Kingdom of Bhutan
National Land Commission Secretariat (NLCS)

The Project for Promotion of Utilization of Geospatial Information through Development of National Spatial Data Infrastructure in the Kingdom of Bhutan

Project Completion Report

January 2025

Japan International Cooperation Agency (JICA)

PASCO CORPORATION

Kokusai Kogyo Co., Ltd.

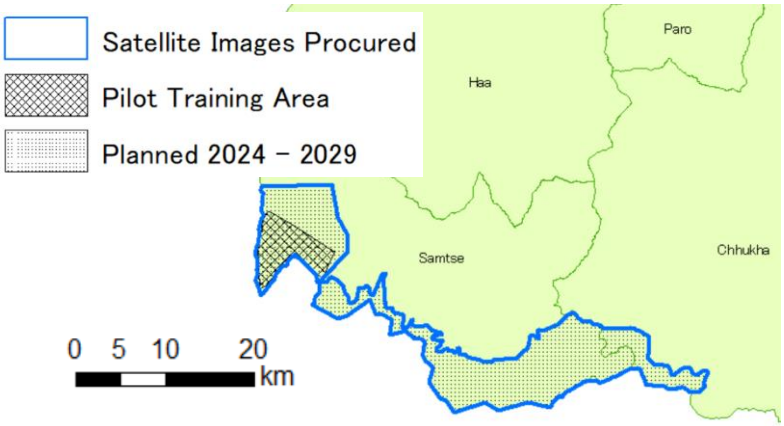
IM
JR
25-004

USD	1.00 = JPY	157.655000
BTN	1.00 = JPY	1.849070

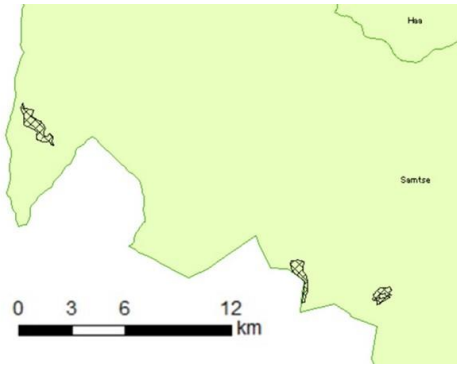
（January 2025）

Location map of target areas, etc.

Pilot Area for 1:25,000 Digital Topographic Map



Pilot Area for
1:5,000 Digital Topographic Map



Pilot Area for
Large Scale Topographic maps

The Project for Promotion of Utilization of Geospatial Information through Development of National Spatial Data Infrastructure

Kingdom of Bhutan

Draft Project Completion Report

Table of Contents

Abbreviations

Summary

CHAPTER1 OUTLINE OF THE PROJECT ---- 13
1.1 BACKGROUND OF THE PROJECT ---- 13
1.2 OUTLINE OF THE PROJECT ---- 14
1.2.1 Project Name ---- 14
1.2.2 Overall Goal and Project purpose ---- 14
1.2.3 Outputs of the Project ---- 14
1.2.4 Project scope and Implementing agency ---- 14
1.2.5 Project Duration ---- 16
1.2.6 Project Implementation Organization ---- 16
CHAPTER2 CURRENT STATUS OF NSDI IN BHUTAN ---- 18
2.1 CURRENT STATUS OF NSDI ESTABLISHMENT AND PROMOTION BY THE GOVERNMENT OF BHUTAN 18
2.1.1 Plan , Institutional and Legal Framework about NSDI ---- 18
2.1.2 NSDI Promotion Structure ---- 19
2.1.3 Geographic Information Standards ---- 24
2.1.4 NSDI System ---- 27
2.2 CURRENT STATUS OF "MAINTENANCE", "UPDATING", "MANAGEMENT" AND "UTILIZATION" OF DIGITAL TOPOGRAPHIC MAPS IN BHUTAN ---- 31
2.2.1 Standards of Surveying ---- 31
2.2.2 Digital Topographic Maps ---- 32
2.2.3 National Geodetic points ---- 35
2.2.4 Equipment ---- 36
2.2.5 Geospatial information management status ---- 38
2.2.6 Status of Utilization of Geospatial Information ---- 40
CHAPTER3 PROJECT ACTIVITIES AND RESULTS ---- 42
3.1 JAPANESE AND BHUTANESE INPUT RESULTS ---- 42

3.1.1 Japanese and Bhutanese input ---- 42
3.1.2 Input results of Bhutanese side ---- 44
3.2 REVISION HISTORY OF THE PDM ---- 44
3.3 RESULTS OF ACTIVITIES ---- 45
3.3.1 Work plan preparation and discussion ---- 47
3.3.2 Preparation and discussion of “Project progress reports” and “Project completion report” 47
3.3.3 Holding the “Joint Coordinating Committee (JCC)” ---- 47
3.3.4 Monitoring and preparation of monitoring sheet summary ---- 53
3.3.5 Output 1: Activities related to ” Capacity development for the operation planning and implementation for the strategic utilization and promotion of NSDI” ---- 54
3.3.6 Output 2: Activities related to ” Capacity development for making, updating, management and utilization of digital topographic map” ---- 102
CHAPTER4 PROJECT ACHIEVEMENT ---- 117
4.1 ACHIEVEMENT OF PROJECT PURPOSE AND INDICATORS OF EACH OUTPUT ---- 117
4.1.1 Achievement of Project Purpose ---- 117
4.1.2 Achievement of the Output 1 ---- 117
4.1.3 Evaluation of each activity in Output 1 ---- 117
4.1.4 Achievement of the Output 2 ---- 121
4.1.5 Evaluation of each activity in Output 2 ---- 122
4.2 REVIEW RESULTS BASED ON DAC EVALUATION CRITERIA ---- 128
4.2.1 Relevance ---- 128
4.2.2 Coherence ---- 129
4.2.3 Effectiveness ---- 129
4.2.4 Efficiency ---- 131
4.2.5 Impact ---- 132
4.2.6 Sustainability ---- 133
4.2.7 Factors affecting the implementation of activities and achievement of outputs and risk management ---- 134
4.3 LESSONS LEARNED OF THE PROJECT ---- 137
4.3.1 Overall Lessons Learned ---- 137
4.3.2 Lessons Learned on the Output 1 ---- 137
4.3.3 Lessons Learned on the Output 2 ---- 138
CHAPTER5 RECOMMENDATIONS FOR ACHIEVING THE OVERALL GOAL ---- 140
5.1 PROSPECTS FOR ACHIEVING OVERALL GOAL ---- 140
5.1.1 Indicator of the Overall goal: Number of planned projects using geospatial information based on NSDI ---- 140

5.2 RECOMMENDATIONS TO THE GOVERNMENT OF BHUTAN ---------- 141
5.2.1 Recommendations on the Output 1 ---------- 141
5.2.2 Recommendations on the Output 2 ---------- 143

Figure Contents

Figure 1.2.1 Project Area of 1:25,000 Topographic maps(Source：NLCS) 15
Figure 1.2.2 Project Area of 1:5,000 Topographic maps(Source：NLCS) 15
Figure 1.2.3 Project Area of Large Scale Topographic maps(Source：NLCS) 16
Figure 1.2.4 Project implementation structure(Source：C/P and JPT) 17
Figure 2.1.1 Example of NSDI Promotion Structure(Source：C/P and JPT) 20
Figure 2.1.2 Organization chart of the NLCS(Source：NLCS) 23
Figure 2.1.3 Relationship among ISO, Bhutan Standards for GI (BTS), Guidelines(Source：JPT) 25
Figure 2.1.4 Relationship between GI standards and data interoperability(Source：JPT) 26
Figure 2.1.5 Image of the management structure and roles of the NSDI system (proposed)(Source：JPT) 31
Figure 2.2.1 Preparation Status of 1:50,000 & 1:25,000 Topographic Map(Source：NLCS and JPT) 33
Figure 2.2.2 Course of the Snowman Race 2024(Source：Snowman Race Secretariat Web Page) 34
Figure 2.2.3 Preparation Status of 1:5,000Topographic Map(Source：NLCS and JPT) 34
Figure 2.2.4 Mapped areas by drone(Red line in the Left)& Topographic Map (Right)(Source：NLCS and JPT) 35
Figure 2.2.5 Geodetic Network(Source：NLCS and JPT) 36
Figure 2.2.6 GI Management with Agency 1(Source：C/P and JPT) 39
Figure 2.2.7 GI Management with Agency 2(Source：C/P and JPT) 39
Figure 2.2.8 Image of data management in NSDI system(Source：C/P and JPT) 40
Figure 3.3.1 Workflow of the Project(Source：JPT) 46
Figure 3.3.2 Status of monitoring activities related to promotion of NSDI and Topographic Map(Upper：NSDI Promotion、Lower：Topographic Map、Source：CGI Office and JPT) 56
Figure 3.3.3 Manual for Organizational Operations (excerpts)(Source：CGI Office and JPT) .. 58
Figure 3.3.4 Sharing status on Google Drive(Source：CGI Office) 59

Figure 3.3.5 Roadmap for Technology Transfer of GI Standards(Source：JPT) 60
Figure 3.3.6 Spatial schema, UML class, GML explanatory material (excerpt)(Source：JPT) .. 61
Figure 3.3.7 Guideline of “Meta Data” (excerpt)(Source：JPT) 62
Figure 3.3.8 Educational Material for GI Standards (excerpt)(Source：JPT) 63
Figure 3.3.9 Agenda for the 1st meeting(Source：C/P) 64
Figure 3.3.10 Relationship between overall goals and key outputs(Source：CGI Office) 69
Figure 3.3.11 Implementation structure for each output identified in the Action Plan(Source：JPT) 70
Figure 3.3.12 Workflow of the Activity 1-5 & Activity 1-6 (Source：JPT) 73
Figure 3.3.13 Designed NSDI System (Left: Catalog Selection Page, Right: Display of searched layer , Source：CGI Office) 77
Figure 3.3.14 System components and their relationships (Source：JPT) 79
Figure 3.3.15 TOT (From Left: Satellite search, Quality Control, 1:25,000 topographic map) (Source：JPT) 104
Figure 3.3.16 “Digital Field Survey” Pilot Area 105
Figure 3.3.17 Vector tiled topographic map on NSDI system 109
Figure 3.3.18 Approaches to the creation of guidelines for the management of GI 110
Figure 3.3.19 Guidelines for Data Management, Updating, and Sharing (Draft)(Source: NCS) 111
Figure 3.3.20 Approaches for building a system that can establish a ToT 112
Figure 3.3.21 Coordination of various activities related to Data Management 113
Figure 3.3.22 Mobile app (left) and Dashboard (right) created during the training (Source: NLCS) 115
Figure 4.1.1 Capacity of NLCS to establish 1:25,000 digital topographic maps in the Project. 123
Figure 4.1.2 Capacity of NLCS to establish digital topographic maps at scales of 1:5,000 and larger (Left: Established area in the project, Right: 1:5,000 Digital Topographic map) 123

