mentioned work processes had been completed in the 1st Technology Transfer.

Because the errors mentioned below were frequently found in the data generated by the participants in the digital plotting, the training with the contents described in Table below was provided to the participants in the technology transfer in the digital editing/data completion.

- Areas where shapes of rivers (valleys) are not represented accurately with contours,
- Failure to capture topography and features including vegetation and other boundaries and precipices, and
- Inefficient data acquisition without consideration to their use in the polygon generation.

The purpose of the second technology transfer in map symbolization was the creation of field completion maps. Therefore, it mainly consisted of exercises and its focus was on the theory of the map symbolization and operation of the software for the symbolization. All the "field completion maps" of the pilot area were created in the second technology transfer.

The final goal of the third technology transfer in map symbolization enables experienced staff to transfer their technology to staffs with less experience in digital work environment.

Therefore, a lecture on the concept of the map symbolization was provided to all the participants in the first stage. A Japanese engineer gave lectures on the map symbolization procedures to the staff of TSD and they practiced the procedures in the second stage. In the third stage, the staff of TSD act as instructors and transfer the map symbolization technology to the staff of GID and the NLCS interns.

Table. 41 Contents of the Technology Transfer

Period	Contents		Training Type
1st Sep - Oct 2016	Manipulation(2 days)	Contour line Editing (Exercise)	Check and correction of intersecting contours with tools in ArcGIS, visual inspection and correction with the 3D representation and DEMs and check and correction of errors in elevation data from the attribute table
	Manipulation(2 days)	Input Annotations & Import Administrative Boundaries(Exercise)	Input of annotation data from the raster data on the existing maps or the field survey records and insertion of the existing boundary data
	Theory(1 day) Manipulation(2 days)	Check & Modification of intersection for features (Exercise)	Understanding and practice of the methods to check intersections for major features and to correct them for the topographic mapping
	Theory(1 day) Manipulation(5 days)	Basic technology of Data Cleaning (Exercise)	Understanding and verification of the line data constituting polygon data, understanding of the types of errors and error detection and correction
	Manipulation(3 days)	Basic technology of Polygon Generation (Exercise)	The method to generate polygon data with tools in ArcGIS, detection and correction of errors in the generated data, the method of the individual data editing
	Manipulation(2 days)	Basic technology of Tie work between adjacent sheets(Exercise)	Review of the rules on edge matching, understanding of the types of errors, the visual inspection method and correction of errors in the edge matching
	Theory(2 days)	Quality Control (Classroom lecture)	Understanding of the types of errors and understanding and preparation of a quality control sheet in the digital editing
	Evaluation(1 day)	Qualitative Evaluation	Quality control of the data generated in the practice
2nd Nov. - Dec. 2016	Theory(5 days)	Basic of symbolization	Understanding of map specifications and symbols
	Exercise(5 days)	Exercise of symbolization	Creation of the marginal information of field completion maps
	Exercise(10 days)		Creation of field completion maps
3rd Aug. - Sep. 2017	Theory(5 days)	Symbolization and basic procedure	ArcGIS Exercise of symbol creation for "Point", "Line", "Polygon" by referring Map symbol catalogue
	Exercise(5 days)	Pilot area (introductory)	Exercise of "marginal Design" Symbolization exercise the pilot area data structuralized.
	Exercise(5 days)	Pilot area (advanced)	Applicable exercise for "Displacement" and "Annotation Edit" of pilot area data Symbolized
	Exercise(3 days)	Exercise of QC and Export of results	Exercise for Quality Control and Correction of pilot area data Symbolized
	Evaluation(1 day)	Quantitative evaluation	Evaluation of Quality and Performance

3) Evaluation and Recommendations

After the participants conducted the digital editing/completion in the pilot area and performed the quality control of the output, the Team evaluated their digital editing/completion in the pilot work both on the quality of the output and on the efficiency of their performance.

In the result of the 1st period, some of errors such as attribute of contours and untied features between adjacent map sheets were found because of insufficient understanding of the check process, however the trainings in 2nd period showed that all trainees understood the check process and the number of errors were decreased drastically. It was also identified that the result of "Field Identification and Field Completion" were reflected.

This is improper that taking over the errors from "Digital Editing" to the following process because process is very important coequally as "Data structuration" to complete the structure of the plotted data which is available for GIS use. To take aim the level of guaranteeing the quality as commercial product, establishing the system which can carry quality control out until the quality closes to 100%, and enhancing the error detection tools which can visualize the existence of errors or status of error-free were expected.

From the aspect of work speed, the trainees require more than 1.6 times the work time of average Japanese operator, however this speed looked adequate because the quality is more important than the speed in this process.

It is expected that the improvement of former process "Digital plotting" by the feeding back from this training comprehensively helps speeding this process up.

Table. 42 Evaluation of Quality Control (Digital Editing/Completion: Quality)

Trainees	Evaluation					
	1st			2nd		
	Number of Errors	Rank	Trend	Number of Errors	Rank	Trend
A	3	○	No problem in particular	0	○	No problem in particular
B	3	○	No problem in particular	0	○	
C	6	○	Relatively poor understanding of the method to inspect the attribute values of contours was noted and errors were left uncorrected.	3	○	
D	11	△	Error detection and correction in the polygon generation was not sufficiently performed. Errors remained in the edge matching.	4	○	
E	7	○	Error detection and correction in the polygon generation was not sufficiently performed.	2	○	

Table. 43 Evaluation of Performance (Digital Editing/Completion Technology Transfer)

NLCS			in Japan
Trainees		Average	
A	Approx. 11 days	Approx. 10 days	Approx. 6 days
B	Approx. 11 days		
C	Approx. 8 days		
D	Approx. 10 days		
E	Approx. 9 days		
		Approx. 0.5 months	Approx. 0.3 months

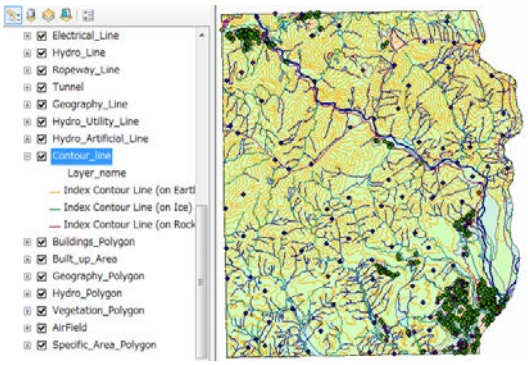


Figure. 18 Digital Editing Technology Transfer (Left: Training, Right: Output of Pilot Work)

After the participants conducted the map symbolization of the pilot area and controlled the quality of the output, the Team evaluated their map symbolization in the pilot work both on the quality of the output and on the efficiency of the performance.

The Team evaluated the trainees understood the theory and method of QC (Quality Control). After implementation of visual Quality Control exercise on the printed map of pilot work, following errors were detected. Most of the errors appeared because that the all works from "Digital plotting" to "Map symbolization" were trainees' first experience and the errors from each work were accumulated on the final result.

Trainees understood the reason and situation of each error happened from each work and it is expected this knowledge about errors shall be feedback to each works arrives to the result with good quality in the future.

Additionally, to take aim the level of guaranteeing the quality as commercial product, an extra effort is required and training of QC specialist, Establishment of QC scheme for them, Structure of workflow and clarification of responsibility will be expected with a goal of "completion as commercial product".

From the aspect of work speed, the trainees require more than 1.8 times the work time of average Japanese operator, however trainees understood and shared the image of "completed product" as printed 1/25,000 topographic map. As future challenging, it is expected that the

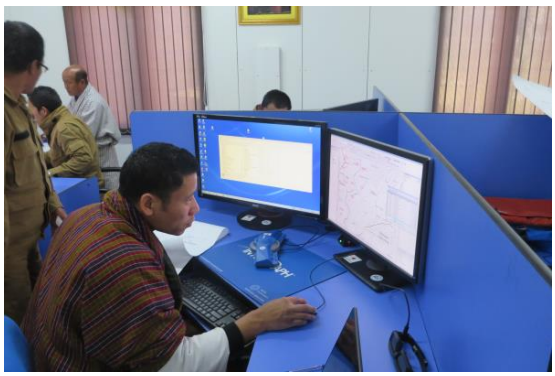
NLCS will improve their performance to the level of implementation even in the urban area with the current speed by feeding back the knowledge to the former steps and continuing repetitive exercise, appropriate roll-sharing arrangement, structure of appropriate work cycle in the future.

Table. 44 Evaluation of Acquisition Accuracy (Map Symbolization : Quality)

Map sheet of pilot area		Sheet base number of errors									
		24	25	26	27	52	53	54	77	78	79
Type of error \ area (km^2)		172	172	172	73	159	143	157	24	5	25
1	Positional errors between each feature	33	3	32	9	17	8	23	18	8	7
2	Errors of "Geomorphic symbols", "Annotations"	18	5	25	8	11	16	16	5	3	6
3	Errors of "Contour lines", "Spot heights"	11	9	13	13	14	19	15	10	1	2
Total errors sheet base		62	17	70	30	42	43	54	33	12	15
Total errors sheet base /sheet		62	17	70	71	45	52	59	237	413	103
Average / sheet		113									
Average in Japan / sheet		10									

Table. 45 Evaluation of Performance (Map Symbolization : Performance)

NLCS			in Japan
Trainees		Average	
A	Approx. 8 days	Approx. 9 days	Approx. 5 days
B	Approx. 10 days		
C	Approx. 9 days		
D	Approx. 10 days		
E	Approx. 9 days		
		Approx. 0.5 months	Approx. 0.3 months



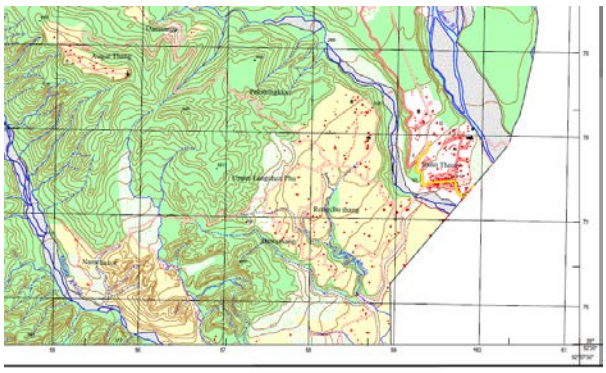


Figure. 19 Map Symbolization (Left: Traininig, Right: Output of Pilot Work)

(6) Data structuration

The Team concluded that NLCS had acquired sufficient basic knowledge and technical capacity required for the GIS data structuration in the 1st Technology Transfer conducted in July and August 2015. Therefore, the Team members gave lectures on the detailed data structures required for this project to the NLC engineers and prepared to this end the "Product Specifications (draft)" and "Structuration Rule (draft)" upon discussion with NLCS in the 2nd Technology Transfer.

The Team members explained the method of the data structuration consistent with the "Product Specifications" and "Structuration Rule" to the participants and the Team members and participants studied and discussed the details of the attribute data to be added in the 3rd Technology Transfer. The Team members revised the "Structuration Rule" in accordance with the outcome of the study and discussion and developed an environment in which the NLCS engineers could practice the structuration by themselves.

After the Pilot training, the Team evaluated the result of the training.

1) Capacity of Trainees

The focus of the third Technology Transfer was on the data structuration. Five NLCS engineers participated in it. Table below shows the levels of their prior knowledge and experience in the data structuration.

Table. 46 Experience of Trainees

Item	With knowledge/experience	Without knowledge/experience
Manipulation of GIS Software	5	0
Knowledge of Data Structure	4	1
Knowledge of Data Attribute	4	1
Knowledge of Data Analysis	2	3
3D Display	0	5

2) Policy and Contents of the Technology transfer

Because the NLC engineers had already basic knowledge and technical capacity in GIS, as mentioned above, the focus of the technology transfer in the data structuration was placed on understanding the theories on data structuration and learning the advanced use of structured data.

Table. 47 Contents of the Technology transfer

Period	Contents		Training type
1st July - Aug 2016	Theory (10 days)	Data Product Specification (DPS)	Comprehension & Discussion of Data Product Specification
	Manipulation (10 days)	Manipulation of GIS Software	Basic Manipulation of GIS Software
2nd June - July 2016	Theory (10 day2)	Lecture of DPS	Lecture of DPS Lecture of Data Structure
	Theory (10 days)	Discussion of Data Structuration Rule	Lecture and Discussion of Data Structuration Rule Lecture of data format
	Manipulation (2 days)	Display of structured data on GIS and basic spatial analysis	Exercise (practice of data representation and spatial analysis with the tools in ArcGIS using the data generated in accordance with the Structuration Rule and evaluation of the practice outputs)
	Theory (3 days)	Understanding of the theories on data structures	Lecture (explanation on the structures of the data generated in accordance with the Structuration Rule, comments on the points of note on structural designs and comments on additional attributes)
	Exercise (5 days)	Spatial analysis, two-dimensional representation and visualization	Exercise (presentation of GIS models generated with structured data and explanation and practice of the software manipulation for the spatial analysis and three-dimensional representation)
	Evaluation	Evaluation of the spatial analysis method	Evaluation of the maps created as the outputs of the advanced practice in the exercises
3rd Aug. 2017	Exercise (3 days)	Exercise of structuration of the data of the pilot area	Implementation of “Data structuration” exercise in pilot area referring to “Product Specifications” using data plotted and edited
	Exercise (1 days)	Quality control exercise	Implementation of logical check exercise on structured data in the pilot area , then comprehension of errors and preparation of Quality Control table
	Evaluation (1 day)	Quantitative evaluation	Evaluation of Quality and Performance

3) Evaluations and Recommendations

After the participants performed structuration of the data of the pilot area and controlled the quality of the output, the Team evaluated their data structuration in the pilot work both on the quality of the output and on the efficiency of their performance.

Table. 48 Evaluation of Performance Accuracy (Data structuration: Quality)

Map sheet of pilot area		Sheet base number of errors									
		24	25	26	27	52	53	54	77	78	79
area (km^2) / Type of error		172	172	172	73	159	143	157	24	5	25
1	Dangle error (End point of line which does not connect to at least 1 line)	62	170	143	105	57	108	107	37	31	72
2	"Duplication", "Intersection", "Touch" of lines in the same layer	12	15	24	22	95	29	14	36	1	8
3	Duplication of feature	5	3	14	11	1	9	8	1	0	0
4	Points not covered by line Ex: bridge & road, waterfall & river	0	0	1	1	0	1	6	0	0	0
5	Tying error inside map sheet	640	443	29	58	26	57	118	9	55	45
6	Tying error between map sheet	476	88	171	194	230	16	20	10	18	34
7	Attribute error of Contour line	4	10	3	1	53	84	3	2	3	0
8	Mismatch between Spot height & Contour line	61	10	57	29	121	145	62	20	10	30
9	Error of label point	60	6	34	11	16	15	13	2	1	6
Total errors sheet base		1316	735	473	431	546	380	348	115	116	195
Total errors sheet base /sheet		15	7	5	12	7	5	4	10	46	15
Average / sheet											13
Average in Japan / sheet											1

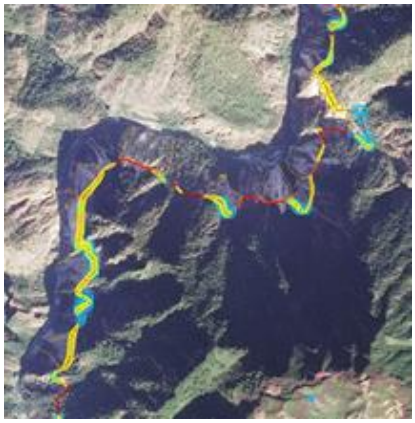
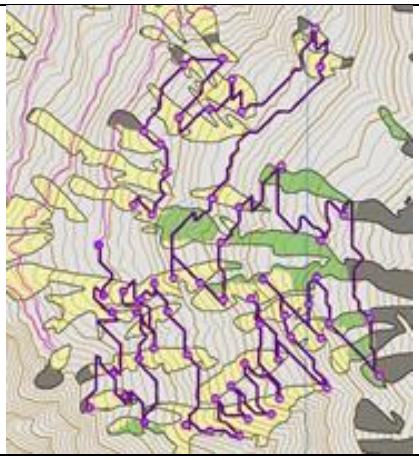
Table. 49 Evaluation of Performance (Data structuration : Performance)

NLCS			in Japan
Trainees		Average	
A	Approx. 10 days	Approx. 11 days	Approx. 6 days
B	Approx. 12 days		
C	Approx. 12 days		
D	Approx. 11 days		
E	Approx. 10 days		
		Approx. 0.6 months	Approx. 0.3 months

(7) GIS data Analysis

The Team prepared following GIS models by utilizing Digital Topographic map for the purpose of promoting utilization of Geospatial Information. For creating GIS models, the features of 1/25,000 Topographic map were used to show the potential of digital topographic map for utilization and versatility.