Table Contents

Table 1.1 Results of the Review Based on the DAC Evaluation Criteria 8
Table 1.2 Promotive Factor and Obstructive Factor 9
Table 1.3 Lessons Learned from the Project 10
Table 1.4 Recommendations to the Government of Bhutan 11
Table 2.1.1 GHLC Member List (As of December 2022) 20

Table 2.1.2 CGI Member Agencies 21
Table 2.1.3 Ideas of TWG Members 22
Table 2.1.4 Proposed Budget of NLCS (2024 - 2025) 24
Table 2.1.5 Established GI Standards 26
Table 2.1.6 NSDI System Specifications and Functions 28
Table 2.1.7 Examples of Data Managed by the NSDI System 29
Table 2.1.8 System Management Structure 30
Table 2.2.1 Coordinate System Referenced in Bhutan 31
Table 2.2.2 History of Support for 1:50,000 and 1:25,000 Topographic Mapping in Bhutan 32
Table 2.2.3 Equipment Used by NLCS to Create Digital Topographic Maps 36
Table 2.2.4 Comparison of Surveying Using Conventional Methods and Drones (Area: 1.6 km^2) 37
Table 2.2.5 Actual and Planned Utilization 41
Table 3.1.1 Input Results of JICA Experts 42
Table 3.1.2 Materials and Equipment Procured 43
Table 3.1.3 Input Results of Bhutanese Side 44
Table 3.2.1 Revision History of the PDM 45
Table 3.3.1 List of Reports 47
Table 3.3.2 Main Agenda for Each JCC 48
Table 3.3.3 Summary of the First JCC 48
Table 3.3.4 Attendees of the First JCC 49
Table 3.3.5 Summary of the Second JCC 50
Table 3.3.6 Attendees of the Second JCC 50
Table 3.3.7 Summary of the Third JCC 51
Table 3.3.8 Attendees of the Third JCC 51
Table 3.3.9 Summary of the Fourth JCC 52
Table 3.3.10 Attendees of the Fourth JCC 52
Table 3.3.11 Summary of the Fifth JCC 53
Table 3.3.12 Attendees of the Fifth JCC 53
Table 3.3.13 Monitoring Sheet Submission History 54
Table 3.3.14 Results of Interviews for Relevant Plans and Laws and Regulations (example) 54
Table 3.3.15 Documentation of Maintained Organizational Operations 57
Table 3.3.16 List of Members Present in the Subcommittee Meeting for Standard on Metadata 63
Table 3.3.17 Engineers for Geospatial Information in C/P Agencies (As of 2021) 65
Table 3.3.18 Geospatial Information Created and Used by C/P Agencies (As of 2021) 66

Table 3.3.19 Activities Related to Geospatial Information in C/P Organizations (As of 2021) ... 67
Table 3.3.20 Example of Common Form with Proposed Contents of Individual Measures (CGI Office) ... 70
Table 3.3.21 Example of a Monitoring Sheet that Organizes the Progress of Individual Measures and Issues (CGI Office) ... 72
Table 3.3.22 Research on Existing Systems (initial technology transfer) ... 74
Table 3.3.23 Specifications of the Geo-portal (As of 2021) ... 74
Table 3.3.24 Background of Discussions on Design and Development ... 75
Table 3.3.25 Structure of Operation Plan (Draft) ... 77
Table 3.3.26 Structure of User Manual ... 78
Table 3.3.27 Specifications of Procured Equipment ... 81
Table 3.3.28 Overview of Each Japanese Training Program ... 82
Table 3.3.29 Trainee List of the First Training in Japan ... 83
Table 3.3.30 Itinerary and Curriculum of the First Training in Japan ... 83
Table 3.3.31 Summary of Questions and Answers in the First Training in Japan ... 85
Table 3.3.32 Trainee List of the Second Training in Japan ... 86
Table 3.3.33 Itinerary and Curriculum of the Second Training in Japan ... 87
Table 3.3.34 Summary of Questions and Answers in the Second Training in Japan ... 88
Table 3.3.35 Trainee List of the Third Training in Japan ... 89
Table 3.3.36 Itinerary and Curriculum of the Third Training in Japan ... 90
Table 3.3.37 Summary of Questions and Answers in the Third Training in Japan ... 91
Table 3.3.38 Trainee List of the Third Country ... 92
Table 3.3.39 Itinerary and Curriculum of the Training in the Third Country ... 93
Table 3.3.40 Overview of Each Seminar ... 94
Table 3.3.41 Participant List for the Kick-off Seminar ... 95
Table 3.3.42 Participant List of the Interim Seminar ... 97
Table 3.3.43 Presentations of the Interim Seminars ... 97
Table 3.3.44 Participant List of the Final Seminar ... 98
Table 3.3.45 Presentations of the Final Seminars ... 99
Table 3.3.46 Summary of Stakeholders Meetings During the Project ... 101
Table 3.3.47 History of Workshops on NSDI Promotion ... 102
Table 3.3.48 Details of Technology Transfer in "JICA project 2015 - 2017" ... 103
Table 3.3.49 Contents of ToT on Topographic Maps Establishment and Updating ... 104
Table 3.3.50 Schedule of Digital Field Survey Training ... 105
Table 3.3.51 Equipment and Data Used for Digital Field Survey Training ... 106
Table 3.3.52 Advantages and Disadvantages of DEM Contour Lines against Stereo Mapping

..... 107
Table 3.3.53 Curriculum and participants for the ToT 114
Table 3.3.54 History of Workshop on Promotion of GI Utilization 116
Table 4.1.1 Indicators and Target Values for Output 1 117
Table 4.1.2 Evaluation of the Achievement of Activity 1-1 118
Table 4.1.3 Evaluation of the Achievement of Activity 1-2 118
Table 4.1.4 Evaluation of the Achievement of Activity 1-3 118
Table 4.1.5 Evaluation of the Achievement of Activity 1-4 119
Table 4.1.6 Evaluation of the Achievement of Activity 1-5 120
Table 4.1.7 Evaluation of the Achievement of Activity 1-6 120
Table 4.1.8 Evaluation of the Achievement of Activity 1-7 121
Table 4.1.9 Indicators and Target Values for Output 2 121
Table 4.1.10 Evaluation of the Achievement of Activity 2-1 122
Table 4.1.11 Effectiveness of Newly Introduced Technologies and Manuals for GI Maintenance 124
Table 4.1.12 Manual on GI Maintained by C/P 125
Table 4.1.13 Comprehension Test Trends and Results 126
Table 4.1.14 Evaluation of the Achievement of Activity 2-2 126
Table 4.1.15 Evaluation of the Achievement of Activity 2-3 127
Table 4.1.16 Evaluation of the Achievement of Activity 2-4 128
Table 4.2.1 Perspectives and Evaluation of Project “Relevance” 128
Table 4.2.2 Perspectives and Evaluation of Project “Coherence” 129
Table 4.2.3 Perspectives and Evaluation of Project “Effectiveness” 130
Table 4.2.4 Perspectives and Evaluation of Project “Efficiency” 131
Table 4.2.5 Perspectives and Evaluation of Project “Impact” 132
Table 4.2.6 Perspectives and Evaluation of Project “Sustainability” 133
Table 4.2.7 Promotive Factor and Obstructive Factor to Outputs 134
Table 4.2.8 Achievements Made and Future Prospects for Implementation on the Bhutanese Side 135
Table 5.2.1 Recommendations for Output 1 141
Table 5.2.2 Recommendations for Output 2 143

Photo Contents

Photo 2.2.1 National Geodetic points(From Left: CORS, 0/1 order, 2nd Order, Benchmark) 36
Photo 2.2.2 Mapping laboratory in NLCS(Left) and Stereo plotter(Right) 37
Photo 2.2.3 Drones provided for this project(Left) & Processing Software(Right) 38
Photo 3.3.1 The 1st JCC 49
Photo 3.3.2 The 3rd JCC 52
Photo 3.3.3 Training on GI standards 62
Photo 3.3.4 Monitoring meeting between CGI Office, member agencies, and the JICA expert. 73
Photo 3.3.5 Training on conceptual design of NSDI System 77
Photo 3.3.6 Training in operation and maintenance planning for NSDI System 78
Photo 3.3.7 Bidding for NSDI System Equipment(Left : Online, Right : Inspection and Acceptance) 81
Photo 3.3.8 The 1st Training in Japan 85
Photo 3.3.9 The 2nd Training in Japan 88
Photo 3.3.10 The 3rd Training in Japan 92
Photo 3.3.11 Training The 3rd country (Left: DOL, Centre: GISTDA, Right: RTSD) 94
Photo 3.3.12 Kick off Seminar 96
Photo 3.3.13 Interim Seminar 98
Photo 3.3.14 Final Seminar 100
Photo 3.3.15 Digital Field Survey training 106
Photo 3.3.16 Efficiency training for topographic map(Left : Drone, Right : Contour lines from DEM) 107
Photo 3.3.17 GIS trainers (for ToT) gathered from NLCS and other agencies 114
Photo 3.3.18 Training with GIS Tools (Creation of a dashboard that statistically displays the data collected by the field survey application) 115

Appendix

Appendix 1 Project Design Matrix and Plan of Operation (PDM and PO)
Appendix 2 Documents regarding NSDI Partnership
Appendix 3 Documents regarding GI Standards
Appendix 4 Action Plan for the Advancement of Utilizing GI
Appendix 5 NSDI System Operation Plan
Appendix 6 Documents regarding GI Management

Abbreviations

Abbreviations	Original
AKRA	Agency Key Result Areas
ALB	Airborne LiDAR Bathymetry
BPC	Bhutan Power Corporation Limited
BSB	Bhutan Standards Bureau
BTL	Bhutan Telecom
BTS	Bhutan Standards for Geographic Information
BTN	Bhutanese Ngultrums
CGI	Center for Geoinformation (New Name of CGISC)
CGISC	Center for GIS Coordination
C/P	Counterpart
CORS	Continuously Operating Reference Stations
DEM	Digital Elevation Model
DGM	Department of Geology & Mines (MoENR)
DHS	Department of Human Settlement (MoIT)
DITT	Department of Information Technology and Telecom (MoIC)
DLGDM	Department of Local Governance and Disaster Management (MoHA)
DoA	Department of Agriculture (MoAL)
DoCDD	Department of Culture and Dzongkha Development (MoHA)
DoDM	Department of Disaster Management
DoE	Department of Energy (MoENR)
DoECC	Department of Environment and Climate Change (former NEC), (MoENR)
DoFPS	Department of Forests and Park Services
DoID	Department of Infrastructure Development (MoIT)
DoL	Department of Livestock (MoAL)
DOL	Department of Lands (Thailand)
DoLAM	Department of Land Administration and Management (NLCS)
DoR	Department of Roads (MoIT)
DoSAM	Department of Survey and Mapping (NLCS)
DoST	Department of Surface Transport (MoIT)
DPS	Data Product Specifications
DQ	Data Quality
DSLR	Department of Survey and Land Record
UN-GGIM-AP	United Nations Global Geospatial Information Management for Asia and the Pacific
GHLC	Geo-information High Level Committee
GI	Geo-Information or Geographic Information
GIS	Geographical Information System
GISTDA	Geo-Informatics and Space Technology Development Agency (Thailand)
GMC	Gelephu Mindfulness City
GNHC	Gross National Happiness Commission
GNSS	Global Navigation Satellite System
GSI	Geospatial Information Authority of Japan
GUI	Graphical User Interface
ICIMOD	International Centre for Integrated Mountain Development
ICT	Information & Communication Technology

Abbreviations	Original
IPA	Information-technology Promotion Agency, Japan
ISO	International Organization for Standardization
ISO/TC211	Technical Committee 211 Geographic information / Geomatics
IT	Information Technology
IWP	Individual Work Plan
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
JPGIS	Japan Profile for Geographic Information
JPT	JICA Project Team
M/M	Minutes of Meeting
MMS	Mobile Mapping System
MoAF	Ministry of Agriculture and Forest
MoAL	Ministry of Agriculture and Livestock (former MoAF)
MoEA	Ministry of Economic Affairs
MoENR	Ministry of Energy and Natural Resources
MoHA	Ministry of Home Affairs (former MoHCA)
MoHCA	Ministry of Home and Cultural Affairs
MoIC	Ministry of Information and Communication
MoIT	Ministry of Infrastructure and Transport (former MoWHS)
MoWHS	Ministry of Works and Human Settlement
NASA	National Aeronautics and Space Administration
NCHM	National Center for Hydrology and Meteorology
NEC	National Environment Commission
NHDCL	National Housing Development Corporation Limited
NKRA	National Key Result Areas
NLC	National Land Commission
NLCS	National Land Commission Secretariat
NLUZ	National Land Use Zoning
NSB	National Statistics Bureau
NSDI	National Spatial Data Infrastructure
NSSC	National Soil & Service Center
OJT	On-the-Job Training
PDCA	Plan-Do-Check-Act cycle
PDM	Project Design Matrix
PO	Plan of Operation
R/D	Record of Discussion
RTSD	Royal Thai Survey Department
SNS	Social Networking Service
SOP	Standard Operating Procedures
SSOT	Single–Source-of-Truth (means a single responsible agency)
TF	Task Force
TWG	Technical Working Group
UI	User Interface
UML	Unified Modeling Language
UNITAR	United Nations Institute for Training and Research

Abbreviations	Original
UNVT	United Nations Vector Tile Toolkit
WFP	World Food Program
WWF	World Wide Fund for Nature
XML	Extensible Markup Language

The Project for Promotion of Utilization of Geospatial Information through Development of NSDI
Project Completion Report

<< Summary >>

1. Project Background and Objectives

The Kingdom of Bhutan (hereinafter Bhutan) requires reliable Geospatial Information to promote urban development plans and infrastructure development.

However, the following issues need to be addressed.

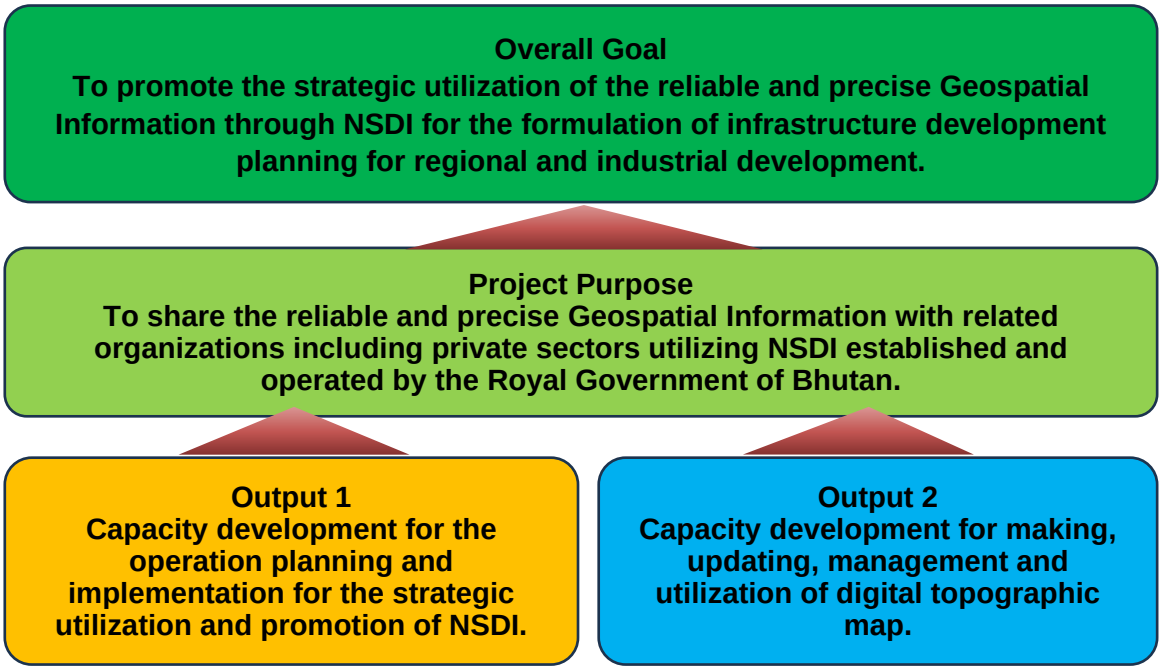
- 1:25,000 scale and 1:5,000 scale digital topographic maps that are expected to be necessary for development planning have not been prepared yet. Although Bhutan had established a plan for 1:25,000 maps and 1:5,000 maps under the 12th Five-Year Plan of Bhutan (hereinafter 12th FYP), achievement of this goal seems to be difficult due to the shortage of budget, human resources, and the technical level of the government.
- Redundancy of works among government agencies is another issue due to individual management of Geospatial Information by each government agency on a project basis.
- For promoting cross-sectional utilization of the Geospatial Information managed by governmental agencies, the Government of Bhutan made National Spatial Data Infrastructure (hereinafter NSDI) one of its priority fields in the 12th FYP (2018 - 2023), and in 2018, Geo-Information Policy (hereinafter GI Policy) was approved by the Cabinet. However, the cross-sectional utilization of Geospatial Information has not been promoted due to a shortage of practical experience and know-how.

Against this background, the National Land Commission Secretariat (hereinafter NLCS) requested Japan for technical cooperation designed to transfer technologies which included rebuilding the NSDI strategy, formulating an operation and maintenance plan for NSDI, low-cost creation of digital maps (scale of 1:25,000, larger than 1:5,000) with semi-automatic processing of elevation data.

In November 2020, The Project for Promotion of Utilization of Geospatial Information through Development of National Spatial Data Infrastructure (hereinafter This Project) was launched.

2. Purpose of the project

The "Overall Goal" and the "Project Purpose" and "Outputs" to be achieved are as follows.



3. Activities and Outputs

3.1 Output 1: Capacity development for the operation planning and implementation for the strategic utilization and promotion of NSDI

3.1.1 To summarize legal framework, plans and policies related to NSDI and to create basic plan of NSDI in accordance with Geo-information policy (Activity 1-1)

Regarding the basic plan for the promotion of NSDI, the time frame of the action plan formulated based on the existing GI policy was revised, and through monitoring of related activities of NSDI promotion measures, including activities in this project, the JICA Project Team (hereinafter JPT) supported the preparation of reference materials for the consideration of future GI policy updates.

For the Digital Topographic Map Development Plan, the JPT supported the planning, monitoring and review of the plan for the pilot areas of the 1:25,000 topographic map and 1:5,000 topographic map in this project, the development areas of the JICA Grant Aid Project: The Project for the Development of Digital Topographic Map, and other areas shall be developed by the NLCS.

3.1.2 To summarize related organizations and their role and responsibility for the establishment and operation of NSDI and to enhance the cooperation among the related organizations (Activity 1-2)

The JPT assisted the CGI (Center for Geo-Information) Office in the NLCS to coordinate among related agencies regarding the establishment and operation of the NSDI such as organizing the role of the CGI Office and the procedures for holding CGI member meetings. Furthermore, through the clarification of the role of the Geo-information High Level Committee (GHLC), Technical Working Group (TWG), CGI member agencies, CGI Office, Task Forces (TF), etc., and their establishment, holding, and operation policies, the JPT supported C/P to prepare management matters, etc.

3.1.3 To establish draft of Geographic Information standards in Bhutan and to implement its promotion to related organizations (Activity 1-3)

The JPT discussed with C/P about prioritization for Bhutan's version of GI Standards in the International Organization for Standardization (ISO) on Geospatial Information and assisted C/P revision for National Standardization and formulation of guidelines subject to ”Metadata”, ”Data Quality (DQ)”, ” Data Product Specifications (DPS)”.

The JPT assisted the coordination between C/P and the Bhutan Standards Bureau (BSB) and the establishment of a subcommittee to study Bhutan's national standardization of Geographic Information.

3.1.4 To develop and implement action plans for utilization of Geospatial Information in member agencies (Activity 1-4)

The CGI Office identified the most important issue and the five outputs to address the issue determined in consultation with the JPT, taking into account the current situation of GI utilization in Bhutan and the C/P. The JPT supported the CGI Office and relevant agencies to prepare draft action plans that aim to promote GI utilization. Furthermore, individual activities described in the draft action plan prepared by the CGI Office and the relevant agencies were implemented following the PDCA cycle. The progress of these activities was monitored periodically on a quarterly basis for one year, and the draft action plan was evaluated at the end. The draft action plan was finalized in consideration of issues and improvements identified as a result of the evaluation.