Table. 50 GIS Sample Models

GIS Sample model		Data
Arable potential area detection model		【Terrain Data】 Contour line, Spot Height, Road, Vegetation 【External Data】 Annual mean temperature
Landslide risk detection model		【Terrain Data】 Contour line, Spot Height, Road, Vegetation, Land slip
Farm road planning model		【Terrain Data】 Contour line, Spot Height, Road, Vegetation, Result from “Arable potential area detection model”

1) Capacity of Trainees

Attendance of Totally 30 trainees from 9 organizations to the training shows the high level of interest and motivation of Bhutan to the data-sharing and data-utilization of Geospatial Information and the impacts of promoting activities in the project. 20% of the attendants did not have the experience of ArcGIS work before but 40% of them (12 people) had more than 5 years ArcGIS manipulation experience.

Table. 51 Experience of Trainees and Organization

Organization		Experience about ArcGIS (years)				
		<0.5	0.5<= <3	3 <= <5	5 <=	Total
1	National Land Commission Secretariat (NLCS)	2	6	3	9	20
2	NLCS/CGISC				1	1
3	Department of Livestock			1		1
4	Department of Hydropower and Power Systems	1			1	2
5	Department of Hydromet Services			1		1
6	Bhutan Telecom Limited		1			1
7	National Environment Commission	1				1
8	Department of Renewable Energy	2				2
9	Department of Information Technology and Telecom				1	1
	Total	6	7	5	12	30

2) Policy and Contents of the Technology transfer

Before preparing the GIS models, the Team implemented hearing to some of the potential user organizations of Geospatial Information for the purpose to explore the owned data and needs of each organization and to enhance the understanding of data-utilization then determined the themes of GIS models.

The Team implemented the technology transfer by focusing on understanding of source data, intermediate outputs and their parameters, the result of analysis.

Table. 52 Contents of the Technology transfer

Period	Contents		Training type
1st Jan - Feb 2017	Exercise (5 days)	Interview with GIS users	The Team conducted an interview survey at 13 potential user organizations with engineers of NLCS.
	Theory (5 days)	Collection of the information and discussion on GIS sample models	The Team had discussion with the engineers of NLCS on GIS sample models that could be developed easily and that are highly usable based on the results of the above-mentioned interview survey.
	Exercise (5 days)	Uploading of GIS sample models on the website	An environment where staff members of relevant organizations and ordinary users can browse geospatial information and make simple measurement with the information has been established by uploading one of the GIS sample models, "topographic map viewer" to the Web server of NLCS.
2nd Aug. 2017	Exercise (4 days)	Arable potential area detection model	The model which detects the arable potential area for the agricultural development analysed with terrain and concerning condition, land use, road accessibility
	Exercise (2 days)	Landslide risk detection model	The model which detects the hazardous area of landslide and visualizes the result along the road. This model also will be applied to the evaluation of access route selected from "Farm road planning model".
	Exercise (1 days)	Farm road planning model	The model for automatic searching recommended route which circulate selected "Arable potential area" for new road planning.
	Evaluation (1 day)	Quantitative evaluation	Evaluation of impact and proficiency of the technology transfer

3) Evaluations and Recommendations

As the result of evaluation based on the exercise in the technology transfer, trainees accomplished the following goals. All trainees understood the effectiveness of GIS analysis as Geospatial information utilization tool to facilitate their daily works and understood the processing technologies of Vector base and Raster base used in the 3 models. It is expected that the trainees will apply this technology to solve issues and to cut waste of their daily works, to utilize the output the project among relevant parties.

Table. 53 Evaluation of the Technology transfer

Goals		Number of accomplisher
Vector Analysis	Understand how to convert from Raster format to Vector format	30
	Understand how to find nearest feature among Vector data	30
	Understand of Vector overlay tools	30
	Understand how to transfer the information from Raster data to Vector data	30
Raster Analysis	Understand how to generate Digital Elevation Model (Grid DEM) from Vector data which has Elevation Information	30
	Understand how to create various data (e.g. Slope data) by using generated Grid DEM	30
	Understand of Raster overlay tools	30
	Understand how to process the Raster Calculator tools	30

Figure. 20 Technology Transfer (Left: Lecture, Right: Exercise)

Chapter 5. Establishment of NSDI

5-1. Framework of NSDI Development in this project

Platform for NSDI Development

The Government of Bhutan established a coordinating committee for the formulation of national strategy and plans for the GIS infrastructure development and established the Centre of GIS Coordination (CGISC) as the secretariat of the committee.

The CGISC is composed of the members listed below. It has been holding regular meetings to discuss the sharing of geospatial information at the initiative of NLCS.

Table. 54 Members of CGISC

Name of Agency			
1	National Land Commission	16	Election Commission of Bhutan
2	National Environment Commission	17	Department of Forests and Park Services
3	Department of Information Technology & Telecom	18	Gross National Happiness Commission
4	Thimphu Thromde	19	National Statistics Bureau
5	Department of Hydropower and Power Systems	20	Bhutan Power Corporation Limited
6	Department of Hydro-Met Services	21	Bhutan Telecom Limited
7	Department of Geology and Mines	22	College of Natural Resources
8	National Soil Service Center	23	Sherubtse College
9	Ministry of Agriculture and Forests	24	World Wildlife Fund
10	Forest Resources Management Division	25	National Housing Development Corporation Limited
11	Ministry of Education	26	Samdrup Jongkhar Thromde
12	Ministry of Works and Human Settlement	27	Royal Society for Protection of Nature
13	Department of Disaster Management	28	Polytechnic
14	Ministry of Health	29	College of Science Technology
15	Royal Audit Authority	30	National Center for Animal Health

Policies for NSDI Development

According to "The 12th Five Year Plan Guideline" formulated on October 2016, NLCS is mentioned as "Contributor / Collaborator" on 9 National Key Results Area (NKRA) out of 16 NKRA, and plays a role as an authority of centralized ""Geographic Information" which works as cross-sectoral source for each development plans.

Legal environment for NSDI Development

The CGISC formulated the preparation of the first draft of "Geographic Information Policy (G.I. Policy)" in January 2016 with assistance from the Government of the Netherlands then updated version was submitted to the parliament on May 2017 and under discussion there. In the "G.I. Policy", there are some description about Policies, Definitions, Availability, Legal framework for data utilization, Mandatory roles of Geographic Information Establishment. "G.I. Policy" also has descriptions of "e-Government mater Plan", "National e-Government policy",

"Bhutan Standards Act", "National Framework for GIS Infrastructure", "Copyright Act", etc as rules, plans, policies for "Geographic Information".

Geoportal

In October 2014 the Geo-Portal went online (http://www.geo.gov.bt/). The geo-spatial data managed by CGISC members is uploaded, with an explanation of how to obtain the metadata and data. Most of the data can be obtained by applying via email to the relevant organization, but some data may be downloaded directly from the Geo-Portal.

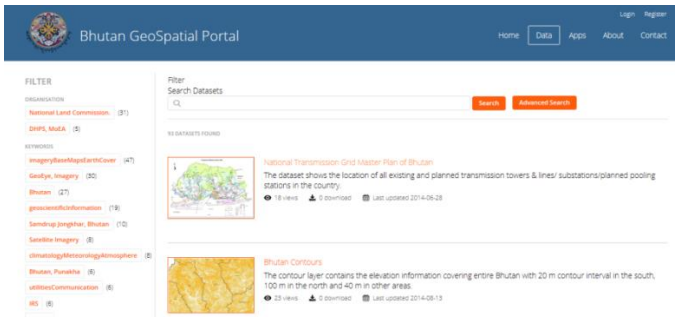


Figure. 21 Geo-portal and Server Room

Table. 55 Handled data on the Geo-portal (Sample)

Theme		Samples	Data sharing
1	Boundary	Gewog Boundary of Bhutan	Downloadable
2	DEM	Aster DEM of Bhutan	Order by e-mail to responsible department
3	Disaster	Location of Flood Warning Stations of Bhutan	
4	Environment	Protected Areas and Biological Corridors in Bhutan	
5	Agriculture/Forest	Forest Management Units in Bhutan	
6	Geodesy	Geodetic Network of Bhutan	
7	Glaciers	Glaciers of Bhutan	
8	Water	Location of Hydrological Stations of Bhutan	
9	Satellite Images	GeoEye Imagery	
10	Infrastructure	Facility Centers in Bhutan	
11	Land use	Land Cover of Bhutan	Downloadable
12	Meteorology	Location of Class C Meteorological Stations of Bhutan	Order by e-mail to responsible department
13	Traffic	Road Network of Bhutan	

5-2. Future Direction of NSDI Development

Potentials of utilizing 1/25,000 digital topographic maps

At the start-up of the project, the status of Geospatial Information utilization in the field of "Agricultural Development" and "Infrastructure Establishment" is following. There were some organizations which have needs for quality and coverage to the existing topographic maps and have potentials to be user of 1/25,000 digital topographic map from the project into the field of "Agriculture", "Electricity", "Road", "Disaster Management".

Table. 56 Current Utilization and Potential for G. I. by Concerned Authorities

Segment	Present Status of Utilization of Geospatial Information		Potential for 1/25,000 Topographic Maps Utilization
	Description	GI Experts	
Ministry of Agriculture and Forests	Land cover maps were developed based on satellite images (1994 and 2010). Part of soil map by field survey. The GIS data was used for forest management.	7 GIS engineers	Use of the data on river systems (useful in the planning of irrigation and geometric correction of satellite images). Improvement of the accuracy of the existing data Creation of the data of the entire country for the selection of land appropriate for agriculture and livestock raising Cadastral analysis and organization of cadastral information by overlaying the cadastral information of NLCS on the digital topographic maps
	Geospatial Information of Irrigation Facilities		
Bhutan Power Corporation Limited	Selection of dam sites and drawing up of master plan for hydroelectric power plants using 1/50,000 topographic maps (printed maps) (selection of dam sites, electric power plant sites, and tunnel locations, and estimation of plant capacity) Feasibility study using 1/10,000 or 1/1,000 topographic maps	One GIS engineer	Selection of the suitable Dam sites Accurate data in the aspect of "Tie" and "Consistency between Spot height and Contour lines"
Ministry of Works and Human Settlement	< Department of Human Settlement> Valley Development Plan and Detailed Plan / Multi Hazard Map		The maps can be utilized in the building of the unconstructed section of an east-west highway in the area near the southern border. The maps can be used in the creation of slope disaster hazard maps.
	<Department of Roads> Selection of construction routes using 1/50,000 topographic maps	19 survey engineers and 2 GIS engineers	Route selection in road construction plans
Thimphu City	Development of 1/5,000 topographic maps based on GeoEye satellite images		Creation of the digital topographic maps of the city is required for the formulation of a development plan of the entire city
Dep. of Information and Communication, Ministry of Information and Communication	Paper maps are normally used for formulation of policies and plans. Contribution to technical aspects of information and communication for the joint use of geospatial information by governmental agencies		Route selection in plans for the development of information communication networks
Dep. of Disaster Management, Ministry of Home and Cultural Affairs	Coordinating services between related technical sections for disasters are largely provided, but little geospatial information is handled.	3 GIS engineers	Application into District Disaster Management Plan will be formulated. The need for topographic maps is high in the southern region where floods occur often.

National Statistics Bureau	A study of public facilities (including schools) was carried out using 1/50,000 maps in 2008.		The use of geospatial information in studies of public facilities by overlaying of existing Cadastral Information managed by NLCS.
Department of Geology and Mines, Ministry of Economic Affairs	Geological maps, landslide distribution maps and hazard maps (including floods and earthquakes) are created. Field surveys are carried out for detailed analysis of landslides.	4 GIS engineers	Use for study of seismic activity. The use of DEM (elevation information) is expected in landslide analysis.

Future Direction for NSDI Development

Regarding the description "Legal environment for NSDI Development" in 5-1., for the future direction for NSDI Development, followings shall be implied.

- Governmental authorization and Practical operation of "G.I. Policy"
- Updation of rules, plans, policies for "Geographic Information" at the operational level.
- Updation and practical operation of "Work Specification" established through the project.
- Implementation of data-sharing and data-utilization along the "G.I. Policy", concerning rules, policies about "Geographic Information" established through the project.
- Establishment of "Survey Act" proposed in the project and Regulating of associated action such as "Qualification system", "Sharing of survey plan and result", "Establishment and Updation method of Geographic Information".
- Continuation of nationwide establishment of "Basic Geographic Information" and partial establishment based on needs.

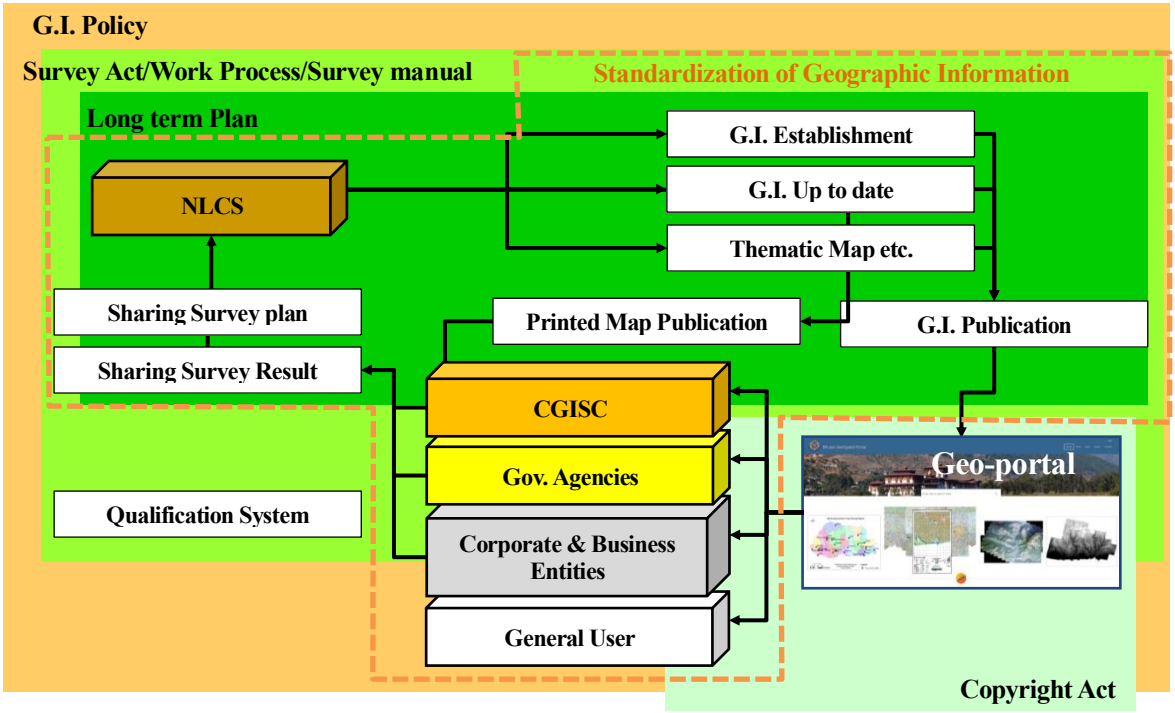


Figure. 22 Strategy for the NSDI development activities in future

[1] Recommendations on utilization of the outputs and holding of seminars 《Work in Bhutan》

1) On 16 March 2015 the kick-off seminar for this Project was held. As a result of the promotion of public relations activities such as the posting of articles in the local mass media prior to the seminar, the seminar was featured on the TV news that day and in the newspapers on the following day. The seminar was attended by 60 persons from 35 organizations, and from the Q&A session it was felt that there were great expectations for the sharing of the latest geo-spatial data and for the sharing of the technologies for their use and application.