3.1.5 To conduct conceptual design for ICT services including Bhutan Geospatial portal for NSDI and to provide an internet map distribution service as a part of NSDI (Activity 1-5)

The activities started with a review of existing Geo-portal and identification of issues, followed by a lecture on the basic knowledge of NSDI services in Bhutan to understand ICT services (hereinafter NSDI system) such as Web maps, open data, and platforms in Japan and other countries. A series of lectures were given on the basic knowledge of NSDI services in Bhutan.

Based on the knowledge and awareness gained through these issue confirmations and studies, training and discussions on service design and functional requirements definition were conducted.

Since the Geo-portal on that time, which was supposed to be the foundation of the development, was found to be unrecoverable, and it was necessary to build a new infrastructure in an environment with limited human and software resources, after discussing how to deal with the situation. Following designing, developing, and training on the system based on the agreed requirements definition, trainings was conducted on data (layer) registration to the NSDI system, user management, log management, backup, and failure recovery, etc. A system operation manual including Standard Operating Procedures (SOPs) was prepared and training was provided to relevant agencies.

3.1.6 To identify the required equipment for the operation of NSDI and to decide the specifications of the equipment (Activity 1-6)

In accordance with the conceptual design of the NSDI system developed in Activity 1-5, through confirmation of requirements for equipment of NSDI operation, preparation of specifications, discussion of procurement methods and installation locations, materials and equipment were procured. After coordinating with the GovTech Agency, the IT department of the Royal Government of Bhutan, it was finally decided to use the facilities of the government data center as the NSDI operating environment. It was agreed with the C/P that the equipment procured for this project would be installed in the NLCS and operated as a backup and development environment for the NSDI system.

3.1.7 To develop the strategy and policy for the promotion of NSDI and Geographic Information Standards and to conduct awareness campaigns such as seminars and training or workshop for the promotion of utilization (Activity 1-7)

Three seminars, three training sessions in Japan, and training sessions in third countries regarding the promotion and utilization of NSDI and geographic information standards were held. Within Activities 1-3, 1-4 and 1-5, related workshops were conducted either with the Bhutanese initiative or led by JICA experts.

3.2 Output 2: Capacity development for making, updating, management and utilization of digital topographic maps

3.2.1 To enhance the capacity of making and updating the digital topographic map of scale 1:25,000 and 1:5,000 or larger (includes Vector Tile focusing advancement to Internet Map Distribution Service) in pilot area (Activity 2-1)

The JPT supported improving the capacity of NLCS with respect to the creation and updating of digital topographic maps at scales of 1:25,000 and 1:5,000 and larger, taking into consideration the sustainability of NLCS. For example, the introduction of technologies such as laser-equipped Drones, Tablets that can streamline field surveys, the use of ready-made or image-processed Digital Elevation Model (DEM), and the use of existing data have confirmed efficiency gains compared to conventional methods. In addition, technology transfer was implemented with an emphasis on the Training of Trainers.

Technology transfer of “Vector Tiles” was also implemented with a view to facilitate use of topographic maps as background images in the Internet map distribution services.

3.2.2 To clarify the authorized organization for the management of Geospatial Information and to develop the efficient process of data management, sharing and updating of each piece of Geospatial Information (Activity 2-2)

Through interviews with data creation agencies, including NLCS, the current situation regarding data management in consideration of practical use was grasped and shared, and support was provided to develop draft guidelines, including procedures for managing, sharing, and updating Geospatial Information. Formulation of these guidelines was conducted in collaboration with the Activity 1-5 Team, which created SOPs for actual system operation.

Training on data management in the NSDI system was conducted using the developed framework and the NSDI operational manual developed based on the framework.

3.2.3 To enhance the capacity to utilize digital topographic maps in related organizations (mechanisms for digital topographic maps are understood by related agencies in Bhutan and utilization capacity of Geospatial Information with GIS Tools is strengthened) (Activity 2-3)

Trainings using GIS Tools was provided for staff selected as ToT (Training of Trainers) trainees from NLCS and participating agencies, helping to create an environment in which staff can provide trainings autonomously. Training was divided into three phases.

(1) Understanding of NSDI, understanding of how to plan and conduct training, experiencing Web maps and creating simple Web map applications with WebGIS

(2) Overview of the NSDI system and data management procedures (understanding of the operation manual)

(3) Utilization of GIS Tool provided by NSDI (mobile tools, WebGIS apps)

In addition, the C/P and the JPT discussed the possibility of continuing training on the use of NSDI data and GIS Tools on the C/P after the project was completed and documented the results as a plan for ongoing training (published in the NSDI system).

3.2.4 To conduct awareness campaign such as seminars and training or workshops for the promotion of utilization of Geospatial Information including digital topographic maps (Activity 2-4)

In Activity 2-1, workshops on “Drones” and “Vector Tiles” were conducted under the leadership of C/P or JICA experts. The seminar also featured a technical presentation on drones by Bhutanese experts.

Activities 2-2 and 2-3 included workshops on the GIS Tool by master trainers and training (workshops) for stakeholder agencies on data registration, NSDI system overview and data management procedures (understanding the operational manual). This activity was carried out in cooperation with Activity 1-5, which is studying and preparing the NSDI system and operational manuals, based on the following role

assignments.

(1) Role of Activity 1-5: Support for workshops, mainly on the systems side. Also, in collaboration with Activity 2-2, preparation of an operational manual based on the data management framework, explanation to participants, and provision of technical guidance

(2) Role of Activity 2-2: In collaboration with Activity 1-5, development of guidelines (framework) for data management and explanation to participants

(3) Role of Activity 2-3: Planning, organizing and managing training activities

4. Project Achievement

4.1 Achievement of the Project purpose and indicators of each Output

4.1.1 Achievement of the Project purpose

The Project purpose is ”To share the reliable and precise Geospatial Information with related organizations including private sectors utilizing NSDI established and operated by the Royal Government of Bhutan.” And the indicator is “The number of geospatial layers available for download by the general public (target value =50 layers)” and “Agreement from each organization (target value =10 agencies)”.

Achievement: As for the registration of layers in the NSDI system, more than 10 agencies have registered data into the NSDI system, and more than 50 layers have already been made downloadable by general public as of the completion of the project.

4.1.2 Achievement of Output 1: capacity development for the operation planning and implementation for the strategic utilization and promotion of NSDI

Indicators for Output 1 and Achievement are as follows. Based that, it is evaluated that the indicator for Output 1 has been achieved.

(1) Indicator: number of stakeholders of NSDI (target value = 36 agencies: achievement = 33 agencies)

Achievement: The agencies expected to become stakeholders with respect to NSDI promotion in Bhutan are already CGI members, and for the next few years, the 33 agencies will be almost the largest.

(2) Indicator: number of meetings and participants (target value = 2 / year: average of the last few years = 2 / year)

Achievement: There was a period of about 3.5 years during which meetings could be held with the relevant agencies during the project period without the influence of COVID-19, 3 seminars and 5 CGI member meetings (including online) were held during that period, with an overall average of at least 2 meetings per year.

(3) Indicator: number of registered layers in the Web Map Service (target value = 10 layers: achievement = more than 50 layers)

Achievement: more than 50 layers are registered as samples for the Web Map Service in the NSDI system.

(4) Indicator: number of proposed action plans (target value =5: achievement = 5)

Achievement: A total of 6 member agencies initially participated in the preparation of action plans for the GI utilization: CGI Office and Department of Surface Transport (DoST), Thimphu Thromde, Samdrup Jongkhar Thromde, DoFPS (MoENR), and Department of Survey and Mapping (DoSAM, NLCS). In the end, 5 of them implemented their activities as originally planned, as well as monitored and evaluated these activities.

4.1.3 Achievement of Output 2: capacity development for making, updating, management and utilization of digital topographic maps.

Indicators for Output 2 and Achievement are as follows. Based that, it is evaluated that the indicator for Output 2 has been achieved.

(1) Indicator: pilot areas for 1:25,000 topographic map (target value = 1,000 km^2: achievement = more than 2,300 km^2), for 1:5,000 topographic map (target value = 50 km^2: achievement = 50 km^2), for larger than 1:5,000 topographic map (target value = 0.1 km^2: achievement = more than 3.2 km^2)

Achievement: digital topographic maps of the pilot area, both 1:25,000 and 1:5,000, and larger than1:5,000 have been developed, exceeding the indicator.

(2) Indicator: number of qualified operators (target value = 3 experts scored 75 or higher on the confirmation test: achievement 5 experts)

Achievement: In terms of theory, a total of 5 trainer candidates passed the confirmation test conducted at the end of the session. On the technical side, the quality of the digital topographic maps of 1:2,500 and 1:5,000 or larger that were developed through pilot training was qualitatively evaluated by a JICA expert, and 3 of them reached the acceptable level.

(3) Indicator: number of training sessions (target value = 3 sessions: achievement = 8 sessions)

Achievement: a total of 8 training sessions on the GIS Tool were conducted in three phases, including supplemental training. A total of 49 people participated. In particular, the members involved in Activity 1-5 were able to acquire a level of technical know-how to prepare for and conduct subsequent system management training by themselves, through understanding of NSDI, actual system development after

understanding basic WebGIS operations, and preparation of operation manuals.

4.2 Review based on DAC evaluation criteria

The table below shows the results of the review based on the DAC evaluation criteria (6 criteria).

Table 1.1 Results of the Review Based on the DAC Evaluation Criteria

#	Indicator	Evaluation	Description of Evaluation
1	Relevance	Satisfactory	1) Development policy: it is consistent with the 12th Five-Year Plan (2018 - 2023) and the 13th Five-Year Plan (2024 - 2029) of the State of Bhutan.
			2) Adequacy as a means: both the selection of the target group and the Spread of Effects were appropriate.
2	Coherence	Highly satisfactory	1) Country Assistance Policy: contribute to the development of GI as the basis for national development plans listed in the priority fields, and to the cross-functional use of GI held by relevant agencies in “Country Assistance Policy for Bhutan (January 2023)”
			2) JICA Country Analysis Paper (Bhutan): particularly consistent in the area of “Urban Environmental Improvement”.
			3) Cooperation with other JICA projects: linking to “The Project for the Development of Digital Topographic Map (JICA Grant Aid Project)” and “Project for Formulation of Comprehensive Development Plan for Bhutan 2030”.
			4) International framework: highly related to “Goal 3”, “Goal 10”, “Goal 11” in the “Sustainable Development Goals (SDGs)“.
3	Effectiveness	Satisfactory	1) Project purpose: goals are clear, indicators and means of obtaining indicators are quantitatively verifiable and precise. It is also achieved if outputs are produced.
			2) Output 1: the level of achievement of the indicator can be verified by the achievement of the 4 output indicators of the activity.
			3) Output 2: the level of achievement of the indicator can be verified by the achievement of the 3 output indicators of the activity.
4	Efficiency	Satisfactory	1) Causes and effects: the necessary quantity and quality of inputs were made to produce outputs.
			2) Period/Timing: due to the delay of the JICA experts traveling to the site caused by COVID-19, the project period was extended by 1 year from the originally planned period, but the results were worth it. The Bhutanese input was appropriately timed.
			3) Cost: it was possible to produce output within the planned amount.
5	Impact	Satisfactory	1) Prediction of achievement of Overall goal: expectations for achievement are high, as examples of the GI utilization for development planning were identified during the project.
			2) Ripple effects: if the GI policy becomes law in the future, its institutional effectiveness will be enhanced. The economic impact of NSDI promotion, such as avoiding double investment and promoting national development plans, is very significant. According to the GI policy, the development of NSDIs is expected to contribute to the realization of policies and resolution of social issues and the well-being of the people of Bhutan.
6	Sustainability	Highly satisfactory	1) Policies and institutions: policy support for NSDI promotion will continue after the project, as the 13th Five-Year Plan will continue to review and revise plans associated with GI policies.
			2) Organization and structure: CGI member agencies have been regularly active prior to the project and have become more active and habitual through each activity of the project.
			3) Finances: the maintenance and update of topographic maps and the

#	Indicator	Evaluation	Description of Evaluation
			NSDI system are based on structures and technologies that are commensurate with the C/P budget. It is also expected that the maintenance of the NLCS hardware and security will be reimbursed by the GovTech Agency.
			4) Technology: with training focused on trainer development and dissemination, C/P have the technical capabilities and structure to disseminate within and beyond the agency. There are some concerns about the cost of maintaining the stereo equipment. NLCS has proposed a budget for expansion in the period 2025-2029. Using commercial software with vendor support for the NSDI system will provide technical assistance after the project is completed as long as the necessary budget is available for maintenance.
			5) Society, Culture and Environment: there are no factors that would hinder project effectiveness.

Source：JPT

4.3 Factors influencing the implementation of activities and achievement of results

The table below shows the major "Promotive Factor" and the major "Obstructive Factor" that may affect the achievement of results.

The main "Promotive Factor" was voluntary activities on the Bhutanese side.

Regarding the 3 main "Obstructive Factors", against 1) Delays in GHLC activities, the JPT supported the promotion of activities by preparing an operation manual and proposing the holding of the first GHLC meeting at the final seminar. Against 2) Geo-portal (on that time) breakdown and 3) Travel restrictions and delay during COVID-19, Through the deployment of JICA experts and other initiatives, it was able to meet the initial plan without major changes to the timeframe or costs.

Table 1.2　Promotive Factor and Obstructive Factor

Factor		Reason
Promotive Factor	Active activities with the Bhutanese initiative	Conducting voluntary workshops and study groups
		Identification of issues, Planning and Dissemination of information
		Cooperation with BSB and GovTech Agency
		Significant leadership, facilitation, and other support from NLCS in "Human Resources", "Technical Resources", "Stakeholder Coordination", "Financial Support"
Obstructive Factor	1) Delays in GHLC activities	The GHLC has been delayed due to the impact of major structural reforms in the Royal Government of Bhutan, which have made it difficult to coordinate at the level of decision makers among the agencies involved.
	2) Geo-portal breakdown	After the project became active, the Geo-portal (on that time) found to be unrecoverable condition, necessitating a change in policy.
	3) Travel restrictions and delay during COVID-19	The full-scale start of the project was delayed by the need to wait for JICA experts to travel to Bhutan after the travel restrictions by the Bhutanese government in connection with COVID19 have settled down, as it was anticipated that the efficiency of online technology transfer of practical contents such as document preparation was limited compared to in-person technology transfer for activities such as "GI Standards," in which Bhutanese engineers had no prior experience.

Source：JPT

4.4 Lessons learned from the Project

Lessons learned through project implementation and operation are shown in the table below.

Table 1.3 Lessons Learned from the Project

Output	Lessons Learned	Contents
Common	1) Delayed start of activities in Bhutan due to COVID-19	Although the online training did achieve some success in understanding the theoretical part, for activities on “GI Standards,” which were new to C/P, For the practical part of the training, it was effective to start with a careful explanation of the basics in-person, as was done in the project.
	2) Number of trainees for the training session in Japan	The size of 16 trainees was difficult to coordinate the schedule of the trainees and venues of training/lunch, placed a heavy burden on the staffs in charge of arrangement and attend both Bhutan and Japan side.
Output 1	1) Recognition of existing GI Policy Action plan	Instead of developing a new “NSDI Basic Plan,” the existing “GI Policy Action Plan,” which had similar functions but had not been put into practical use, could be effectively utilized.
	2) Partnership	By documenting, archiving, and sharing the roles and scope of responsibility of each agency, as well as procedures and minutes, the importance of the project was recognized, and the C/P side gained awareness regarding their own responsibilities.
	3) GI Standards	The fact that the C/Ps themselves had the opportunity to study in groups helped promote understanding and gave them a great deal of confidence, enabling them to engage in more active discussions.
	4) GI Utilization Action Plan	Prior briefings for the decision-makers, who are the supervisors of the trainees at each institution, made it easier for the focal persons to participate in Activity 1-4. Common forms were introduced for individual measures and their monitoring to efficiently share the progress of the individual measures and their issues.
	5) NSDI system	C/P was able to undertake in-house development using a commercial GIS development tools, resulting in a flexible development attitude. It also became an element that will be utilized in the future when C/P outsources development.
Output 2	1) Establishment and update of GI	C/P often relied on JICA experts to manage the accuracy of aerial triangulation results and to make pass/fail decisions at the beginning of the project, but training focused on quality theory has accelerated the work and improved pass/fail capabilities. When sharing work progress among operators, sometimes digital methods alone are not sufficient, so “visualization” through analog methods can be effective.
	2) Maintenance of GI	A single responsible agency manages its own data of the NSDI, and this has become a matter of common understanding among NSDI participating agencies, fostering a situation in which consensus can be built to adhere to these principles.
	3) Utilization tools for GI	Training materials were developed, and actual training sessions were provided to show what trainers should do as well as to convey the operational skills necessary for trainers and to spread these skills to other staff members. Trained trainers began to voluntarily serve as trainers at workshops and other events.

Source：JPT

5. Recommendations for achieving the Overall Goal

5.1 Prospects for achieving Overall Goal

During the project, examples of GI utilization for infrastructure planning (e.g., Gelephu Mindfulness City) were identified, and prospects for achieving the Overall goal "To promote the strategic utilization of the reliable and precise Geospatial Information through NSDI for the formulation of infrastructure development planning for regional and industrial development" are high because of the high feasibility of "GI being managed with high reliability and accuracy" and "shared with relevant agencies, including the private sector," after the project.

5.2 Recommendations to the Government of Bhutan

To sustainably promote the results of this project, it is expected that the Government of Bhutan will continue to implement what is listed in the table below and to achieve the Overall goal.

Table 1.4 Recommendations to the Government of Bhutan

Themes		Recommendations
To Promote GI utilization for infrastructure planning		Through Output 1, the rules for searching, accessing, and obtaining necessary geospatial information have been unified and streamlined through the development of geographic information standards and the NSDI system, and through Output 2, the number of organizations that have enhanced their ability to share and utilize geospatial information through GIS has increased. Furthermore, since the entire Bhutan will be generally covered by the base map by 2025, it is desirable to increase opportunities and agencies to utilize GI in infrastructure development planning.
Output 1	Policy and institutional aspects	It is desirable to revise the GI policy from the perspective necessary to resolve the issues of "Consistency with relevant documents", "Gap with reality", "Ambiguity in procedures for setting up the organization," and "Ambiguity in definition of decision-making authority", and to ensure the sustainable maintenance and management of the NSDI.
	GI Standards	It is advisable to start "Data Quality assessment" from a feasible step, such as automatic checks by GIS software or visual checks by sampling, and gradually gain experience. In addition, persistent outreach from NLCS to relevant agencies is important.
		It is important for NSDIs to conduct sustained education and training on the common rules of "GI Standards".
	NSDI system operation	In developing NSDI systems, it is important to fully design services and define requirements, be sure to document them, and be prepared to recover them in the event of a problem.
		It is also important to continue to promote activities that expand the usefulness of the NSDI by making services such as application release available on the NSDI Portal as a result of the NSDI.

Themes		Recommendations	
	Planning / Personnel aspects	It is effective to consider measures or activities in line with the fiscal year. This will make it possible for future projects to implement measures or activities not as additional work designated only for the project but as a part of mandatory tasks for government employees.	
Output 2	Digital topographic maps	Establishment	While there may be a shortage of stereo equipment in the future, it is necessary to devise ways to maintain operations with a minimum of stereo equipment by appropriately segregating the methods used to create the geographic features to be created and the equipment used, while utilizing drones and commercially available or existing data.
		Vector Tile	It is desirable that all fundamental digital topographic maps be vector tiled and used as background for NSDI systems in the future.
		Update of maintenance framework	The framework for the management, sharing, and updating of GI should be established through periodic review discussions necessary to match the actual operational conditions.
		Improvement of NSDI services	To improve useful services related to the NSDI system, the following initiatives shall be realized. - Efforts to make the existence of NSDI known - Improving the quality and efficiency of operations through the use of NSDI data - Improving skills of data users to use data

Source：JPT

Chapter1 Outline of the project

1.1 Background of the project

The Kingdom of Bhutan (hereinafter Bhutan) requires reliable Geospatial Information to promote urban development plans and infrastructure development on a limited number of suitable sites due to the precipitous mountains that cover most of the territory.

Topographic maps are essential for development plans; however, Bhutan has 1:50,000 maps covering the entire territory which were produced with the support of the government of India in the 1960s. Moreover, JICA implemented the "Project on the development of national Geo-spatial data" in the period from 2015 to 2017 and produced 1:25,000 topographic maps covering the southern part of the country (11,000 km^2) and prepared large-scale maps for some major towns.

However, 1:25,000 topographic maps could not cover the whole country as envisioned under the 12th FYP due to the shortage of budget, human resources and technical capacity.

For this, the project was started for the development of digital topographic maps including large-scale maps of 1:5,000 maps for major cities covering the central part of the country. The project was supported by the JICA Grant Aid project and is due for completion.