Table. 57 Contents of the Kick-off Seminar

Kick-off seminar	**Purpose**	Introduction of 1/25,000 digital topographic maps and overview of utilization of the maps
	Time	16th March 2015
	Contents	Overview of this Project (Introduction of the Team members and NLCS, outline of work, training in Japan, outputs, technology transfer, etc.: JICA Team) Specifications of 1/25,000 topographic maps (JICA Team) Concept of utilization and concept of NSDI (JICA Team) Present status of utilization of 1/25,000 topographic maps in Japan (JICA Team) Present status and problems of geospatial information in Bhutan NLCS Geo-portal (NLCS staff)
	Materials	General description of the Project, 1/25,000 printed maps and data available in Japan (Website, etc.) General descriptions and materials used for each presentation
	Venue	Thimphu City

Table. 58 Participants to the Kick-off Seminar

	Organization	Head count		Organization	Head count
1	National Land Commission	8	19	Samdrup Jongkhar Thromde	1
2	Ministry of Information Communication	1	20	Sarpang Dzongkhag	1
3	Ministry of Economical Affairs	3	21	Chukha Dzongkhag	2
4	Ministry of Agriculture & Forestry	4	22	Dagana Dzongkhag	
5	Election Commission of Bhutan	2	23	Mongar Dzongkhag	1
6	Ministry of Home & Cultural Affairs Department of Disaster Management	2	24	Tashigang Dzongkhag	1
7	WWF Bhutan	1	25	Pemagatshel Dzongkhag	2
8	Gross National Happiness Commission	1	26	Zhemgang Dzongkhag	1
9	National Statistical Bureau	3	27	Phuntsholing Thromde	1
10	Bhutan Power Corporation	1	28	Phuntsholing Drunghkag	1
11	Bhutan Telecom	1	29	Gelephu Thromde	1
12	Sherubtse College	1	30	Samtse Dzongkhag	1
13	National Housing Development Corporation Ltd.	2	31	Thimphu Thrommde	1
14	Royal Society for Production of Nature	1	32	Bhutan Broadcasting Service	1
15	College of Science& Technology	1	33	Kuensel	1
16	College of Natural Resource	1	34	JICA	4
17	Department of Information Technology & Telecom	1	35	JICA Study Team	5
18	Samdrup Jongkhar Dzongkhag	1			
				TOTAL	**60**

Table. 59 Question and Answer

	Question	Answer/Comment
1	Why was the southern part of the country made the focus of the project?	The project area was selected in the light of past or ongoing JICA projects, ADB projects, the potential for agricultural development, etc.
2	How is the frequency and method of updating the newly-created topographical maps considered? Also, can the topographical map of Thimphu be updated?	The frequency of updates will depend on the area in question and level of priority. In addition to remote sensing using satellite images, updates can also be carried out using a combination of on-site surveys and schemes. It is also possible to select an appropriate combination depending on the budget and time available. In that respect too, the sharing of data among stakeholders is essential.
3	With respect to working with GIS, if this were incorporated into school lessons would it be possible to obtain support from the JICA Study Team?	The Team would like to provide active cooperation.
4	About data management and analysis: How about the technology transfer being done in Thimphu City, and then passed on from Thimphu to other cities?	That is a good idea. We would like to discuss and consider it at the appropriate time.
5	Why is the pilot area only about one-tenth of the project area?	The pilot area provides scope for the NLCS staff to work on their own, making the most of the outcomes of the technology transfer of the Project, and represents an appropriate amount of work through which to evaluate the technology transfer and clarify future issues in the NLCS proceeding alone.
6	How is the access rights to the Geo-Portal or the use of a Cloud system considered?	There is no classification of access rights, but at the present time matters involving legal issues are not made public. The use of the Cloud is at present at the idea stage.
7	Will the preparation of these topographical maps not give rise to problems in sensitive areas, such as the question of the border with India?	Local work will be carried out using satellite images, but as data concerning national borders will not be handled, this will not be a problem.
8	How accurate will the topographical maps be?	It will depend on the resolution of the satellite images. The maps will not be as precise as cadastral maps.

[2] Preparation and implementation of NSDI Action Plan 《Work in Bhutan》

1) The Team summarized the concept to be used in the formulation of the NSDI Action Plan through discussion with NLCS based on the results of the survey conducted in the first dispatch of experts and the details of NSDI development mentioned in Chapter 1.

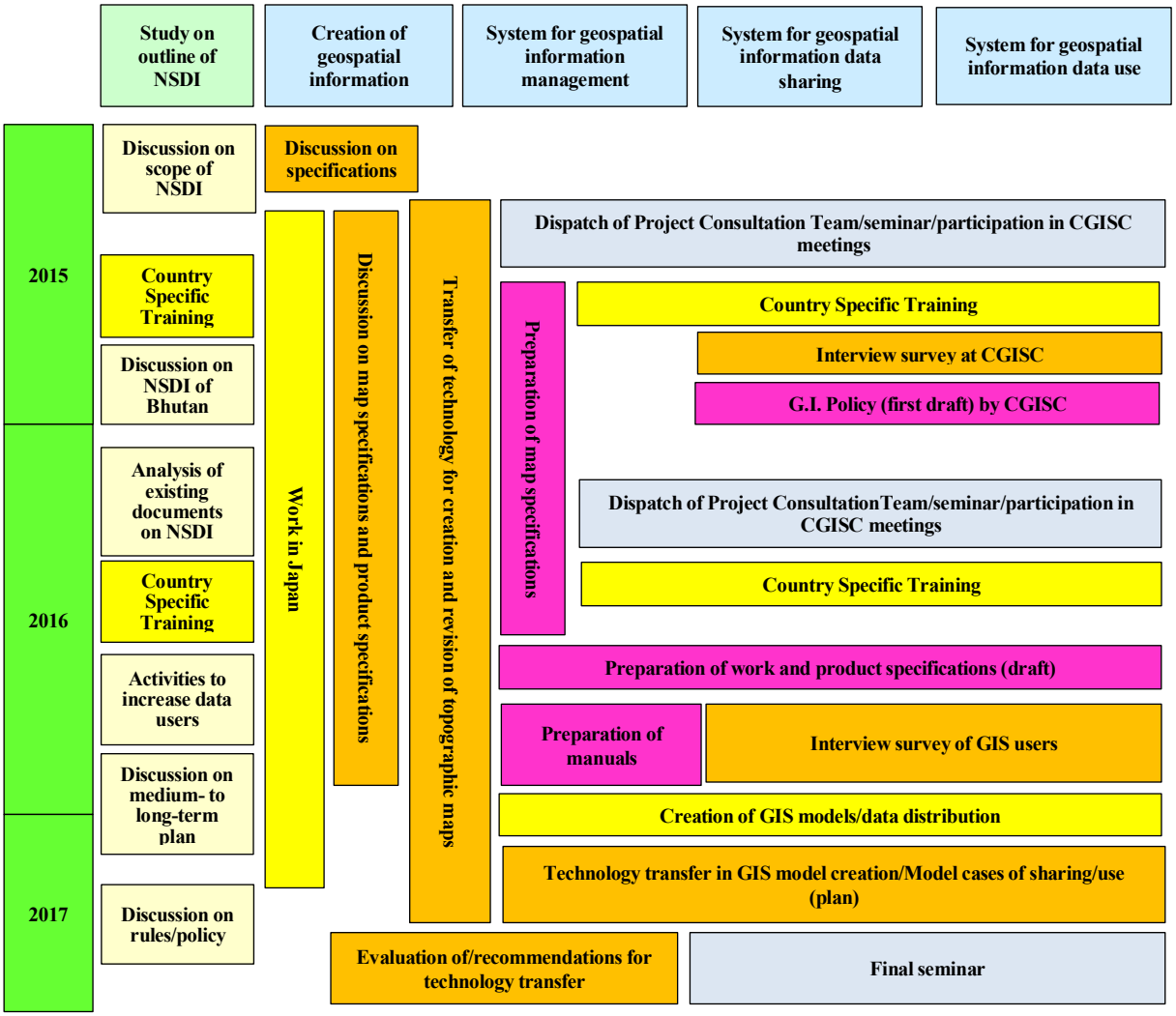


Figure. 23 NSDI Action Plan

2) Arrangement of the 1st "Project Consultation Team"

The following field work was conducted jointly with "Project Consultation Team" and a JICA Study Team from the end of June to the beginning of July, 2015. The role of NLCS in NSDI was confirmed in the conference with the related people from NLCS, and it was possible to share the significance and the directionality of the NSDI formulation among the related people through a CGIS meeting and individual hearing to CGIS members.

- Conference with NLCS about directionality of the NSDI formulation
- Participation in a CGISC meeting and information sharing about NSDI to a participant
- Individual hearing to CGISC members

Members of the Project Consultation Team and the JICA Study Team participated in the meeting of CGISC held on 3rd July as observers. The members of the consultation team gave presentations on a case of the development of NSDI in Japan in the meeting.

Much of a question about the presentation was concerned with a problem of geographical spatial information management in Bhutan which CGISC member concerns about, and this shows the intention to utilize a case in Japan positively. An example of management and utilization of country geospatial information at the time of an accident such as "the Great East Japan Earthquake" was effective information to share an image to state decision support.

Table. 60 Actions of the "Project Consultation Team"

Period		Objectives	Contents	Opportunities
1st	From 29th June To 10th July 2015	Intelligence sharing of Japanese model case about NSDI Development	Necessity of NSDI and history of GIS development in Japan Establishment of minister concerned liaison conference and government plan for GIS utilization Preparation of GIS Action plan Enactment of Basic act for promoting Geospatial Information Utilization Case study of Geospatial Information Utilization Recommendation for NSDI development in Bhutan	NLCS meeting Individual Interview to CGISC member
		Intelligence sharing of concrete application examples about geospatial Information in NSDI	Role of Geospatial Information for Disasters < Explanation of the cases of geospatial information use > Case study of "Geospatial Information Authority of Japan" action "Great East Japan Earthquake" Case study of "Landslide in Hiroshima" and "Eruption of Ontakesan"	
	3rd July 2015	Understanding of the necessity to control national geospatial information Understanding of the importance of geospatial information as reference for the government in decision-making	<Presentation> ・ Implementation of the project in accordance with a law ・ Improvement of the organizational capacity to realize better coordination with relevant organizations ・ Importance of the basic map information of the entire country ・ Importance of generating DEMs of the entire country ・ Importance of visualizing geospatial information with such a method as Web mapping	CGISC meeting

Table. 61 Participants to CGISC (On 3rd July 2015)

	Organizations	Head Count
1	National Land Commission	6
2	Ministry of Agriculture & Forestry	1
3	Ministry of Economical Affairs, Department of Hydro-Meteorological Service(DHMS)	1
4	Ministry of Economical Affairs, Department of Hydropower and Power Systems(DHPS)	2
5	Ministry of Economical Affairs, Department of Geology and Mines	1
6	Thimphu Thromde	1
7	Bhutan Telecom	1
8	National Housing Development Corporation Ltd.	2
9	World Wildlife Fund Bhutan	1
10	Department of Livestock	1
11	Samdrup Jongkhar	1
12	JICA Project Consultation Team, JICA Study Team	2
	TOTAL	**20**

Table. 62 Question and Answers in CGISC (On 3rd July 2015)

	Questions	Answers
1	To which organization in Japan is the Committee Secretariat attached?	The Cabinet Office.
2	Does the server belong to a central office, or does each agency have its own server?	Each agency has its own server.
3	Who manages the geo-spatial data?	The Geospatial Information Authority of Japan. (GSI)
4	How was an understanding of the horizontal and vertical changes that occurred due to the Great East Japan Earthquake gained?	They were calculated using data from the GSI's network of GNSS stations.
5	How long after the earthquake did it take for the changes to be understood?	Approximately one day.
6	In what way were the results of surveys carried out after the earthquake reflected in the cadastral data?	They were reflected by means of conversion parameters.
7	Is the source code for the Web Map system written in English?	It is written in English.
8	Is the source code for the Web Map system provided free of charge?	At the GSI, it is provided free of charge.

3) Arrangement of the 2nd "Project Consultation Team"

The 2nd Project Consultation Team and the JICA Study Team jointly implemented the following activities in early June 2016.

・Presentation of a case of NSDI in Japan at the Interim Seminar (See [4] below for the details)

・Participation in a CGISC meeting and sharing of the information on NSDI with the participants of the meeting (10th June 2016)

Table. 63 Discussion in the meeting consulted by 2nd "Project Consultation Team"

Items	Contents
Report on the activities implemented so far by CGISC	Progress in the development of "G.I. Policy (draft)" and NSDI
	State of the development of Geo-portal
Presentations by the Project Consultation Team	Management of the public survey outputs, creation, updating and disclosure of the basic map data
	Provision of data at the time of disaster, the Open Data Policy
Demonstration of Royal Thimphu College	Presentation of the cases of the use of GIS in the "environment" and "disaster management" sectors
Demonstration by the Study Team	A report on the up-loading of the planimetric feature data and contour data of the western priority area to the server of NLCS
	Presentation on the original topographic map viewer developed from open-source software of "GSI maps" by the team
Question-and-answer session /sharing issues of common concern	<Sharing issues in "Geo-portal"> The number and types of available data are limited. The data specifications have not been standardized. The data not up-to-date. Application that meets the needs of users is not sufficiently available. The Web environment in Bhutan is vulnerable. Users do not have sufficient knowledge and technical capacity in GIS (for data use and updating).

Figure. 24 Action of "Project Consultation Team" (2nd Assignment)

[3] Drawing up and implementation of the NSDI Action Plan (Continued) 《Work in Bhutan》

The activities for NSDI development were carried out jointly with the NLCS and other related agencies in accordance with the NSDI Action Plan as prepared or revised in the first year.

In this work, a system to achieve the orientation and utilization of feasible NSDI development were established in order to conduct the activities in consideration of the progress of NSDI development in Japan and the present status in Bhutan as discussed in the interim seminar.

Table. 64 Outputs of the Activities for NSDI Development

Item			Specific activity	Output
0	Study on the outline of NSDI	Study on the scope of NSDI to be developed in this Project	Examination of the scope of the NSDI to be developed in this Project	A study was conducted on the roles of "G.I. policy, "Survey Manual" and "work specifications." A detailed NSDI development policy was formulated and the specific terms used in the development were defined clearly.
			Examination of the appropriate organizational system for NSDI development for RGOB	
1	Development of geospatial information	Development of 1/25,000 digital topographic maps covering the southern region	Creation of 1/25,000 digital topographic maps of the southern region in Work in Japan	Preparation of the work specifications (draft), map specifications (draft) and product specifications (draft) for the 1/25,000 digital topographic mapping and the technology transfer concerning 1/25,000 digital topographic maps and creation of the maps
2	Establishment of maintenance system for geospatial information	Establishment of technology and system for development of 1/25,000 topographic maps for the southern region, quality control, process management and management of equipment	Discussion on a plan for the maintenance and updating of the 1/25,000 digital topographic maps	The information on a long-term plan for the creation and updating of maps of different regions, different scales and different themes were shared among the stakeholders.
			Technology transfer in each process in the creation and updating of 1/25,000 digital topographic maps	Proposal of a method to update maps through "Geo-portal" and the information on a long-term updating plan were shared among the stakeholders.
				Technology transfer for the updating of 1/25,000 digital topographic maps
				Preparation of various manuals
		Study on data models and formats and sharing of the study results	Definition of points, lines, polygons, attribute information	Preparation of the work specifications (draft), map specifications (draft) and product specifications (draft) for the

			and formats and definition of the relationship between shapes based on international standards for 1/25,000 digital topographic maps	1/25,000 digital topographic mapping
3	Establishment of system for joint use of geospatial information data	Study on measures to prevent duplication of geospatial information and sharing of the study results	Examination of the scheme for central management of geospatial information suitable for the actual situation of Bhutan	A scheme for the "approval of duplication" was added in the "work specifications." Discussion is to be held on plans for updating of "G.I. Policy" under the scheme of NSDI development and the capacity development of CGISC.
		Study on the rules and policy on data sharing and sharing of the study results	A study on measures to fully integrate the geospatial information of Bhutan owned separately by different organizations into NLCS	
		Study on the policy and mechanism for data sharing among stakeholders in the government and sharing of the study results	Defining the work of geospatial information development and the functions of related agencies in Bhutan, and building a system to allow the NLCS to provide guidance and advice to related agencies	Development of the rules on "surveying plan," "technical advice of NLCS," "submission of the surveying results," etc. was added in the "work specifications". Discussion on a "medium- to long-term plan" with NLCS
4	Establishment of system for utilization of geospatial information data	Study on data sales and sharing of the study results	Examination of the measures for external distribution of data owned by NLCS	Recommendations for the improvement in the convenience of the data use such as a proposal of the development of "smartphone application" using geospatial information
			Examination of the method to provide geospatial data and the content of the data to be provided	
			Establishment of rules, standards and a pricing method for provision geospatial information	To be discussed with NLCS
		Study and discussion on data use models by the stakeholders in the government	Identification of potential users and joint development of utilization model concerning the utilization of the outputs of this project in "agricultural development planning" and "infrastructure development planning"	Technology transfer of GIS technology to the individual CGISC members is to be implemented, a model case is to be developed, its availability is to be notified and its use is to be promoted.
		Study on methods of data browsing, development of a data browsing system and data for browsing for the general public and the sharing of the study results	Discussion on a plan for the utilization of "Geo-portal" Development and public use of the "topographic map viewer" Final seminar	A consensus has been formed on the importance of data sharing including the data sharing on "Geo-portal" and with "topographic map viewer."

[4] Recommendations for utilization of outputs and holding of seminar 《Work in Bhutan》

A seminar to promote the utilization of digital topographic maps was held on the following contents at the time of completion of this Project.

The Interim Seminar was held on 8th June 2016. Sixty-four people from 25 organizations participated in the seminar. The participants asked many questions on the "policy on the sharing of geographical information" and "data updating (both from the technical and financial viewpoints)." This observation

re-confirmed their interest in the continuous management of the geographical information data.

Reporters of newspapers and TV stations also participated in the seminar. They reported the seminar in news programs on TV on the day of the seminar and articles in newspapers on the following day.

Table. 65 Contents of Interim Seminar

Interim seminar	**Purpose**	Introduction of utilization of geospatial information such as 1/25,000 topographic maps in Japan, and examination of feasible utilization plans and problems in Bhutan
	Time	8th June 2016
	Contents	Framework of utilization of geospatial information in Japan (Project Consultation Team) Development and dissemination of geospatial information by the Geospatial Information Authority of Japan (Project Consultation Team) Utilization of Geo-info in the public and private sectors in Japan (Project Consultation Team) Demonstration of GIS-application sample models and introduction of model application cases (Project Consultation Team) Present status of policies and legislation on distribution and utilization (NLCS administrative staff) Proposals by the NLCS on utilization in agricultural development projects and infrastructure development projects (NLCS administrative and technical staff) Proposals by the CGISC on utilization in agricultural development projects and infrastructure development projects (CGISC administrative and technical staff)
	Materials	Presentation materials and general descriptions of NSDI in Japan Presentation materials and general descriptions for each presentation and GIS software
	Venue	Hotel in Thimphu City
	Participants	Project Consultation Team, About 50 participants selected mainly from NLCS and CGISC

Table. 66 Participants to Interim Seminar (Head Count)

	Organizations	Participants		Organizations	Participants
1	Bhutan Power Corporation	2	14	National Housing Development Corporation Limited	2
2	Bhutan Telecom Limited	3	15	NLCS	24
3	College of Science and Technology	1	16	National Soil Service Center, Ministry of Agriculture and Forest	1
4	Department of Disaster Management, Ministry of Home and Cultural Affairs	1	17	National Statistical Bureau	1
5	Department of Hydropower and Power Systems, Ministry of Economic Affairs	2	18	Phuntsholing Drungkhag	1
6	Department of Information Technology and Telecom, Ministry of Information and Communication	1	19	Phuntsholing Thromde	1
7	Department of Livestock, Ministry on Agriculture and Forest	1	20	Royal University of Bhutan	1
8	Gelephu Thromde	1	21	Samdrup Jongkhar Thromde	1
9	Government to Citizen Service, Ministry of Information and Communication	1	22	Thimphu Thromde	1
10	Gross National Happiness Commission	1	23	University of Twente	2
11	JICA	7	24	Bhutan Broadcasting Service Corporation	1
12	Ministry of Education	1	25	Kuensel	2
13	Ministry of Home and Cultural Affairs	3			
				TOTAL	**64**

Table. 67 Question and Answers in the Interim Seminar

	Questions	Answers
1	More than 1,300 CORSs have been installed in Japan. Is it necessary to install that many CORSs in Bhutan?	Different densities (positioning) of CORSs are (is) required for different purposes. While the density of one CORS in every 20 km will be required for their use in the "real-time kinematic GPS" and "construction with GPS-based IT technology," that of one in every 80 km is considered appropriate for geodetic purposes. In addition, different countries have different opinions on the CORS density.
2	Will the satellite imagery used in the project be provided to NLCS?	The imagery shall be handed over to NLCS after the completion of the project and, in certain cases, during the project period.
3	With regard to the intervals of the data updating, are the organizations that are supposed be data providers in the free data sharing scheme cooperative to the scheme?	There are two approaches to the data updating: routine updating (at different intervals at different places) and updating whenever the state of development has changed.
		The G.I. Policy shall include the provision on the data updating.
4	Is statistical information included in NSDI in Japan?	The geospatial information data managed by GSI of Japan are designed as basic data to which "statistical information" can be included as attribute.
		Because statistical information may include personal information, careful consideration is required for the formulation of the specifications of the statistical information to be included in geospatial information.
5	Is the scale of 1/25,000 sufficient to ensure the accuracy required for data to be used as the "Basic Map Information" of the entire country?	The "basic map information" that covers the entire Japan is based on the data of 1/25,000 topographic maps. In addition, other sets of the information based on the data of maps of larger scales are available for large metropolitan areas to ensure better positional accuracy of the data.
6	Are there going to be organizations reluctant to provide their data free of charge for the data utilization and sharing?	Such a concern does not exist in Japan because the policy of free data provision had been established in the beginning of the NSDI development by the "Survey Act" and budget has been allocated to the free data provision. In principle, GSI is supposed to have an agreement on free data provision with each local government and receive data free of charge at the time of data updating in accordance with the agreement.
7	Has there been any copyright-related problem by making geospatial information open data in Japan?	Information could be used inappropriately. However, we do not intend to impose stricter restriction on its use only for this reason. When inappropriate use is found, we will demand the person concerned to stop using the information.
8	Is an opportunity for internal training available for institutions other than NLCS such as the CGISC members?	We had such training at the "Royal Thimphu College" once in the past. Unfortunately, not many people participated in this training. However, we consider that this training is the first step to extend the use of GIS and intend to continue it.

The final seminar was held on 10th August 2017. 112 people from 27 organizations participated and shared comments and questions about presentations in the seminar such as "Accuracy of Topographic map", "future Geospatial Information sharing policy", "Ideas for future utilization of Geospatial Information", "Cybersecurity", "Applicability of arable potential area GIS model", "issues of the feedbacks from the Technology Transfer to human resource development and daily business".

In the seminar, 9 presentations out of every 11 were made by Bhutan side (NLCS and relevant organizations). This showed the technology transfer was really understood by Bhutan side and increased the independence of NLCS and relevant organizations.

Reporters of newspapers and TV stations also participated in the seminar. They reported the seminar in news programs on TV on the day of the seminar and articles in newspapers on the following day.

Table. 68 Contents of the Final Seminar

Final seminar	**Purpose**	To monitor the progress of NSDI development and problems in Bhutan under this Project
	Time	10th August 2017
	Contents	Final Report (Overview of outputs of the Project and recommendations, method of providing outputs: JICA Study Team) Details and outputs of Technology Transfer (NLCS) Use of the reference stations in Bhutan at present and in future (NLCS) State of progress of NSDI development and future solutions and recommendations (CGISC) Present status of policies and legislation on distribution and utilization, and problems and recommendations (NLCS administrative staff) Report on training by country (NLCS engineers) Future concept of how to develop geospatial information (NLCS) Utilization of 1/25,000 digital topographic maps in the fields of agricultural development and infrastructure development (JICA Study Team and NLCS)
	Materials	Final outputs (topographic map data, orthophotos, GIS application sample models, etc.) Materials and general descriptions for each presentation as well as Geoportal
	Venue	Hotel in Thimphu City

Table. 69 Participants to the Final Seminar (Head Count)

	Organizations	Participants		Organizations	Participants
1	Bhutan Power Corporation	2	15	Royal Thimphu College	2
2	Bhutan Telecom Limited Ministry of Education	1	16	Royal University of Bhutan	2
3	Gross National Happiness Commission	1	17	Ugyen Wangchuck Institute for Conservation and Environmental	2
4	International Boundaries	1	18	Haa Zongkhag	1
5	Department of Information Technology and Telecom, Ministry of Information and Communication	2	19	Samdrup Jongkhar Zongkhag	1
6	National Soil Service Center, Ministry of Agriculture and Forest	3	20	Samdrup Jongkhar Thromde	1
7	Other Departments, Ministry on Agriculture and Forest	2	21	Trashigang Zongkhag	1
8	Department of Hydropower and Power Systems, Ministry of Economic Affairs	2	22	Tshirang Zongkhag	1
9	Other Departments, Ministry of Economic Affairs	5	23	World Wild life Fund	1
10	Ministry of Works and Human Settlement	1	24	JICA	7
11	National Council	4	25	NLCS	56
12	National Assembly	6	26	Bhutan Broadcasting Service Corporation	2
13	National Statistical Bureau	2	27	Kuensel	2
14	National Housing Development Corporation Limited	1			
				TOTAL	**112**

Table. 70 Question and Answers in the Final Seminar

Questions		Answers
1	What is the importance and challenges of ground truthing	The main essence of the work was clarity, visibility and reality. When there were some clouds covering the satellite image, we had to realize in the ground. Also to assure the quality of accuracy, JICA training had a very good QC method.
2	How can we approach NLCS for data sharing and what is the policy concept issue	For now you can always contact NLCS as the previous method for data sharing. Though, due to the undergoing in our GI policy, there are some issues in data categorization and uniformed standardization. When the policy is approved, it will be more smooth to open to the public through our geo-portal.
3	How reliable is the DEM accuracy in inaccessible areas	Example in Kurigongri. Using the existing control point for reference and shift the coordinates to the project area by total station. Vertical tolerance is half of the contour interval and the result is within the tolerance.
4	There is an idea to manage past and current JICA activities in geo-spatial data, with the budget, who, when, where and what project kind of information.	We had several discussions regarding to the securitu insurance, though the decision was made from the donor. But after the establishment of the geo-portal, no further discussion was made.
5	Are cyber security measures introduced or discussed in NLCS for the geo-portal?	No answer (this is a comment)
6	The GIS sample model was very interesting. Is this model applicable to nationwide agriculture possibility study?	If the criteria for each land type are clarified, we can discuss your needs and come up with some solution. This model can be used not only for arable land, but also for national forest coverage. Tough, for now we only have the 1/25,000 scale map for the southern belt. In order to ensure and analyse such kind of data, we will need the nationwide fundamental data for analysis and validation.

After the final seminar, the Team had questionnaire as follow to the participants about the seminar. From the answers of questionnaire, the understanding of participants did not rise to the level of active dialogue and exchange about the concrete ideas of Geospatial Information utilization in Bhutan side. However the understanding of participants about “the project purpose and the target”, “importance and actions of 1/25,000 topo map and Geospatial Information”, “advantage and method of data sharing & data utilization” showed envisioned impact.

Table. 71 Reply of Questionnaire (the Final seminar)

Question		Answer(%)	
		Yes	No
1	Have you understood the target, project area and the importance of this project?	100	0
2	Have you understood the specifications of 1/25,000 topographic map data?	100	0
3	Have you understood the outline of general technic to produce 1/25,000 topographic map data?	75	25
4	Was the any presentation which fulfilled your interest or expectations?	100	0
5	Were there any presentations which will contribute to your work?	100	0
6	Have you understood the importance of the cross-sectional data sharing of national fundamental spatial information for national development planning?	100	0
7	Were you able to find out the future tasks for Bhutan’s G.I. management/ implementation?	100	0
8	Do you have any inconvenience in the usage of Bhutan’s geo-spatial data?	38	62
9	Do you think the “Topo Map view page” and “Geo-portal” is/will be useful and do you use this feature?	88	12
10	Have you understood the advantage of sharing/utilizing the topographic map data?	100	0
11	Have you understood the potentials and its’ positive effects of GIS?	100	0
12	Have you understood that overlaying thematic data on top of topographic data will be the basis of utilization and analysis?	88	12
13	Is the 1/25,000 topographic data and your work in a close relationship?	75	25
14	Will the development of nationwide 1/25,000 topographic data make a positive impact to your work?	100	0
15	Would you like to use the 1/25,000 topographic data immediately in your work?	100	0
16	Are you or your organization possession to any type of geo-spatial data for sharing/utilization?	75	25
17	Does your organization have any development plan in the southern belt which is mentioned in the 12th 5YP?	50	50
18	Was the seminar an eye opener for the utilization of geo-spatial information?	100	0
19	Do you have any interest in the GIS analysis training which is implemented in this project?	100	0
20	Do you have expectations for the nationwide 1/25,000 topographic data preparation?	100	0

Figure. 25 Final Seminar

Chapter 6. Other works

[1] Collection, arrangement, analysis of related materials and information 《Work in Japan》

1) Analyzed the materials collected in the study for formulating detailed plans and collected, arranged and analyzed the additional information available in Japan.
2) Arranged the geospatial information possessed by the NLCS and CGISC to utilize the data for formulation such as "GCP survey plan", "Field Identification plan", "Map Symbol Catalogue (Draft)", "Map layout Design (Draft)".
3) Arranged the agricultural development projects and infrastructure development projects as well as the associated projects which were under formulation or implementation by RGOB and donors.

[2] Preparation and discussion on Inception Report 《Work in Japan / Work in Bhutan》

1) Summarized the implementation policies, work schedules and implementation system of this Project, prepared the Inception Report and explained it to JICA in the "Report Review Meeting" on February 2015 to acquire its approval.
2) Provided explanations and held discussions over the Inception Report with the NLCS on March 2015 and obtained its consent, especially on the methods of execution of local work, copyrights, survey standards and use of existing materials.
3) Held discussions on the Technology Transfer Action Plan and NSDI Action Plan and formulate the basic plan.

[3] Preparation and discussion on Progress Report 1 《Work in Japan / Work in Bhutan》

1) The work results after preparation of the Inception Report, the state of progress of the technology transfer and development of the topographic maps as well as the progress of NSDI development was summarized to prepare Progress Report 1, which was explained to JICA for its approval.

2) Progress Report 1 was submitted to the NLCS and its contents were explained and discussed to obtain the approval of the NLCS. For the Technology Transfer Action Plan and NSDI Action Plan as drafted at the time of submission of the Inception Report, the level of achievement was checked and if necessary, the plans was reviewed through discussions with the NLCS.

[4] Training in Japan 《Work in Japan》

Two sessions of country-focused training were implemented for the technical and administrative staff of Bhutan.

Table. 72 1st Training in Japan

Item	Description
Purpose	Acquisition of digital topographic mapping methods Acquisition of accuracy/quality control methods Acquisition of sale and promotion methods for topographic maps Understanding of latest NSDI policies Understanding of related advanced technologies
Contents of Training	Methods of developing digital topographic maps by national geographic mapping agency and private sector Type approval system for survey equipment and outputs for accuracy/quality control Method of sale and promotion of topographic maps, and inventory control methods National policies on NSDI Inspection tour of advanced survey technologies
Period of Training	First: From 27th August to 12th September 2015 Second: From 25th September 7th October 2016
Number of Trainees	First: 8 Technical trainees per training course Second:10 management trainees per training course
Expected Effects	Transfer of knowledge acquired by trainees to NLC or other related agencies

＜1st Training in Japan（From 27th August to 12th September: 8 Technical Members）＞

The content of the training by country was planned to reflect as far as possible the requests received in advance from those participating in the training. The results of the questionnaire taken at the end of the training indicated that the training of "the establishment of various types of legislation concerning national spatial data", "the building of rules and a system for the inspection of surveying instruments and survey results", "Quality Control" were deeply relevant to the normal operations of participants from the national surveying agencies and posed a challenge for the NLCS; thus being able to acquire knowledge and skills in the advanced technologies, related laws, rules and regulations of Japan was extremely beneficial, and it is hoped that the spread of the content of the training both within and outside the organization will help enhance the capacity not only of the NLCS but also of the CGISC.

Table. 73 Schedule of the 1st Training in Japan

Date		Training	Venues
27th Aug	Thu	Moving	
28th Aug	Fri	Briefing, Presentation of latest technology in private sectors	JICA Tokyo, Consultant Head Office
29th Aug	Sat	Data filing	
30th Aug	Sun		
31th Aug	Mon	Geospatial operation in the National Survey and Mapping Organization	Geospatial Information Authority of Japan
1st Sep	Tue	Calibration method of Survey Materials	Japan Association of Surveyors
2nd Sep	Wed	Calibration method of Mapping Quality Control method	Japan Association of Surveyors
3rd Sep	Thu	Digital plotting, Digital Editing, Symbolization training	Private Sector
4th Sep	Fri	Digital plotting, Digital Editing, Symbolization training	Private Sector
5th Sep	Sat	Data filing	
6th Sep	Sun		
7th Sep	Mon	Operation of Satellite Image Analysis Technology	Consultant Branch Office
8th Sep	Tue	Cadastral works in Japan	Consultant Branch Office
9th Sep	Wed	Quality Control examples of Mapping data	Consultant Branch Office
10th Sep	Thu	Project management of Private Sector	Consultant Head Office
11th Sep	Fri	Discussion, Reporting to JICA	JICA Headquarters, Consultant Head Office
12th Sep	Sat	Moving	

Table. 74 Questionnaire Result from Trainees about the training

	Name	Position	Answer to the Questionnaire
1	Tenzin Norbu	Survey engineer	Bhutan has no proper QC method for Public and private mapping and surveying systems. Training through JICA was an eye opening for us.
2	Chokila	Senior Survey engineer	The GEONET and instrument calibration center are the two most important programs that would help the National Land Commission of Bhutan to establish the center with similar kind of infrastructures and mechanism in future. The other important aspects are the data quality control check mechanism to maintain the data standards as per the clause of the Acts.
3	Dorji Tashi	Senior Survey engineer	GSI functions as Supreme body in Surveying and Mapping under the purview of well-established laws, guidelines, rules and regulations where our national mapping agency (National Land Commission) lacks such essential aspects.
4	Jampel Gyeltshen	Surveyor	The calibration center in JAS was wonderful setup for all instruments but Bhutan is yet to establish soon.
5	Pemphu Tshering	Survey Associate / Photogrammetrist	The QC and instrument management system was highly appreciative because we do not have basic regulations for topographical survey.
6	Sonam Dhendup	Deputy Chief Survey engineer	These procedures help in maintaining a high quality map products & data; convenient mapping with required precision.
7	Tashi Phuntsho	Surveyor	The inspection and examination of geo-spatial data, accuracy of the field data including data monitoring and data quality control systems by JAS is highly appreciated.
8	Ugyen Dorji	Senior Survey engineer	We are at the moment trying to start a calibration center for inspecting survey equipment so the training was timely and most appropriate.