In addition, redundancy of works among government agencies was another issue due to individual management of Geospatial Information by each government agency on project base. Promoting data sharing of this Geospatial Information contributes to the enrichment of added value and contributes to decision-making at an early stage to realize cost savings and cost efficiency. To promote cross-sectional utilization of the Geospatial Information managed by governmental agencies, the Government of Bhutan made "National Spatial Data Infrastructure (NSDI)" one of the prioritized fields in the 12th FYP (2018-2023), and in 2018, "Geo-Information Policy (GI Policy)" was approved by the Cabinet. However, the cross-sectional utilization of Geospatial Information has not been promoted due to a shortage of practical experience and knowhow.

Against this background, the National Land Commission Secretariat (NLCS) requested Japanese technical cooperation designed to transfer technologies which include rebuilding the NSDI strategy, formulating an operation and maintenance plan of NSDI, and low-cost creation of digital maps (scale of 1:25,000, larger than 1:5,000) with semi-automatic processing of elevation data.

To ensure that Geospatial Information maintained by government agencies in Bhutan is properly and efficiently managed and utilized within the agencies concerned through NSDI, this project was implemented to sharing reliable and precise Geospatial Information with related organizations including the private sectors utilizing NSDI infrastructure developed and operated by the Royal Government of Bhutan including the development, updating, management and utilization of the digital topographic maps in the country.

1.2 Outline of the Project

1.2.1 Project name

The Project for Promotion of Utilization of Geospatial Information through Development of National Spatial Data Infrastructure

1.2.2 Overall goal and Project purpose

(1) Overall goal

To promote the strategic utilization of the reliable and precise Geospatial Information through NSDI for the formulation of infrastructure development planning for regional and industrial development.

(2) Project purpose

To share the reliable and precise Geospatial Information with related organizations including the private sectors utilizing NSDI established and operated by the Royal Government of Bhutan.

1.2.3 Outputs of the project

Output 1 : capacity development for the operation planning and implementation for the strategic utilization and promotion of NSDI

Output 2 ： capacity development for making, updating, management and utilization of digital topographic maps

1.2.4 Project scope and implementing agency

Project scope 1: the project covers the entire country for the strategic utilization and promotion of NSDI

Project scope 2: selected AOI (Figure 1.2.1 - 1.2.3 below, see Chapter 4 for details) through discussion between the C/P and the JPT

Implementing agency: National Land Commission Secretariat (NLCS)

As shown in the figure below, the area of satellite imagery procured for the 1:25,000 digital topographic mapping was approximately 2,700 km^2 in eastern and northeastern Bhutan. The pilot area was selected through the discussion with NLCS to cover a total of 2,100 km^2, consisting of 870 km^2 from the area where NLCS is using satellite imagery procured with World Wide Fund for Nature (WWF) and 1,230 km^2 from the area where satellite imagery was procured in this project.

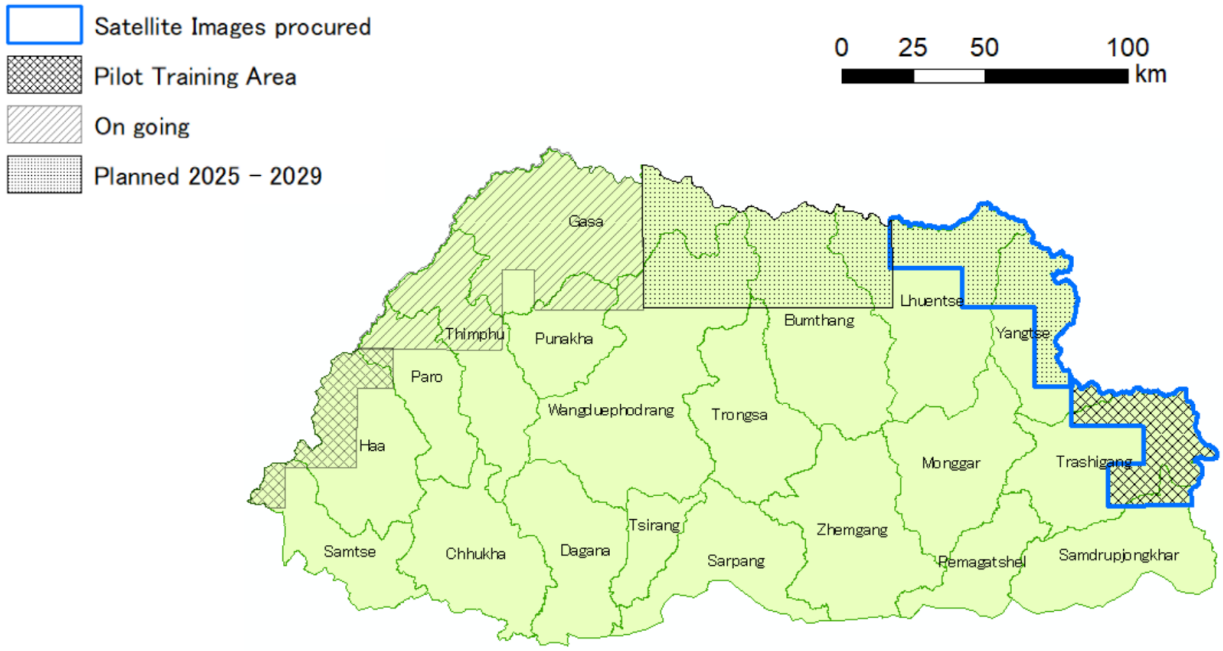


Figure 1.2.1 Project Area of 1:25,000 Topographic Maps (Source: NLCS)

As shown in the figure below, the procurement area of satellite imagery (stereo pair or ortho imagery) for the 1:5,000 digital topographic map was approximately 240 km^2 in Samtse. The pilot area was 50 km^2 of that area after consultation with NLCS.

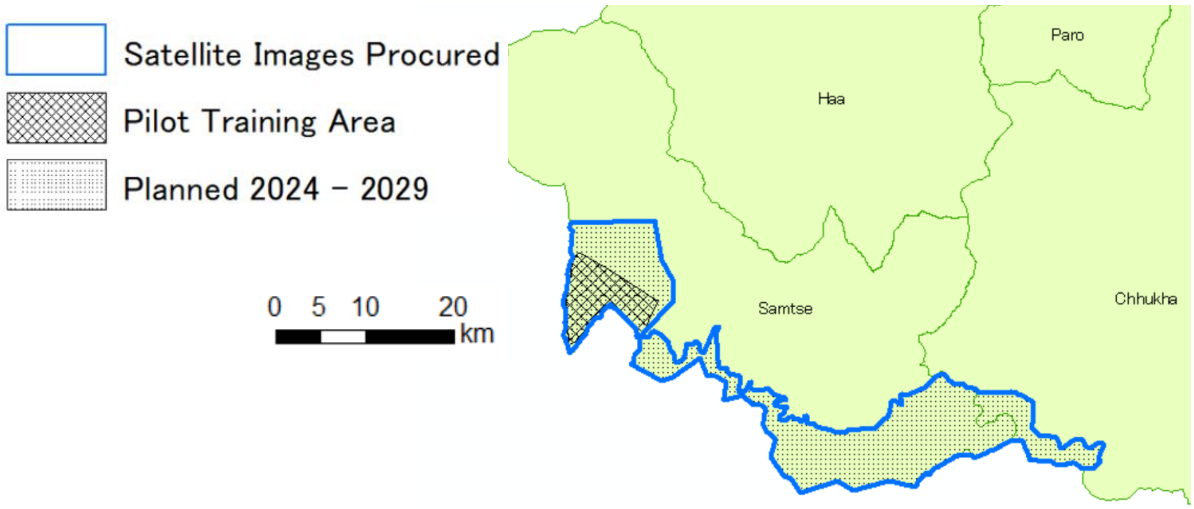


Figure 1.2.2 Project Area of 1:5,000 Topographic Maps (Source: NLCS)

The pilot area for the large-scale digital topographic map using the drone was 1.6 km^2 in total in the two areas to the east of the map below, as through the discussion with NLCS. After the pilot area was completed, areas outside the pilot area were also maintained by offers from other agencies.

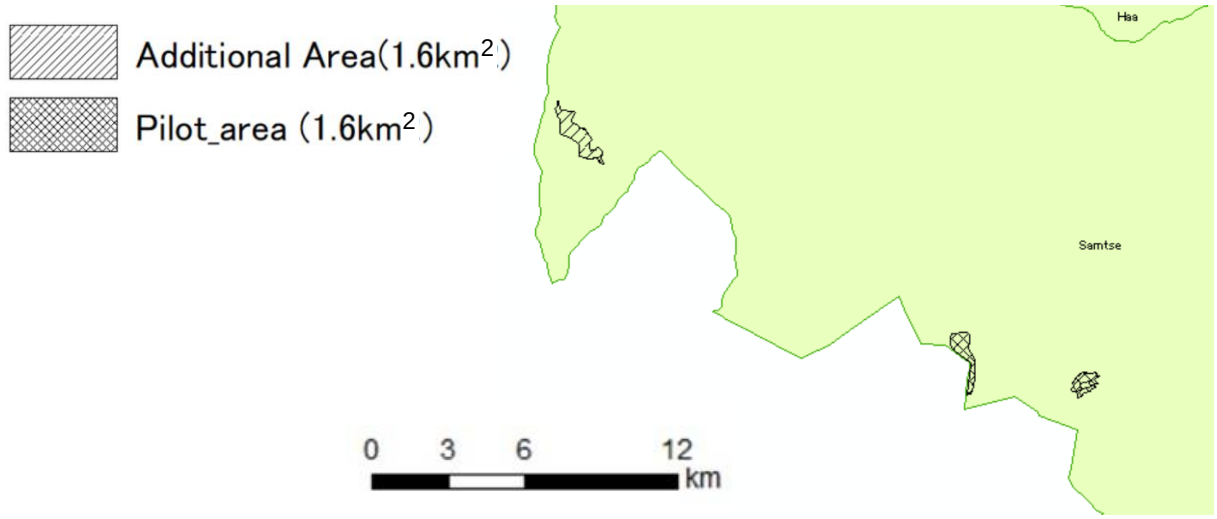


Figure 1.2.3 Project Area of Large-Scale Topographic Maps (Source: NLCS)

1.2.5 Project duration

In the Record of Discussion (R/D), the duration of the project is mentioned as “The Duration of the Project is Thirty – eight (38) months from the arrival of the first expert for the Project”.

Since the first arrival of JICA experts in the country was on 29 November 2021, the final "Time for completion" was set for 28 January 2025, 38 months after the initial trip of the experts.

1.2.6 Project implementation organization

The project implementation structure is as follows.

The members in the red dashed line in the figure are defined as the “Project Working Group” and the members in the red thick box line are defined as the Counterpart (C/P).

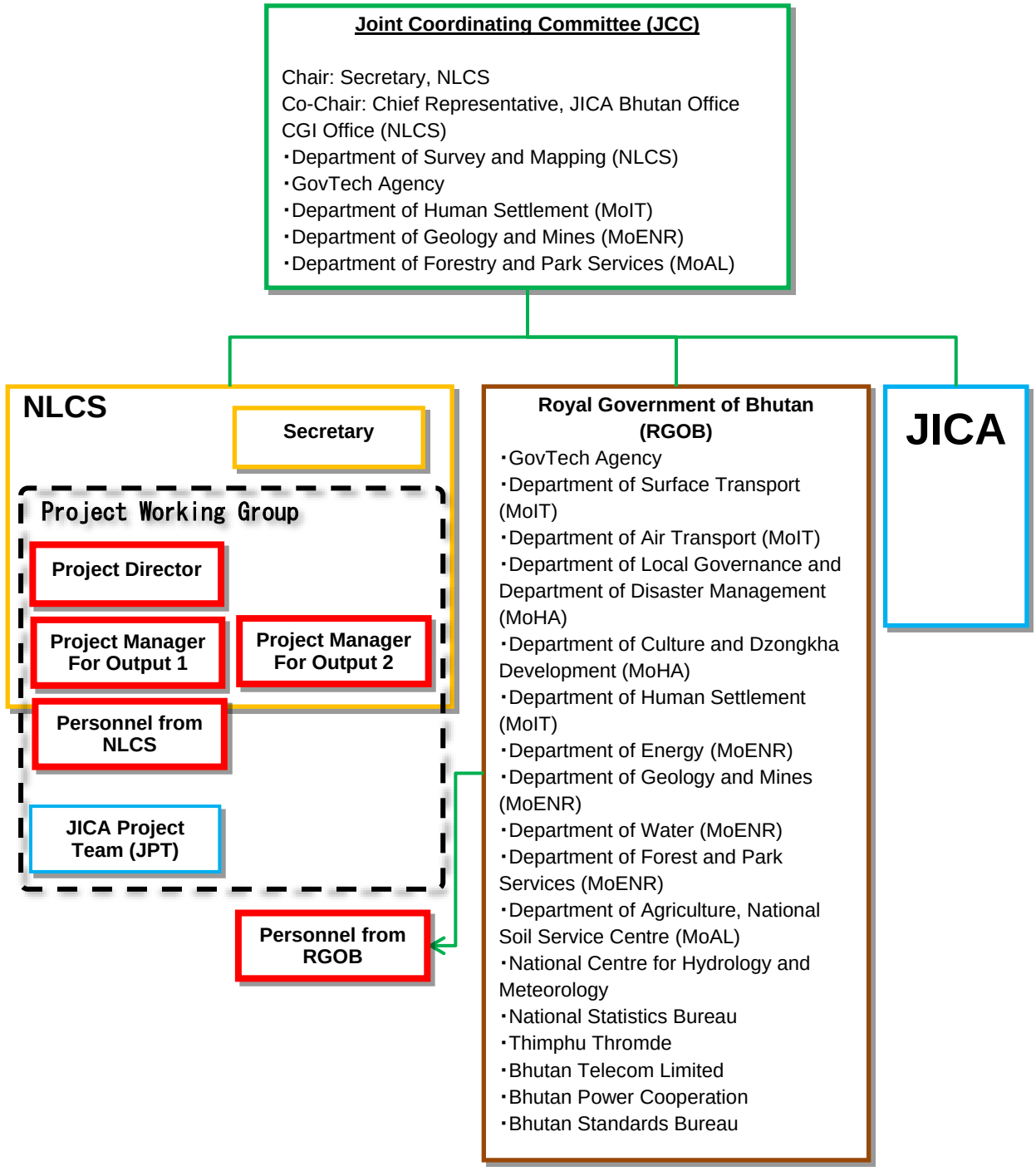


Figure 1.2.4　Project Implementation Structure (Source: C/P and JPT)

Chapter2 Current Status of NSDI in Bhutan

2.1 Current status of NSDI establishment and promotion by the Government of Bhutan

2.1.1 Plan, institutional and legal framework about NSDI

(1) 12th Five-Year Plan and 13th Five-Year Plan

The NLCS's 13th Five-Year Plan (2024 - 2029) states “Review and harmonize existing policies such as GI policy and others,” although no legislative or other institutional enhancements to GI policy are planned in the next 5 years, it is stated that the GI policy will be reviewed and aligned with the current status of NSDI.

(2) Land Act of Bhutan 2007

The Land Act (2007) was a law to manage, regulate, and handle the ownership and use of land and to preserve the country's socioeconomic development and environment. At the same time, it also intends to implement efficient and effective land management, guarantee of land leases, equal opportunities to land, facilitation of land market transactions, effective use of land resources, and preservation of ecosystems.

However, the act does not specify the requirements and development of NSDI, unlike the Survey Act of Japan.

(3) GI Policy

The GI Policy, developed by the CGI and its member agencies in 2018 was approved by the Cabinet in July 2018. It is driving each of the NSDI activities to achieve the following goals:

(1) To ensure availability of reliable geo-information
(2) To institute inclusive institutional and legal framework
(3) To enhance data discovery, accessibility and sharing mechanism without duplication or silos in operation
(4) To promote sustainable and optimal use of geo-information and technologies

To achieve the goals of the GI Policy, the GI Policy Action Plan was already developed by the C/P in 2018.

During the scope of this project, for Activity 1-1, the baseline, evaluation indicators, and timeline for each of the GI Policy Action Plan were reviewed together with the JPT.

The C/P took the initiative to review the policy statements and provided recommendations for the amendment of the GI Policy in the 13th FYP of NLCS.

(4) Rules and Regulations

Guidelines have been drafted to implement the GI policy. It mentions definitions and procedures for the specific implementation of the Policy Charter of the GI policy, including the members and roles of the NSDI's coordinating and promoting bodies that have a coordinating and promoting function.

(5) Geospatial Data Sharing and Single-Source-of-Truth (SSOT)

In the initial phase of the project, the C/P conducted geospatial data inventory and consultations on SSOT and data categorization among the working group level. Later a Standard Operating Procedure for data categorization and SSOT was developed by the C/P and accordingly, the SSOT was identified for each geospatial data through the endorsement of respective agency/department heads.

(6) Other related matters

Copyright of the maps has been addressed through Activity 2-3 "Data Management, Updating, and Sharing Framework" of the project in line with the Copyright Act of Bhutan.

2.1.2 NSDI promotion structure

The GI policy 2018 specifies the clear institutional set up and the roles and responsibilities of GHLC and TWG including the stakeholders.

These roles and responsibilities as the coordinating and facilitating bodies of NSDI are the most important foundations for achieving the project purpose as well as the overall goal.

Apart from the current implementation structure, one important aspect is to conduct the CGI member meeting at least once a year which is composed of the same level of decision-making. This enables effective and lively discussion and builds trust among the member agencies. Such practices will enable operational improvements in the promotion of NSDI in the future.

The leadership of the NLCS is important to ensure that the participating agencies of each meeting body are continually aware of their responsibilities and act accordingly.

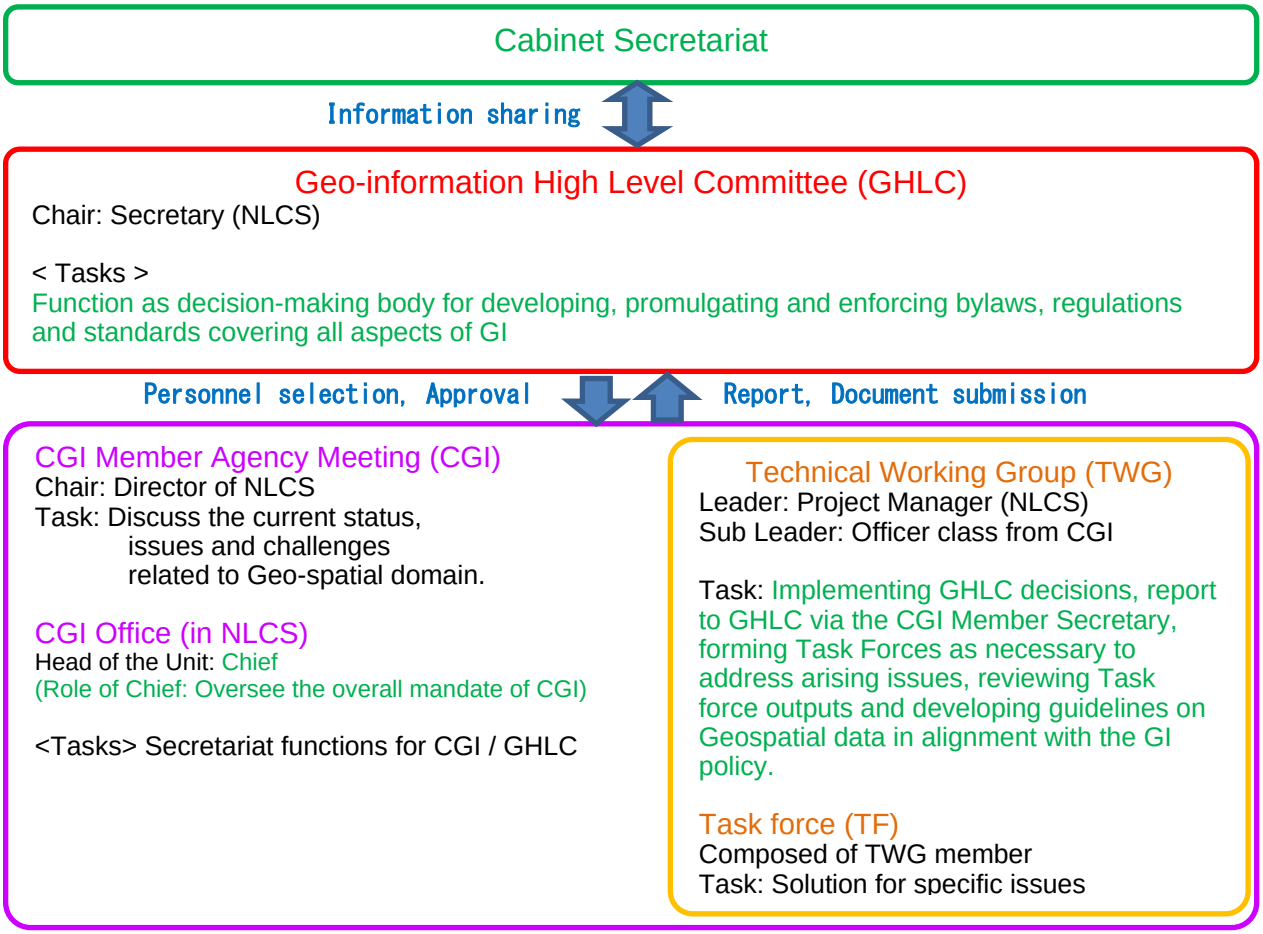


Figure 2.1.1 Example of NSDI Promotion Structure (Source: C/P and JPT)

(1) GHLC

GHLC is the steering committee and highest decision-making body of NSDI in Bhutan. As of December 2022, it was chaired by the Secretary of NLCS and consists of 9 other members, including directors of related organizations. The organization and members are still under consideration.