< 2nd Training in Japan (25th September to 5th October 2016: 10 Management Members) >

The training was focused on the management of, and systems in, a national survey institution. It also included opportunities for the participants to see GIS being used not only at the national level but also at the local government level (integrated use of GIS).

The participants learned the development of geospatial information based mainly on satellite imagery, cases of the development of IT-based NSDI and the methods of business management, human resource and equipment management and systematic operation used for the utilization of geospatial information by private companies in lectures and field trips.

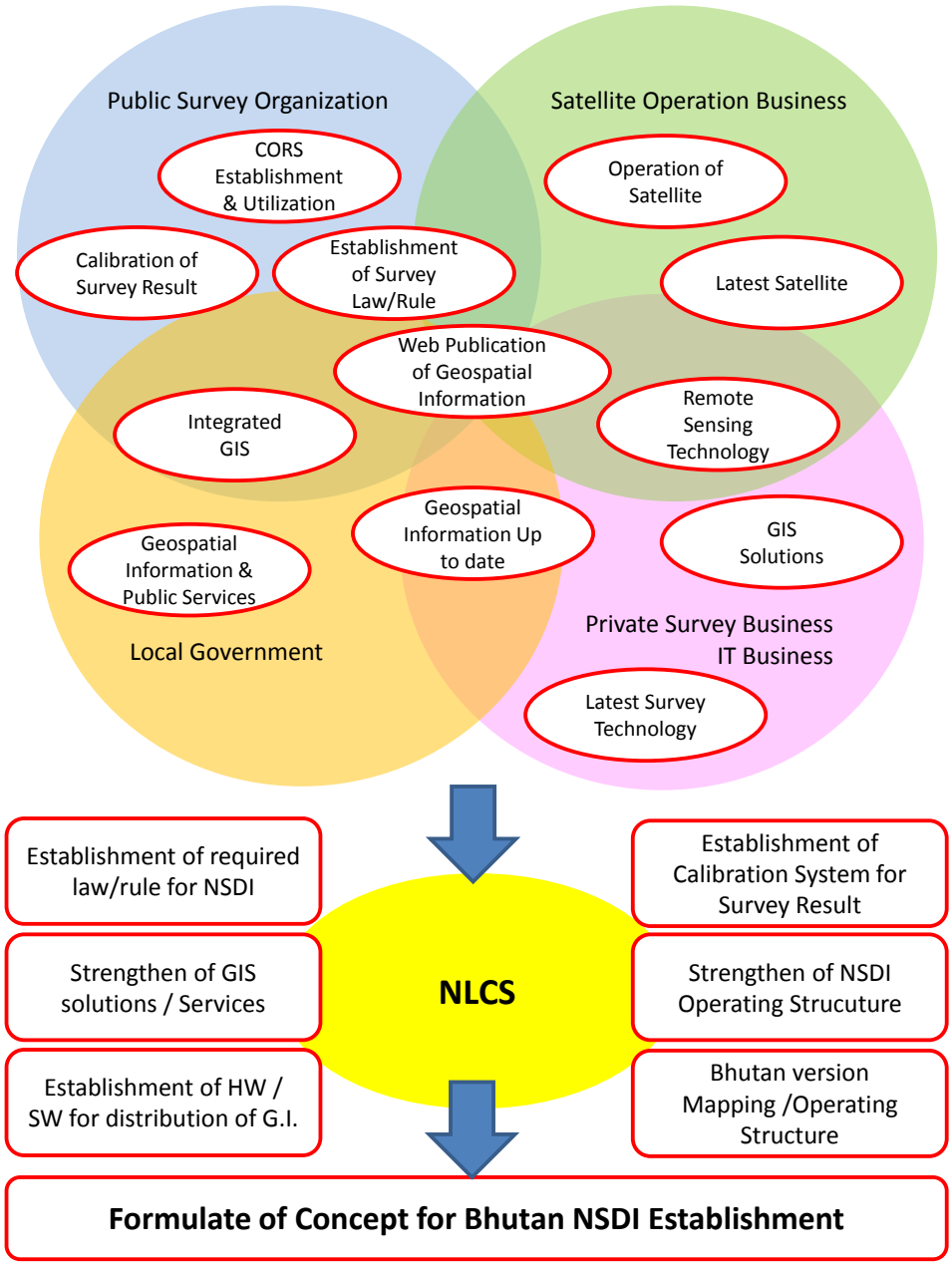


Figure. 26 Concept of 2nd Training in Japan

Table. 75 Schedule of the 2nd Training in Japan

Date		Training	Venues
25th Sep	Sun	Moving	
26th Sep	Mon	Briefing, Inspection tour of CORS	JICA Tokyo Geospatial Information Authority of Japan
27th Sep	Tue	Surveyor qualification system and education of surveyors in Japan	JICA Tokyo Japan Association of Surveyors
28th Sep	Wed	Procurement procedures and development of satellite imagery	JAXA
29th Sep	Thu	National mapping and surveying and Web mapping	Geospatial Information Authority of Japan
30th Sep	Fri	Cooperation between the headquarters and a branch office of the national surveying institution Activities at a branch office of the national surveying institution	GSI Kinki Regional Survey Department
1st Oct	Sat	Visit of Japanese Culture	Osaka Castle, Kinkakuji, Kiyomizu Temple
2nd Oct	Sun		Private Sector
3rd Oct	Mon	Discussion, Reporting to JICA Team A Work management in a private company	JICA Tokyo Consultant Head Office
4th Oct	Tue	Work Structure of Local Government Office, GIS service	Honjo City
5th Oct	Wed	Operation of artificial satellites and their characteristics ALOS , AW3D (ALOS World 3D), and remote sensing technologies and their use	RESTEC
		Use of elevation data generated from satellite imagery Presentation of cases of the NSDI development and use of geographic information in the IT sector	NTT Data
6th Oct	Thu	Presentation of the human resource and equipment management methods Presentation of the methods for systematic operation	Consultant Head Office
7th Oct	Fri	Discussion, Reporting to JICA Team B	JICA Tokyo
8th Oct	Sat	Moving	

Table. 76 Contents of Reporting about Training in Japan

Presenter	theme	Contents
Yeshi Dorji (Team A)	Presentation	・Understood the importance of considering the development and operation of NSDI from a comprehensive viewpoint ・Recognized the key role played by the basic part of the development of rules and systems in the development and expansion of NSDI anew ・Understood that an appropriate institutional agreement would allow the relevant organizations to make a systematic and cooperative approach when they coordinate their operations ・Understood the importance of clear demarcation of the responsibilities of the parties involved and the data classification in a broad sense in the development of NSDI ・Recognized the importance of the improvement of the GNSS-based control stations network anew ・Recognized the importance of the calibration of measuring instruments anew ・Understood the necessity for the development of a mechanism for quality control and accreditation ・Understood the necessity of improving the capacity in the use of open-source software ・Understood the importance of the shared use of geographical information and promotion of its use in the studies on and risk management against natural disasters and climate change ・Understood the urgency and efficiency of the Web use in the geographical information data service
	Result from the Training	・Development of the basic part of NSDI ・Coordination with the organizations involved in NSDI ・GNSS-based control stations ・Calibration of measuring instruments and quality control of the survey results ・Dissemination of national geospatial information with application and through the Web
	Ideas of Utilization of the result	・The approaches to the development of laws and systems concerning NSDI adopted by GSI will be taken in Bhutan in the order of applicability/feasibility in Bhutan. ・Relationship with the organizations concerned with NSDI (the members of CGISC) will be constructed in the collaboration between NLCS and the Study Team with the collaboration

		and partner network GSI maintains with its partner organizations used as reference. ・ Creation of model cases targeting the currently operating GNSS- based control stations will be continued. ・ As the Government of Bhutan has a plan to construct a facility for the calibration of measuring instruments and quality control of survey results, the outputs of this training will be included in the development of the plan. ・ Studies on the development of applications using the national geospatial information in the natural disaster management and mitigation of the impact of climate change and the improvement and expansion of the Web environment will be continued.
Chimi Dem (Team B)	Presentation	・ Understood the importance of the photogrammetry and remote sensing technologies in the risk management. ・ Understood that GIS is the optimal tool for the development in various fields for local governments. ・ Understood that applications can be developed for specific needs of individual data users. ・ Understood that various platforms can be used in combination for the acquisition of geospatial information.
	Result from the Training	・ Methods of time management used in Japan and people's awareness to time management in Japan ・ Qualification system for surveyors ・ Mechanism for updating geographic information and cooperation among the institutions involved in the data updating ・ Calibration of surveying instruments and quality control of surveying outputs ・ Knowledge of simple stereo plotters that can be utilized in the forestry sector ・ Various types of applications for the use of geospatial information
	Ideas of Utilization of the result	・ The qualification system of surveyors in Bhutan will be revised. The systems used by GSI will be introduced in Bhutan in the order of applicability/feasibility in Bhutan. ・ NSDI will continue building a cooperative relationship with organizations concerned with NSDI (the members of CGIS), based on the cooperation between CGIS and the Study Team, using the collaboration and networks that GSI has established with its partners as reference. ・ As the Government of Bhutan has a plan to develop a facility for the calibration of surveying instruments and quality control of the surveying results, the outputs of this training will be included in its planning. ・ A study will be conducted on the development of mobile apps for the use of geospatial information.

Figure. 27 2nd Training in Japan

[5] Preparation and discussion on Progress Report 2 《Work in Japan / Work in Bhutan》

The Team prepared Progress Report 2 by compiling the outcome of the work conducted after the preparation of Progress Report 1 and the progress of the technology transfer, topographic mapping and development of NSDI and obtained approval of JICA and NLCS for the report after giving explanation on and having discussion on the following points.

1) Progress in the implementation of the technology transfer plan and the NSDI Action Plan described in Progress Report 1,
2) Dispatch of the 2nd Project Consultation Team and the activities of the team, and
3) Implementation and contents of the Interim Seminar.

[6] Preparation and discussion on Interim Report 《Work in Japan / Work in Bhutan》

1) The work results after preparation of Progress Report 2, the state of progress of the technology transfer and development of topographic maps as well as the progress of NSDI development were summarized to prepare the Interim Report and explain it to JICA for its approval.

2) The Interim Report was submitted to the NLCS and explanations provided and discussions held on the contents to obtain the approval of the NLCS. In addition, the achievement level of the Technology Transfer Action Plan and NSDI Action Plan as drawn up at the time of submission of Progress Report 2 was checked.

[7] Preparation and discussion on Draft Final Report 《Work in Japan / Work in Bhutan》

1) The work results after preparation of the Interim Report, the state of progress of the technology transfer and the development of topographic maps as well as the progress of NSDI development was summarized to prepare the Draft Final Report. The achievement level and problems after the end of this Project, in particular the items described below, were defined and explained to JICA in the Draft Final report review meeting on 22nd June 2017 for its approval.
2) The Draft Final Report was submitted to the NLCS and its contents was explained and discussed to obtain the approval of the NLCS.

Table. 77 Centrepieces of Draft Final Report

	Item		Evaluation of effect	Recommendation
1	Technology Transfer	Development of topographic maps	Could the NLCS staff engage in the pilot work using the results of the technology transfer and the acquired materials without any problem?	For the creation of topographic maps conforming to standards by controlling quality For the long-term process and equipment control
		Organizational reinforcement for NSDI development	Could the organizational system be built to allow national development?	For the improvement of performance For the overall capacity development of the staff
		Utilization	Could the technical system and model cases be developed for joint use, processing and provision of data?	For expansion of GIS utilization sample models and model cases
2	NSDI Development	System for joint use of data	Have the functions of related agencies been defined to allow mutual cooperation between them?	For new agricultural development projects and infrastructure development projects
		Establishment of rules	Have the Work Specifications and Product Specifications been prepared which will allow the NLCS to carry out operations? How many rules have been established for use during this Project?	For data copying without any problem
		Development of utilization system	Have the description items of meta data been determined and the distribution tools provided? How many utilization cases have been confirmed during this Project?	For access by many users to the web portal

[8] Preparation of Final Report 《Work in Japan》

The Final Report is prepared by making final adjustments based on NLCS comments on the Draft Final Report and submitted to JICA.

Chapter 7. Project Implementation System

7-1. Work Assignment of the Team Members

The members of the Team and their responsibilities were as follows:

Table. 78 Work Assignment of the Team Members

Name	Assigned Work	Content of Work
Akira OTA	Team Leader /Planning of Digital Mapping	First Year [1] Collection, arrangement and analysis of related materials and information
		First Year [2] Preparation and discussion on Inception Report
		First Year [3] Planning and implementation of the technology transfer
		First Year [5] Recommendations on utilization of the outputs and holding of seminars
		First Year [10] Preparation and discussion on Progress Report 1
		First Year [12] Training by country
		First Year [13] Preparation and discussion on Progress Report 2
		First Year [15] Preparation and discussion on Interim Report
		Second Year [22] Preparation and discussion on Draft Final Report
		Second Year [24] Preparation of manuals
		Second Year [25] Preparation of Final Report
Akira SUZUKI	Sub Leader/NSDI Action Plan/ Utilization Promotion	First Year [4] Preparation and implementation of NSDI Action Plan
		First Year [5] Recommendations on utilization of the outputs and holding of seminars
		First Year [6] Discussion on specifications
		First Year [12] Training by country
		First Year [13] Preparation and discussion on Progress Report 2
		Second Year [22] Preparation and discussion on Draft Final Report
		Second Year [24] Preparation of manuals
		Second Year [25] Preparation of Final Report
Takeo SUGIMOTO	Control Point Survey-1	First Year [3] Planning and implementation of the technology transfer
		First Year [8] Control point survey
		First Year [10] Preparation and discussion on Progress Report 1
		Second Year [16] Technology transfer (Continued)
		Second Year [24] Preparation of manuals
Atsushi MOCHIZUKI	Control Point Survey-2	First Year [3] Planning and implementation of the technology transfer
		First Year [8] Control point survey
		First Year [10] Preparation and discussion on Progress Report 1
		Second Year [16] Technology transfer (Continued)
		Second Year [24] Preparation of manuals
Takeo SUGIMOTO	Field Identification/ Field Completion-1	First Year [3] Planning and implementation of the technology transfer
		First Year [11] Field identification and field completion
		First Year [10] Preparation and discussion on Progress Report 1
		Second Year [16] Technology transfer (Continued)
		First Year [15] Preparation and discussion on Interim Report
		Second Year [24] Preparation of manuals
James K. WATSON	Field Identification/ Field Completion-2	First Year [3] Planning and implementation of the technology transfer
		First Year [11] Field identification and field completion
		First Year [10] Preparation and discussion on Progress Report 1
		Second Year [16] Technology transfer (Continued)
		First Year [15] Preparation and discussion on Interim Report
		Second Year [24] Preparation of manuals

Akihiro SUGITA	Aerial Triangulation	First Year [3] Planning and implementation of the technology transfer
		First Year [9] Aerial triangulation / DTM / creation of orthophotos
		First Year [10] Preparation and discussion on Progress Report 1
		First Year [13] Preparation and discussion on Progress Report 2
Nobuhiro SATA		Second Year [16] Technology transfer (Continued)
		Second Year [22] Preparation and discussion on Draft Final Report
		Second Year [24] Preparation of manuals
Nobuhiro SATA	Digital Plotting	First Year [3] Planning and implementation of the technology transfer
		First Year [14] Digital plotting/ digital editing
		Second Year [16] Technology transfer (Continued)
		Second Year [22] Preparation and discussion on Draft Final Report
		Second Year [24] Preparation of manuals
Ryusuke NAKATANI	Digital Editing/Digital Completion /Map Symbolization	First Year [6] Discussion on specifications
James K. WATSON		Second Year [16] Technology transfer (Continued)
		Second Year [18] Digital editing / digital completion
		Second Year [19] Map symbolization for topographic maps
		Second Year [21] Creation of data files
		Second Year [22] Preparation and discussion on Draft Final Report
		Second Year [24] Preparation of manuals
Akihiro SUGITA	Data Structuration/ GIS Data Analysis	First Year [6] Discussion on specifications
		Second Year [16] Technology transfer (Continued)
		Second Year [20] Digital data structuration / GIS data analysis
		Second Year [21] Creation of data files
		Second Year [22] Preparation and discussion on Draft Final Report
		Second Year [24] Preparation of manuals
James K. WATSON	Digital Plotting Assistance/Coordinator	First Year [1] Collection, arrangement and analysis of related materials and information
		First Year [2] Preparation and discussion on Inception Report
		First Year [5] Recommendations on utilization of the outputs and holding of seminars
		First Year [10] Preparation and discussion on Progress Report 1
		First Year [14] Digital plotting/ digital editing
		First Year [12] Training by country
		Second Year [22] Preparation and discussion on Draft Final Report
		Second Year [25] Preparation of Final Report

7-2. Organigram of the Team

The organigram was as follows:

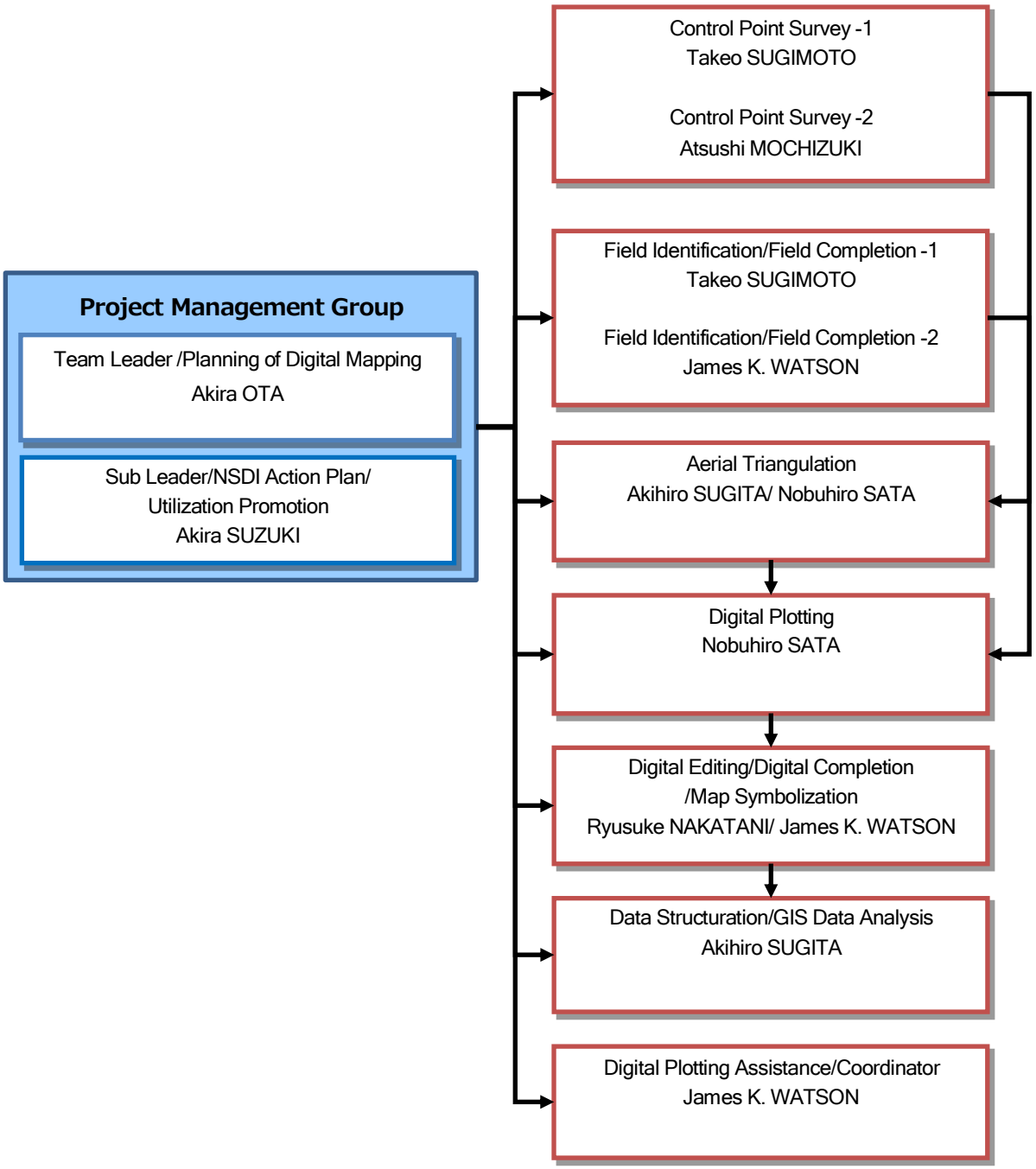


Figure. 28 Operational Structure of the Team

7-3. Personnel Plan of the Team

The personnel plan for implementation of the Project is shown below.

Table. 79 Personnel Plan Table

	Assignment	Name	2015 (2 3 4 5 6 7 8 9 10 11 12)	2016 (1 2 3 4 5 6 7 8 9 10 11 12)	2017 (1 2 3 4 5 6 7 8 9 10 11)	M/M 1st Stage Bhutan	M/M 1st Stage Japan	M/M 2nd Stage Bhutan	M/M 2nd Stage Japan	M/M Total Bhutan	M/M Total Japan
			First Stage	First Stage	Second Stage						
In Bhutan	**Team Leader/Planning of Digital Mapping**	**Akira OTA**	30 15 11	16 48	30 30	5.00		1.00		6.00	
	Sub Leader/NSDI Actionplan/ Utilization Promotion	**Akira SUZUKI**	30 21	30	30 30	3.70		1.00		4.70	
	Control Point Survey1	Takeo SUGIMOTO	60			2.00		0.00		2.00	
	Control Point Survey2	Atsushi MOCHIZUKI	60			2.00		0.00		2.00	
	Field Identification/ Field Completion 1	Takeo SUGIMOTO	60	45	45	5.00		0.00		5.00	
	Field Identification/ Field Completion 2	James. K. WATSON	60	60		4.00		0.00		4.00	
	Aerial Triangulation	Akihiro SUGITA		30 30	30	2.00		1.00		3.00	
	Digital Plotting	**Nobuhiro SATA**	30 30	30 30	30	4.00		1.00		5.00	
	Digital Editing/Digital Completion /Map Symbolization	Ryusuke NAKATANI	30	30 30	30	3.00		1.00		4.00	
	Data Structuration/ GIS Data Analysis	Akihiro SUGITA	30	30 30	30 30	3.00		1.00		4.00	
	Digital Plotting Assistance/Coordinator	James. K. WATSON	38	14 14	30 30	3.20		1.00		4.20	
	Team Leader/Planning of Digital Mapping (Additional Assignment)	Akira OTA			4	0.00		0.13		0.13	
					Total M/M in Bhutan	36.90		7.13		44.03	
in Japan	**Team Leader/Planning of Digital Mapping**	**Akira OTA**	5 3	3 3	3 4 5		0.70		0.45		1.15
					Total M/M in Japan		0.70		0.45		1.15
	Reports	Submission Period	IC/R PR/R1	PR/R2	IT/R DF/R F/R						
					TOTAL	**37.60**		**7.58**		**45.18**	

Legend

Works in Bhutan

Works in Japan

Appendix-1

Minutes of Meeting on the reports

MINUTES OF MEETING

ON

THE INCEPTION REPORT OF THE POJECT

FOR

DEVELOPMENT OF

NATIONAL GEO-SPATIAL DATA IN BHUTAN

AGREED UPON BETWEEN

NATIONAL LAND COMMISSION SECRETARIAT (NLCS)

AND

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Thimphu

25th March, 2015

MR. YESHI DORJI	MR. AKIRA OTA
OFFTG. SECRETARY	PROJECT MANAGER
NATIONAL LAND COMMISSION SECRETARIAT	JAPAN INTERNATIONAL COOPERATION AGENCY
ROYAL GOVERNMENT OF BHUTAN	

The JICA Project Team (hereinafter referred to as "the Team") headed by Mr. Akira OTA visited Bhutan from 27 February, 2015 in order to carry out Project for DEVELOPMENT OF NATIONAL GEO-SPATIAL DATA IN BHUTAN (hereinafter referred to as" the Project"). The Team had an occasion for the meetings to explain the project details based on the Inception Report of the Project to the staff of NLCS. As a result of discussions held after the explanation, the Inception Report was accepted by NLC. The points we discussed and agreed on are as follows;
The attendant list is attached in Appendix-1.

1. Acceptance of the Inception Report

NLCS received ten "10" sets of Inception Report in advance for the discussion of Inception Report from the Team. The Team explained the crucial issues shown hereunder that should be taken into account for successful implementation of the Project. NLCS understood the points that are stressed in the presentation of the Inception Report and agreed to the all.

1. Highlighting of overall objectives;
2. The importance of skills for creating a medium scale topographic map (1/25000);
3. Work frame of National Spatial Data Infrastructure(hereinafter referred to as "NSDI");
4. The methodology to be used during project implementation;
5. Action plan of Technology Transfer;
6. Involving Centre for GIS Coordination (hereinafter referred to as "CGISC") members etc. into the seminar
7. Rigorous selection of the counterpart participants.

2. Undertaking matter

The Team confirmed the followings as undertaking matter of NLCS.

(1) To provide counterpart personnel from NLCS to be involved in the Technology Transfer.
(2) To provide necessary existing topographic maps, digital aerial photographic data, results of aerial triangulation and observation data of ground control points for the Project area.
(3) To provide necessary existing equipment (GPS/GNSS Receivers and their accessories) for ground control survey.
(4) To provide all necessary existing data for mapping such as boundary data and whatsoever to be needed after a series of discussion on map symbols.

3. Holding the first seminar

NLCS and The Team decided that the first seminar will be held on 16th March, 2015. NLCS accepted to make an announcement to call for attendance from all parts of BHUTAN.

The seminar was held on 16th November at the conference room of National Resource

Development Office. There were 60 participants including mass media (Appendix-2). All agenda programmed in advance were smoothly raised and presented to the participants by key speakers.

4. Specifications of New digital maps created in the project

NLCS agreed with the proposition from the team proposed in the Inception Report about "Geodetic system", "Reference ellipsoid" and "Elevation reference".

Description about copyright on printed map was discussed between NLCS and the team and decided as "© NLCS GOVERNMENT OF BHUTAN", that is shown below.

This digital map was prepared jointly by Japan International Cooperation Agency (JICA) under the Japanese Government Technical Cooperation Program and the National Land Commission (NLCS) under the Government of the Kingdom of Bhutan.

© NLCS GOVERNMENT OF BHUTAN

Appendix 1

Attendant list of discussion of Inception Report

NLCS

Mr. Tshering PENJOR	Chief Survey Engineer
Mr. Bishwanath PRADHAN	Chief of Map Production Division
Mr. K.B. TAMANG	Specialist of Map Production
Mr. Tenzin Norbu	Survey Engineer

JICA Project Team

Mr. Akira OTA	Project Manager/ Planning of Digital Mapping
Mr. Akira SUZUKI	Sub Leader/NSDI Action Plan/Utilization Promotion
Mr. Nobuhiro SATA	Digital Plotting
Mr. Ryusuke NAKATANI	Digital Editing/Digital Completion/Map Symbolization
Mr. James K. WATSON	Digital Plotting Assistance/Coordinator

Appendix 2

	Organization	Number of participants
1	National Land Commission	8
2	Ministry of Information Communication	1
3	Ministry of Economical Affairs	3
4	Ministry of Agriculture & Forestry	4
5	Election Commission of Bhutan	2
6	Ministry of Home& Cultural Affairs Department of Disaster Management	2
7	WWF Bhutan	1
8	Gross National Happiness Commission	1
9	National Statistical Bureau	3
10	Bhutan Power Corporation	1
11	Bhutan Telecom	1
12	Sherubtse College	1
13	National Housing Development Cooperation Ltd.	2
14	Royal Society for Production of Nature	1
15	College of Science& Technology	1
16	College of Natural Resource	1
17	Department of Information Technology & Telecom	1
18	Samdrup Jongkhar Dzongkhag	1
19	Samdrup Jongkhar Thromde	1
20	Sarpang Dzongkhag	1
21	Chukha Dzongkhag	2
22	Dagana Dzongkhag	1
23	Mongar Dzongkhag	1
24	Tashigang Dzongkhag	1
25	Pemagatshel Dzongkhag	2
26	Zhemgang Dzongkhag	1
27	Phuntsholing Thromde	1
28	Phuntsholing Drunghkag	1
29	Gelephu Thromde	1
30	Samtse Dzongkhag	1
31	Thimphu Thrommde	1
32	Bhutan Broadcasting Service	1
33	Kuensel	1
34	Japan International Cooperation Agency	4
35	JICA Study Team	5
	Total	62

MINUTES OF MEETING

ON

THE PROGRESS REPORT-1 OF THE POJECT

FOR

DEVELOPMENT OF
NATIONAL GEO-SPATIAL DATA IN BHUTAN

AGREED UPON BETWEEN

NATIONAL LAND COMMISSION SECRETARIAT (NLCS)
AND
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Thimphu

21st October, 2015

Mr. Ugyen Tenzin
Offtg. Secretary

NATIONAL LAND COMMISSION SECRETARIAT
ROYAL GOVERNMENT OF BHUTAN

Mr. Akira Ota
Project Manager

JAPAN INTERNATIONAL COOPERATION AGENCY

The JICA Project Team (hereinafter referred to as "the Team") headed by Mr. Akira OTA visited Bhutan from 14 October, 2015 in order to carry out Project for DEVELOPMENT OF NATIONAL GEO-SPATIAL DATA IN BHUTAN (hereinafter referred to as" the Project"). The Team had an occasion for the meetings to explain the project progress based on the Progress Report-1 of the Project to the staff of NLCS. As a result of discussions held after the explanation, the Progress Report-1 was accepted by NLC. The points we discussed and agreed on are as follows;
The attendant list is attached in Appendix-1.

1. Acceptance of the Progress Report-1

NLCS received ten "10" sets of Progress Report-1 in advance for the discussion of Progress Report-1 from the Team. The Team explained the progress about implemented works in Bhutan and in Japan after the Inception Report shown hereunder. NLCS understood the points that are stressed in the presentation of the Progress Report-1 and agreed to the all.

1. Discussion over 1/25,000 Topographic Map Specifications;
2. Satellite images Acquisition (almost completed);
3. Control Point Survey (completed);
4. Aerial Triangulation, DEM and Orthophoto generation (completed);
5. Digital Plotting (on going);
6. Field Identification and Field Completion planning (on going);
7. Action plan Discussion and Implementation of the Technology Transfer (Control Point Survey, Digital Plotting, Data Structuration/GIS Data Analysis);
8. Procurement Progress of the Technology Transfer Equipment;
9. Discussion over work frame of National Spatial Data Infrastructure(hereinafter referred to as "NSDI") such as "Launching Seminar"; "CGISC meeting", "Study about Geo-portal", "Project Consultation Team"
10. Training in Japan 2015 (completed) ;

Appendix 1

Attendant list of discussion of Progress Report-1

NLCS

Mr. Tshering PENJOR	Chief Survey Engineer
Mr. K.B. TAMANG	Specialist of Map Production
Mr. Tenzin Norbu	Survey Engineer

JICA Project Team

Mr. Akira OTA	Project Manager/ Planning of Digital Mapping

MINUTES OF MEETING
ON
THE PROGRESS REPORT-2 OF THE POJECT
FOR
DEVELOPMENT OF
NATIONAL GEO-SPATIAL DATA IN BHUTAN

AGREED UPON BETWEEN

NATIONAL LAND COMMISSION SECRETARIAT (NLCS)
AND
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Thimphu

10th June, 2016

Mr. Yeshi Dorji
Director
Department of Survey and Mapping
NATIONAL LAND COMMISSION SECRETARIAT
ROYAL GOVERNMENT OF BHUTAN

Mr. Akira OTA
Project Manager
JAPAN INTERNATIONAL COOPERATION AGENCY

JICA Project Team (hereinafter referred to as "the Team") headed by Mr. Akira OTA visited Bhutan from 31 May, 2016 in order to carry out the Project for DEVELOPMENT OF NATIONAL GEO-SPATIAL DATA IN BHUTAN (hereinafter referred to as" the Project"). The Team had an occasion for a meeting to explain the project progress to the staffs of NLCS, based on the Progress Report-2. As a result of discussions held after the explanation, the Progress Report-2 was accepted by NLCS. The points which were discussed and agreed on are as follows;
The attendant list is attached in Appendix-1.

1. Acceptance of the Progress Report-2

NLCS received ten "10" sets of Progress Report-2 in advance for the discussion of Progress Report-2 from the Team. The Team explained the progress about implemented works in Bhutan and in Japan after the Inception Report shown hereunder. NLCS understood the points that are stressed in the presentation of the Progress Report-2 and agreed to the all.

1. Map Symbol Catalog;
2. Digital Plotting (on going);
3. Field Identification and Field Completion planning (Eastern area: completed, Western area: Planed from October to November 2016);
4. Implementation of the Technology Transfer (Aerial Triangulation, Digital Plotting, Data Structuration/GIS Data Analysis);
5. Procurement Progress of the Technology Transfer Equipment;
6. Discussion over work frame of National Spatial Data Infrastructure(hereinafter referred to as "NSDI") such as "Interim Seminar"; "CGISC meeting", "Project Consultation Team"
7. Training in Japan 2016 (Planed in September 2016) ;

Appendix 1

Attendant list of discussion on Progress Report-2

NLCS

Mr. Yeshi Dorji	Director, Department of Survey and Mapping
Mr. Bishwanath Pradhan	Chief Survey Engineer, Topographical Survey Division
Mr. Tenzin Norbu	Project Manager

JICA Project Team

Mr. Akira OTA	Project Manager/ Planning of Digital Mapping
Mr. James K. WATSON	Digital Plotting Assistance/Coordinator

MINUTES OF MEETING
ON
THE INTERIM REPORT OF THE POJECT
FOR
DEVELOPMENT OF
NATIONAL GEO-SPATIAL DATA IN BHUTAN

AGREED UPON BETWEEN

NATIONAL LAND COMMISSION SECRETARIAT (NLCS)
AND
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Thimphu

3rd March, 2017

Mr. PEMA CHEWANG
Sectretary
NATIONAL LAND COMMISSION SECRETARIAT
ROYAL GOVERNMENT OF BHUTAN

Mr. Akira OTA
Project Manager
JAPAN INTERNATIONAL COOPERATION AGENCY

JICA Project Team (hereinafter referred to as "the Team") headed by Mr. Akira OTA visited Bhutan from 4 February, 2017 in order to carry out the Project for DEVELOPMENT OF NATIONAL GEO-SPATIAL DATA IN BHUTAN (hereinafter referred to as" the Project"). The Team had an occasion for a meeting to explain the project progress to the staffs of NLCS, based on the Interim Report. As a result of discussions held after the explanation, the Interim Report was accepted by NLCS. The points which were discussed and agreed on are as follows:
The attendant list is attached in Appendix-1.

1. Acceptance of the Interim Report

NLCS received ten "10" sets of Interim Report in advance for the discussion of the Report from the Team. The Team explained the progress about implemented works in Bhutan and in Japan after the Inception Report shown hereunder. NLCS understood the points that are stressed in the presentation of the Interim Report and agreed to the all.

1. Finalizing of Map Symbol Catalog;
2. Reporting of Mapping work in Japan (Digital Completion from Field Completion);
3. Field Identification and Field Completion progress (Eastern area: completed, Western area: completed, Pilot area: Under implementation);
4. Implementation of the Technology Transfer (Aerial Triangulation, Digital Plotting, Data Structuration/GIS Data Analysis/ Map Symbolization);
5. Discussion over work frame of National Spatial Data Infrastructure(hereinafter referred to as "NSDI") such as "Survey Regulation"; "Long term Plan of NLCS", "Geo-portal up-to-date", "G.I.policy up-to-date";
6. Arrangement of Interview to CGIS member (Technology Transfer of GIS Data Analysis) ;

Appendix 1

Attendant list of discussion on Interim Report

NLCS

Mr. Tashi	Offtg. Director, Department of Survey and Mapping
Mr. Bishwanath Pradhan	Chief Survey Engineer, Topographical Survey Division
Mr. Tenzin Norbu	Project Manager

JICA Project Team

Mr. Akira OTA	Project Manager/ Planning of Digital Mapping
Mr. Akira SUZUKI	Sub Leader/NSDI Action Plan/Utilization Promotion
Mr. Akihiro SUGITA	Data Structuration/GIS Data Analysis
Mr. James K. WATSON	Digital Plotting Assistance/Coordinator

MINUTES OF MEETING
ON
THE DRAFT FINAL REPORT OF THE POJECT
FOR
DEVELOPMENT OF
NATIONAL GEO-SPATIAL DATA IN BHUTAN

AGREED UPON BETWEEN

NATIONAL LAND COMMISSION SECRETARIAT (NLCS)
AND
JAPAN INTERNATIONAL COOPERATION AGENCY PROJECT TEAM
(JICA PROJECT TEAM)

Thimphu

11th August, 2017

Mr. PEMA CHEWANG
Sectretary
NATIONAL LAND COMMISSION SECRETARIAT
ROYAL GOVERNMENT OF BHUTAN

Mr. Akira OTA
Project Manager
JAPAN INTERNATIONAL COOPERATION AGENCY PROJECT TEAM

JICA Project Team (hereinafter referred to as "the Team") headed by Mr. Akira OTA visited Bhutan from 21 August, 2017 in order to carry out the Project for DEVELOPMENT OF NATIONAL GEO-SPATIAL DATA IN BHUTAN (hereinafter referred to as" the Project"). The Team had an occasion for a meeting to explain the project progress to the staffs of NLCS, based on the Draft Final Report. As a result of discussions held after the explanation, the Draft Final Report was accepted by NLCS. The points which were discussed and agreed on are as follows;
The attendant list is attached in Appendix-1.

1. Acceptance of the Draft Final Report

NLCS received ten "10" sets of Draft Final Report in advance for the discussion of the Report from the Team. The Team explained the progress about implemented works in Bhutan and in Japan after the Interim Report shown hereunder. NLCS understood the points that are stressed in the presentation of the Draft Final Report and agreed to the all and there was no request of correction regarding on the contents in the report.

NLCS has agreed to submit a letter of agreement with the signature from NLCS Secretary, on the completion of the inspection for all 1/25,000 map sheets produced through this project.

The following contents was discussed and agreed between both parties:

1. Final symbol regulation;
2. Final map sheet design;
3. NLCS's inspection for 8 symbolized Map sheets (NLCS officer Mr. Biswanath, has agreed and signed);
4. Technology Transfer implementation status report(Digital Plotting, Data Structuration/GIS Data Analysis/ Map Symbolization);
5. Submission of Technology Transfer Manuals (Work manuals, QC Manuals , Management Operation Manual);
6. Reporting of National Spatial Data Infrastructure(hereinafter referred to as "NSDI") such as "Survey & Product Regulation"; "Data sharing model", "Data Utilization model";
7. Closing seminar date as 10th of August 2017 ;

Appendix 1

Attendant list of discussion on Draft Final Report

NLCS

Mr. Pema Chewang	Sectretary
Mr. Gelay Norbu	Director, Department of Survey and Mapping
Mr. Gonpo Tenzin	Chief, Planning and Policy Division
Mr. Bishwanath Pradhan	Chief Survey Engineer, Topographical Survey Division
Mr. Tenzin Norbu	Project Manager

JICA Project Team

Mr. Akira OTA	Project Manager/ Planning of Digital Mapping
Mr. Akira SUZUKI	Sub Leader/NSDI Action Plan/Utilization Promotion
Mr. James K. WATSON	Digital Plotting Assistance/Coordinator

Appendix-2

Questionnaire about the final Seminar

Project on Development of Geo-Spatial Data in Bhutan

Questionnaire of "Closing Seminar"

Name / position	Samir Patel, Associate Dean
Name of institution/organization	Royal Thimphu College
Name of Section or Department are you belonging to	Academic Affairs; Development & External Relations

	QUESTION	ANSWER	
1	Have you understood the target, project area and the importance of this project?	☒YES	☐NO
2	Have you understood the specifications of 1/25,000 topographic map data?	☒YES	☐NO
3	Have you understood the outline of general technic to produce 1/25,000 topographic map data?	☒YES	☐NO
4	Was the any presentation which fulfilled your interest or expectations?	☒YES	☐NO
5	Were there any presentations which will contribute to your work?	☒YES	☐NO
If YES, please describe: Presentation on plans for GI policy. Glad this is moving ahead.			
6	Have you understood the importance of the cross-sectional data sharing of national fundamental spatial information for national development planning?	☒YES	☐NO
7	Were you able to find out the future tasks for Bhutan's geo-spatial information management/ implementation?	☒YES	☐NO
8	Do you have any inconvenience in the usage of Bhutan's geo-spatial data?	☒YES	☐NO
If YES, please describe your situation and ideas to solve the issue: Difficulty in accessing data; Geoportal is interesting concept, but no data useful for real purposes is available through it. Organizations and individuals that have obtained/created data through the use of public funds (mostly government employees) must be required to deposit their data and grant access to it in a timely manner. Currently, most do not respond to requests for data; the data then become obsolete without ever having been fully utilized – this is very inefficient and goes against the principle of avoid duplication of effort/use of resources.			
9	Do you think the "Topo Map view page" and "Geo-portal" is/will be useful and do you like to use this feature?	☐YES	☒NO

If YES, please describe the usage:

These are pubic interest pages, and they are useful only in that sense, for casual browsing. However, any data for scientific use must be available in raw format. Serious researchers will not be able to use a web portal to do analyses, since each step requires manual point and click. Rather, the data must be analyzable in the manner intended, i.e., as geodatabase compatible. Base map and layers must be available directly.

10	Have you understood the advantage of sharing/utilizing the topographic map data?	☒YES	☐NO
11	Have you understood the potentials and its' positive effects of GIS?	☒YES	☐NO
12	Have you understood that overlaying thematic data on top of topographic data will be the basis of utilization and analysis?	☒YES	☐NO
13	Is the 1/25,000 topographic data and your work in a close relationship?	☒YES	☐NO
14	Will the development of nationwide 1/25,000 topographic data make a positive impact to your work?	☒YES	☐NO

If YES, what kind of impact? :

Will utilize the data for real-world projects of relevance to Bhutan for educational and research purposes in academic programmes.

15	Would you like to use the 1/25,000 topographic data immediately in your work?	☒YES	☐NO
16	Are you or your organization possession to any type of geo-spatial data for sharing/utilization?	☒YES	☐NO
17	Does your organization have any development plan in the southern belt which is mentioned in the 12^{th} 5YP?	☐YES	☒NO
18	Was the seminar an eye opener for the utilization of geo-spatial information?	☒YES	☐NO
19	Do you have any interest in the GIS analysis training which is implemented in this project?	☒YES	☐NO
20	Do you have expectations for the nationwide 1/25,000 topographic data preparation?	☒YES	☐NO

Thank you very much for your cooperation!

Project on Development of Geo-Spatial Data in Bhutan

Questionnaire of "Closing Seminar"

Name / position	Pema Tshewang, Engineer
Name of institution/organization	MOEA
Name of Section or Department are you belonging to	DRE

	QUESTION	ANSWER	
1	Have you understood the target, project area and the importance of this project?	☒YES	☐NO
2	Have you understood the specifications of 1/25,000 topographic map data?	☒YES	☐NO
3	Have you understood the outline of general technic to produce 1/25,000 topographic map data?	☒YES	☐NO
4	Was the any presentation which fulfilled your interest or expectations?	☒YES	☐NO
5	Were there any presentations which will contribute to your work?	☒YES	☐NO
If YES, please describe: Study of Small Hydropower Projects			
6	Have you understood the importance of the cross-sectional data sharing of national fundamental spatial information for national development planning?	☒YES	☐NO
7	Were you able to find out the future tasks for Bhutan's geo-spatial information management/ implementation?	☒YES	☐NO
8	Do you have any inconvenience in the usage of Bhutan's geo-spatial data?	☐YES	☒NO
If YES, please describe your situation and ideas to solve the issue:			
9	Do you think the "Topo Map view page" and "Geo-portal" is/will be useful and do you like to use this feature?	☒YES	☐NO
If YES, please describe the usage: Study of Small Hydropower Projects			

10	Have you understood the advantage of sharing/utilizing the topographic map data?	☒YES	☐NO
11	Have you understood the potentials and its' positive effects of GIS?	☒YES	☐NO
12	Have you understood that overlaying thematic data on top of topographic data will be the basis of utilization and analysis?	☒YES	☐NO
13	Is the 1/25,000 topographic data and your work in a close relationship?	☒YES	☐NO
14	Will the development of nationwide 1/25,000 topographic data make a positive impact to your work?	☒YES	☐NO
If YES, what kind of impact? : Reliable and correct maps can be used for study of small hydropower projects			
15	Would you like to use the 1/25,000 topographic data immediately in your work?	☒YES	☐NO
16	Are you or your organization possession to any type of geo-spatial data for sharing/utilization?	☒YES	☐NO
17	Does your organization have any development plan in the southern belt which is mentioned in the 12^{th} 5YP?	☒YES	☐NO
18	Was the seminar an eye opener for the utilization of geo-spatial information?	☒YES	☐NO
19	Do you have any interest in the GIS analysis training which is implemented in this project?	☒YES	☐NO
20	Do you have expectations for the nationwide 1/25,000 topographic data preparation?	☒YES	☐NO

Thank you very much for your cooperation!

Project on Development of Geo-Spatial Data in Bhutan

Questionnaire of "Closing Seminar"

Name / position	Dema Yangzom
Name of institution/organization	Cryosphere Services Division
Name of Section or Department are you belonging to	National Center for Hydrology and Meteorology

	QUESTION	ANSWER	
1	Have you understood the target, project area and the importance of this project?	☒YES	☐NO
2	Have you understood the specifications of 1/25,000 topographic map data?	☒YES	☐NO
3	Have you understood the outline of general technic to produce 1/25,000 topographic map data?	☒YES	☐NO
4	Was the any presentation which fulfilled your interest or expectations?	☒YES	☐NO
5	Were there any presentations which will contribute to your work?	☒YES	☐NO
If YES, please describe: As topographic map has information on terrain and elevation, it will help for the hydraulic and hydrological modeling. Usually the southern foothills are prone to flash floods, the topographic map developed by JICA project would be more useful. However, for our center, if we could have 1/25,000 topographic map for the Northern belt of Bhutan, it would help us to find the volume of glacier ice.			
6	Have you understood the importance of the cross-sectional data sharing of national fundamental spatial information for national development planning?	☒YES	☐NO
7	Were you able to find out the future tasks for Bhutan's geo-spatial information management/ implementation?	☒YES	☐NO
8	Do you have any inconvenience in the usage of Bhutan's geo-spatial data?	☐YES	☒NO
If YES, please describe your situation and ideas to solve the issue:			
9	Do you think the "Topo Map view page" and "Geo-portal" is/will be useful and do you like to use this feature?	☒YES	☐NO
If YES, please describe the usage: For geodetic glacier mass balance Preparation of input for hydraulic and hydrological modeling.			

10	Have you understood the advantage of sharing/utilizing the topographic map data?	☒YES	☐NO
11	Have you understood the potentials and its' positive effects of GIS?	☒YES	☐NO
12	Have you understood that overlaying thematic data on top of topographic data will be the basis of utilization and analysis?	☒YES	☐NO
13	Is the 1/25,000 topographic data and your work in a close relationship?	☒YES	☐NO
14	Will the development of nationwide 1/25,000 topographic data make a positive impact to your work?	☒YES	☐NO
If YES, what kind of impact? : -Help to enhance the flood forecast.			
15	Would you like to use the 1/25,000 topographic data immediately in your work?	☒YES	☐NO
16	Are you or your organization possession to any type of geo-spatial data for sharing/utilization?	☒YES	☐NO
17	Does your organization have any development plan in the southern belt which is mentioned in the 12th 5YP?	☐YES	☒NO
18	Was the seminar an eye opener for the utilization of geo-spatial information?	☒YES	☐NO
19	Do you have any interest in the GIS analysis training which is implemented in this project?	☒YES	☐NO
20	Do you have expectations for the nationwide 1/25,000 topographic data preparation?	☒YES	☐NO

Thank you very much for your cooperation!

Project on Development of Geo-Spatial Data in Bhutan

Questionnaire of "Closing Seminar"

Name / position	Kinzang Dema / GIS Engineer
Name of institution/organization	Bhutan Telecom Limited
Name of Section or Department are you belonging to	GIS Unit, Corporate Planning and Strategy Division.

	QUESTION	ANSWER	
1	Have you understood the target, project area and the importance of this project?	☒YES	☐NO
2	Have you understood the specifications of 1/25,000 topographic map data?	☒YES	☐NO
3	Have you understood the outline of general technic to produce 1/25,000 topographic map data?	☒YES	☐NO
4	Was the any presentation which fulfilled your interest or expectations?	☒YES	☐NO
5	Were there any presentations which will contribute to your work?	☒YES	☐NO
If YES, please describe: Some of the presentations that talked about GIS tools were quite useful for some of the work we do in GIS for telecom.			
6	Have you understood the importance of the cross-sectional data sharing of national fundamental spatial information for national development planning?	☒YES	☐NO
7	Were you able to find out the future tasks for Bhutan's geo-spatial information management/ implementation?	☒YES	☐NO
8	Do you have any inconvenience in the usage of Bhutan's geo-spatial data?	☒YES	☒NO
If YES, please describe your situation and ideas to solve the issue:			
9	Do you think the "Topo Map view page" and "Geo-portal" is/will be useful and do you like to use this feature?	☒YES	☐NO
If YES, please describe the usage: Yes such features would be useful since it provides a platform for the users to acquire relevant data for each individual purposes.			

10	Have you understood the advantage of sharing/utilizing the topographic map data?	☒YES	☐NO
11	Have you understood the potentials and its' positive effects of GIS?	☒YES	☐NO
12	Have you understood that overlaying thematic data on top of topographic data will be the basis of utilization and analysis?	☒YES	☐NO
13	Is the 1/25,000 topographic data and your work in a close relationship?	☒YES	☐NO
14	Will the development of nationwide 1/25,000 topographic data make a positive impact to your work?	☒YES	☐NO
If YES, what kind of impact? :			
15	Would you like to use the 1/25,000 topographic data immediately in your work?	☒YES	☐NO
16	Are you or your organization possession to any type of geo-spatial data for sharing/utilization?	☐YES	☒NO
17	Does your organization have any development plan in the southern belt which is mentioned in the 12th 5YP?	☐YES	☒NO
18	Was the seminar an eye opener for the utilization of geo-spatial information?	☒YES	☐NO
19	Do you have any interest in the GIS analysis training which is implemented in this project?	☒YES	☐NO
20	Do you have expectations for the nationwide 1/25,000 topographic data preparation?	☒YES	☐NO

Thank you very much for your cooperation!

Project on Development of Geo-Spatial Data in Bhutan

Questionnaire of "Closing Seminar"

Name / position	Tsheten Dorji
Name of institution/organization	NSSC, DoA, MoAF
Name of Section or Department are you belonging to	Soil Survey Unit, National Soil Services Centre

	QUESTION	ANSWER	
1	Have you understood the target, project area and the importance of this project?	☒YES	☐NO
2	Have you understood the specifications of 1/25,000 topographic map data?	☒YES	☐NO
3	Have you understood the outline of general technic to produce 1/25,000 topographic map data?	☒YES	☐NO
4	Was the any presentation which fulfilled your interest or expectations?	☒YES	☐NO
5	Were there any presentations which will contribute to your work?	☒YES	☐NO
If YES, please describe: Especially the presentation on land use and land slide zoning			
6	Have you understood the importance of the cross-sectional data sharing of national fundamental spatial information for national development planning?	☒YES	☐NO
7	Were you able to find out the future tasks for Bhutan's geo-spatial information management/ implementation?	☒YES	☐NO
8	Do you have any inconvenience in the usage of Bhutan's geo-spatial data?	☐YES	☒NO
If YES, please describe your situation and ideas to solve the issue:			
9	Do you think the "Topo Map view page" and "Geo-portal" is/will be useful and do you like to use this feature?	☒YES	☐NO
If YES, please describe the usage:			

10	Have you understood the advantage of sharing/utilizing the topographic map data?	☒YES	☐NO
11	Have you understood the potentials and its' positive effects of GIS?	☒YES	☐NO
12	Have you understood that overlaying thematic data on top of topographic data will be the basis of utilization and analysis?	☒YES	☐NO
13	Is the 1/25,000 topographic data and your work in a close relationship?	☒YES	☐NO
14	Will the development of nationwide 1/25,000 topographic data make a positive impact to your work?	☒YES	☐NO
If YES, what kind of impact? : The topo map at a scale of 1: 25000 has greater detail when compare to 50000 scale. Hence the new product from NLCS can be used as ancillary data while executing reconnaissance soil survey of arable land.			
15	Would you like to use the 1/25,000 topographic data immediately in your work?	☒YES	☐NO
16	Are you or your organization possession to any type of geo-spatial data for sharing/utilization?	☒YES	☐NO
17	Does your organization have any development plan in the southern belt which is mentioned in the 12^{th} 5YP?	☐YES	☒NO
18	Was the seminar an eye opener for the utilization of geo-spatial information?	☒YES	☐NO
19	Do you have any interest in the GIS analysis training which is implemented in this project?	☒YES	☐NO
20	Do you have expectations for the nationwide 1/25,000 topographic data preparation?	☒YES	☐NO

Thank you very much for your cooperation!

Project on Development of Geo-Spatial Data in Bhutan

Questionnaire of "Closing Seminar"

Name / position	Wangmo/Assistant Engineer
Name of institution/organization	Ministry of Economic Affairs
Name of Section or Department are you belonging to	Hydropower Development Division, Dept. of Hydropower & Power Systems

	QUESTION	ANSWER	
1	Have you understood the target, project area and the importance of this project?	✓YES	☐NO
2	Have you understood the specifications of 1/25,000 topographic map data?	✓YES	☐NO
3	Have you understood the outline of general technic to produce 1/25,000 topographic map data?	✓YES	☐NO
4	Was there any presentation which fulfilled your interest or expectations?	✓YES	☐NO
5	Were there any presentations which will contribute to your work?	✓YES	☐NO
If YES, please describe: The most important that I learnt from the seminar was the field verification or the ground truthing of the dataset			
6	Have you understood the importance of the cross-sectional data sharing of national fundamental spatial information for national development planning?	✓YES	☐NO
7	Were you able to find out the future tasks for Bhutan's geo-spatial information management/ implementation?	✓YES	☐NO
8	Do you have any inconvenience in the usage of Bhutan's geo-spatial data?	✓YES	☐NO
If YES, please describe your situation and ideas to solve the issue: Yes, due to different projection systems within the GIS users. But, the NLCS through CGISC has now been trying to navigate their existing dataset to one standard Bhutan Projection system. However, due to lack of knowledge in the use or the application of projection system I still feel that overlaying and using data from other agencies are still a problem.			
9	Do you think the "Topo Map view page" and "Geo-portal" is/will be useful and do you like to use this feature?	✓YES	☐NO

If YES, please describe the usage:
Top Map view is definitely useful. It is a quick reference to note and abstract the topographical features otherwise what we do at the moment is we use and refer hardcopy topo maps which entails in searching for the sheet no. references first and then stitching the toposheets to view our area of interest (project area not covered within one toposheet)
Through Geo-portal, any users can know what and where the geospatial data are and how to acquire the required data.

10	Have you understood the advantage of sharing/utilizing the topographic map data?	✓YES	☐NO
11	Have you understood the potentials and its' positive effects of GIS?	✓YES	☐NO
12	Have you understood that overlaying thematic data on top of topographic data will be the basis of utilization and analysis?	✓YES	☐NO
13	Is the 1/25,000 topographic data and your work in a close relationship?	✓YES	☐NO
14	Will the development of nationwide 1/25,000 topographic data make a positive impact to your work?	✓YES	☐NO

If YES, what kind of impact? : **YES.**

- Updated elevation information is important to use.
- Hydrological studies and hydropower studies require large scale maps and higher accuracy in elevation data. So, the updated elevation data will be of much use to this department.
- The ground reality has been changed and these new information need to be reflected on the map

15	Would you like to use the 1/25,000 topographic data immediately in your work?	✓YES	☐NO
16	Are you or your organization possession to any type of geo-spatial data for sharing/utilization?	✓YES	☐NO
17	Does your organization have any development plan in the southern belt which is mentioned in the 12^{th} 5YP?	✓YES	☐NO
18	Was the seminar an eye opener for the utilization of geo-spatial information?	✓YES	☐NO
19	Do you have any interest in the GIS analysis training which is implemented in this project?	✓YES	☐NO
20	Do you have expectations for the nationwide 1/25,000 topographic data preparation?	✓YES	☐NO

Thank you very much for your cooperation!

Project on Development of Geo-Spatial Data in Bhutan

Questionnaire of "Closing Seminar"

Name / position	Yeshi Wangchuk
Name of institution/organization	BPC
Name of Section or Department are you belonging to	Env. & GIS Division

	QUESTION	ANSWER	
1	Have you understood the target, project area and the importance of this project?	☒YES	☐NO
2	Have you understood the specifications of 1/25,000 topographic map data?	☒YES	☐NO
3	Have you understood the outline of general technic to produce 1/25,000 topographic map data?	☐YES	☒NO
4	Was the any presentation which fulfilled your interest or expectations?	☒YES	☐NO
5	Were there any presentations which will contribute to your work?	☒YES	☐NO
If YES, please describe: Topography survey			
6	Have you understood the importance of the cross-sectional data sharing of national fundamental spatial information for national development planning?	☒YES	☐NO
7	Were you able to find out the future tasks for Bhutan's geo-spatial information management/ implementation?	☒YES	☐NO
8	Do you have any inconvenience in the usage of Bhutan's geo-spatial data?	☐YES	☒NO
If YES, please describe your situation and ideas to solve the issue:			
9	Do you think the "Topo Map view page" and "Geo-portal" is/will be useful and do you like to use this feature?	☒YES	☐NO
If YES, please describe the usage 1. Easy access to view the data/ maps and common forum to share your data.			

10	Have you understood the advantage of sharing/utilizing the topographic map data?	☒YES	☐NO
11	Have you understood the potentials and its' positive effects of GIS?	☒YES	☐NO
12	Have you understood that overlaying thematic data on top of topographic data will be the basis of utilization and analysis?	☒YES	☐NO
13	Is the 1/25,000 topographic data and your work in a close relationship?	☐YES	☒NO
14	Will the development of nationwide 1/25,000 topographic data make a positive impact to your work?	☒YES	☐NO
If YES, what kind of impact? : 1. We can have proper planning of the upcoming projects/ detailed desktop study prior to implementation. 2. Cost cutting.			
15	Would you like to use the 1/25,000 topographic data immediately in your work?	☒YES	☐NO
16	Are you or your organization possession to any type of geo-spatial data for sharing/utilization?	☒YES	☐NO
17	Does your organization have any development plan in the southern belt which is mentioned in the 12^{th} 5YP?	☒YES	☐NO
18	Was the seminar an eye opener for the utilization of geo-spatial information?	☒YES	☐NO
19	Do you have any interest in the GIS analysis training which is implemented in this project?	☒YES	☐NO
20	Do you have expectations for the nationwide 1/25,000 topographic data preparation?	☒YES	☐NO

Thank you very much for your cooperation!

Project on Development of Geo-Spatial Data in Bhutan

Questionnaire of "Closing Seminar"

Name / position	Lokey Thapa, ***Sr Livestock Production Officer***
Name of institution/organization	National Dairy Research Centre, Yusipang,
Name of Section or Department are you belonging to	Department of Livestock, Ministry of Agriculture & Forests

	QUESTION	ANSWER	
1	Have you understood the target, project area and the importance of this project?	√YES	
2	Have you understood the specifications of 1/25,000 topographic map data?	√YES	
3	Have you understood the outline of general technic to produce 1/25,000 topographic map data?		√NO
4	Was the any presentation which fulfilled your interest or expectations?	√YES	
5	Were there any presentations which will contribute to your work?	√YES	
If YES, please describe: Since GIS is useful to all Departments, it will be always useful in one way or other			
6	Have you understood the importance of the cross-sectional data sharing of national fundamental spatial information for national development planning?	√YES	
7	Were you able to find out the future tasks for Bhutan's geo-spatial information management/ implementation?	√YES	
8	Do you have any inconvenience in the usage of Bhutan's geo-spatial data?	√YES	
If YES, please describe your situation and ideas to solve the issue: Data is not being shared at the moment and the new policy which is with GNHC would ease to share the information by different departments, Lack of software analysis knowledge			
9	Do you think the "Topo Map view page" and "Geo-portal" is/will be useful and do you like to use this feature?	√YES	☐NO
If YES, please describe the usage: Geo-portal is useful as it help us to see the different database and its usage and also help our relevant stakeholders on the information available for future planning			

10	Have you understood the advantage of sharing/utilizing the topographic map data? Not very clearly	√YES	
11	Have you understood the potentials and its' positive effects of GIS?	√YES	
12	Have you understood that overlaying thematic data on top of topographic data will be the basis of utilization and analysis?		√NO
13	Is the 1/25,000 topographic data and your work in a close relationship?		√NO
14	Will the development of nationwide1/25,000 topographic data make a positive impact to your work?	√YES	
If YES, what kind of impact? : With the information available and shared Grazing area pasture land available in different attitude, different livestock can be reared in different places Modeling by use of Special analysis and three D analysis on the information available would be useful			
15	Would you like to use the 1/25,000 topographic data immediately in your work?	√YES	
16	Are you or your organization possession to any type of geo-spatial data for sharing/utilization?		√NO
17	Does your organization have any development plan in the southern belt which is mentioned in the 12^{th} 5YP?	√YES	
18	Was the seminar an eye opener for the utilization of geo-spatial information?	√YES	
19	Do you have any interest in the GIS analysis training which is implemented in this project?	√YES	
20	Do you have expectations for the nationwide 1/25,000 topographic data preparation?	√YES	

Thank you very much for your cooperation!

Project on Development of Geo-Spatial Data in Bhutan

Questionnaire of "Closing Seminar"

Name / position	Leslie Backus / Professor
Name of institution/organization	Royal Thimphu College
Name of Section or Department are you belonging to	Environmental Managment

	QUESTION	ANSWER	
1	Have you understood the target, project area and the importance of this project?	☒YES	☐NO
2	Have you understood the specifications of 1/25,000 topographic map data?	☒YES	☐NO
3	Have you understood the outline of general technic to produce 1/25,000 topographic map data?	☒YES	☐NO
4	Was the any presentation which fulfilled your interest or expectations?	☒YES	☐NO
5	Were there any presentations which will contribute to your work?	☒YES	☐NO
If YES, please describe: I think all of the presentations and the data will contribute to sharing with my students about their country, about the new steps the government is taking, about the exploration of data in their classroom,…..			
6	Have you understood the importance of the cross-sectional data sharing of national fundamental spatial information for national development planning?	☒YES	☐NO
7	Were you able to find out the future tasks for Bhutan's geo-spatial information management/ implementation?	☒YES	☐NO
8	Do you have any inconvenience in the usage of Bhutan's geo-spatial data?	☒YES	☐NO
If YES, please describe your situation and ideas to solve the issue: At RTC having this data helps with research being done by both students and professors, as well as giving a real-world application to the data the students are using in class.			
9	Do you think the "Topo Map view page" and "Geo-portal" is/will be useful and do you like to use this feature?	☒YES	☐NO

If YES, please describe the usage: yes, I believe the Geo-portal is very useful, but we need more data on there and we need to be able to access and share data readily. The Topo Map View page I will have to think about. I am sure I can develop a lesson plan around using it.			
10	Have you understood the advantage of sharing/utilizing the topographic map data?	☒YES	☐NO
11	Have you understood the potentials and its' positive effects of GIS?	☒YES	☐NO
12	Have you understood that overlaying thematic data on top of topographic data will be the basis of utilization and analysis?	☒YES	☐NO
13	Is the 1/25,000 topographic data and your work in a close relationship?	☒YES	☐NO
14	Will the development of nationwide 1/25,000 topographic data make a positive impact to your work?	☒YES	☐NO
If YES, what kind of impact? : Mainly for research purposes. Having that level of topo data will help with researching animal distributions, plant distributions, planning development with a sustainable approach,…. Many things.			
15	Would you like to use the 1/25,000 topographic data immediately in your work?	☒YES	☐NO
16	Are you or your organization possession to any type of geo-spatial data for sharing/utilization?	☒YES	☐NO
17	Does your organization have any development plan in the southern belt which is mentioned in the 12^{th} 5YP?	☐YES	☒NO
18	Was the seminar an eye opener for the utilization of geo-spatial information?	☐YES	☒NO
19	Do you have any interest in the GIS analysis training which is implemented in this project?	☒YES	☐NO
20	Do you have expectations for the nationwide 1/25,000 topographic data preparation?	☒YES	☐NO

Thank you very much for your cooperation!

Appendix-3

Agreement Document about Final Outputs

དབལ་ལྡན་འབྲུག་གཞུང་།རྒྱལ་ཡོངས་ས་ཚ་ལྟན་ཚོགས།
National Land Commission Secretariat

Subject : **Certificate of Acceptance for Deliverables**

To:
PASCO CORPORATION
1-1-2, Higashiyama,
Meguro-ku, Tokyo
153-0043, JAPAN

Dear Sir,

Regarding to the activity of the PROJECT ON DEVELOPMENT OF NATIONAL GEO-SPATIAL DATA IN BHUTAN, JICA Project Team has produced the following Final outputs to NATIONAL LAND COMMISSION SECRETARIAT for authorization on November 2, 2017.

The Products are 75map sheet of approx. 9,870km^2 worth data as follows:

1. 1/25,000 topographic map data
2. 1/25,000 GIS fundamental data
3. 1/25,000 topographic map data (PDF)
4. Orthophotos

NATIONAL LAND COMMISSION SECRETARIAT hereby certifies and authorizes the above mentioned deliverables. And state from now on, any further modification or so on shall be undertaken by NATIONAL LAND COMMISSION SECRETARIAT itself.

Thimphu, Bhutan, November 2, 2017

PEMA CHEWANG (Mr.)
SECRETARY
NATIONAL LAND COMMISSION SECRETARIAT
ROYAL GOVERNMENT OF BHUTAN

Tel: 321743 /336062 Fax: 336063 /335340 EPABX: 321217 /328181 Post Box No. 142