Table 2.1.1 GHLC Member List (As of December 2022)

#	Designation	Department	Ministry/Agency	Remarks
1	Hon'ble Secretary	-	National Land Commission Secretariat (NLCS)	Chairperson
2	Acting Secretary	-	GovTech Agency	Member
3	Director	Department of Geology and Mines (DGM)	Ministry of Energy and Natural Resources (MoENR)	Member
4	Director	Department of Forest and Park Services (DoFPS)	MoENR (former in Ministry of Agriculture and Forest)	Member
5	Director	Department of Local Government and Disaster	Ministry of Home Affairs (MoHA)	Member

#	Designation	Department	Ministry/Agency	Remarks
		Management		
6	Director	Department of Human Settlement (DHS)	Ministry of Infrastructure and Transport (MoIT)	Member
7	Director	Department of Survey and Mapping (DoSAM)	NLCS	Member
8	Director	-	Cabinet Secretariat	Member
9	Director	Department of Academic Affairs	Royal University of Bhutan	Member

Source：CGI Office

(2) CGI Member Meeting

The CGI Member Meeting is a meeting body under the GHLC, independent of the NLCS. It will be involved in all operations at NSDI and will be responsible for coordination between agencies. Members include not only government agencies, but also independent organizations (government agencies not affiliated with ministries) and private companies (including public corporations).

At the start of this project, there were approximately 36 institutions, but due to the reorganization of ministries and agencies, there are now 33 institutions, including private companies.

It is required to continue to hold regular meetings to identify issues, study countermeasures, and make adjustments, such as requests from related organizations regarding “Effective use of drones and Geographic Information.

Table 2.1.2 CGI Member Agencies

Ministry/Agency		#	Ministry/Department/Divisions
Autonomous Agencies		1	National Land Commission Secretariat (NLCS)
		2	Election Commission of Bhutan (ECB)
		3	National Statistics Bureau (NSB)
		4	Bhutan Standards Bureau (BSB)
		5	National Center for Hydrology and Meteorology (NCHM)
Ministry	Infrastructure and Transport (former Works and Human Settlement)	6	Department of Human Settlement (DHS)
		7	Department of Surface Transport (DoST)
	Agriculture and Livestock (former Agriculture and Forest)	8	Department of Livestock (DoL)
		9	National Soil Services Center (NSSC)
		10	Department of Agriculture (DoA)
		11	Agriculture Machinery and Technology Centre
	Energy and Natural Resources (former Economic Affairs)	12	Department of Geology and Mines (DGM)
		13	Department of Forest and Park Services (DoFPS)
		14	Department of Water
		15	Department of Energy
	Information and Communication (MoIC)	16	GovTech Agency
	Health (MoH)	17	Ministry of Health
	Home Affairs (former Home and Cultural Affairs)	18	Department of Local Governance and Department of Disaster Management (DLGDM)

Ministry/Agency	#	Ministry/Department/Divisions
Non-Governmental Organization	19	Royal Society for Protection of Nature (RSPN)
Corporation	20	Bhutan Telecom Limited (BTL)
	21	Bhutan Power Corporation Limited (BPC)
	22	National Housing and Development Corporation Limited (NHDCL)
	23	Druk Holding and Investment
Thromdes	24	Thimphu Thromde
	25	Phuntsholing Thromde
	26	Gelephu
	27	S/J Thromde
Academic Institutions	28	College of Science and Technology (CST)
	29	Jigme Namgyel Engineering College (JNEC)
	30	Sherubtse College
	31	Royal Thimphu College (RTC)
	32	College of Natural Resources (CNR)
Private sector	33	Kheychok GeoInfosys

Source：CGI Office

(3) TWG and Task Force

TWG will be formulated with selected members from CGI member agencies as an organization to technically address the diverse challenges of Geospatial Information in Bhutan. Direct consideration of individual issues will be handled by a Task Force to be established with members selected by the TWG.

The TWG will examine the results and proposals made by the Task Force, after confirmation of their validity, and then share them at the CGI member meeting. If decisions need to be made at a higher level, they are proposed to the GHLC and approval is required.

Table 2.1.3 Ideas of TWG Members

#	Designation	Agency
1	GIS Officer	DoDM (renamed DLGDM, MoHA)
2	Principal Forestry Officer	DoFPS (MoENR)
3	Sr. ICTO	GovTech Agency
4	Executive Engineer	Bhutan Standards Bureau (BSB)
5	Superintendent Survey Engineer	DGM (MoENR)
6	Dy. Chief Map Production Officer	NSB
7	GIS Officer	DHS (MoIT)
8	Superintendent Survey Engineer	NLCS
9	GIS Officer	CGI Office

Source：C/P

(4) Organizational structure of NLCS

The figure below shows the organizational chart of the NLCS, the central agency for promoting NSDI in Bhutan (departments that are strongly related to this project are indicated by bold line boxes). Within the NLCS, the central department for NSDI promotion, including topographic map data management, is the "Department of Survey and Mapping (DoSAM)". The CGI Office is in the Geo-Informatics Division (GID) below the department.

Within DoSAM, about 8 GIS technicians from the Topographical Survey Division handle the surveying and photogrammetric part of digital topographic map maintenance, while about 4 GIS technicians from the Geo-Information Division handle the symbolization and data management part. The movement of personnel between sections is fluid and flexibly adjusted according to the work.

NLCS has been conducting internships for students and sending lecturers to technical universities to train personnel and strengthen the organization through technical presentations within the organization and joint workshops with other agencies (GI policy, Geo-portals, satellite imagery, drones, E-sakor, etc.). Training by international donors is also conducted several times a year.

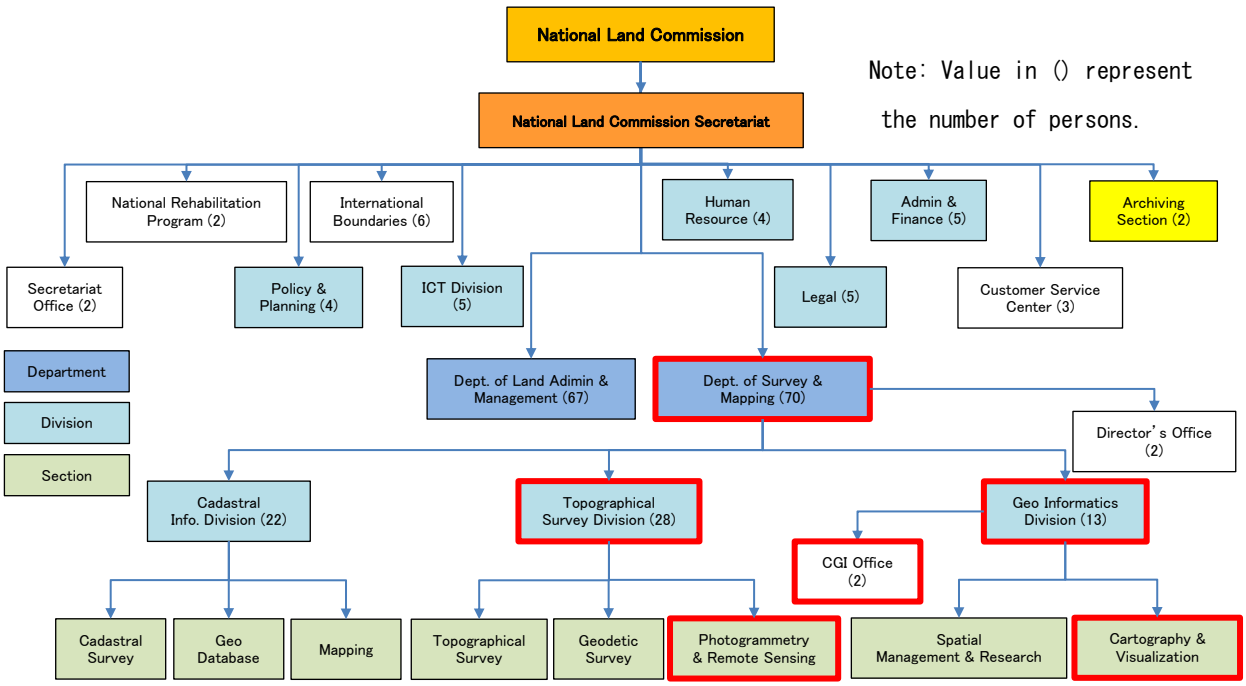


Figure 2.1.2 Organization Chart of the NLCS (Source: NLCS)

(5) Budget of NLCS

The table below shows the proposed budget for 2024 - 2025 of the NLCS. The budget for 2025 and beyond in the 13th Five-Year Plan is generally planned to be similar.

Also proposed are budgets for the promotion of NSDI and the expansion of the NSDI system.

Table 2.1.4 Proposed Budget of NLCS (2024 - 2025)

#	Expenditure		Budget (BTN)
1	BASE MAPPING OF THE COUNTRY	1:25,000 topographic map (satellite image procurement, GCP observation, mapping, approx. 5,000 km^2)	34,400,000
2		1:5,000 topographic map (satellite image procurement, GCP observation, mapping, 5 Dzongkhags)	
3		1:1,000 topographic map (field surveyed, 16 Gewogs)	
4		Procurement of Workstations (4 sets)	
5		Procurement of UAV with LiDAR Capacity (2 sets)	
6	ENHANCEMENT OF GEODETIC NETWORK IN THE COUNTRY	DRUKREF 2023 for the Datum Transformation CORS STATIONS ENHANCEMENT	34,844,000
7	DEVELOP NSDI AND STRENGTHEN GEOSPATIAL TECHNOLOGY	Management for Geospatial Data and NSDI system Develop Bhutan Standards for Geographic Information Strengthen Partnership and Create Awareness	28,696,000
8	ENHANCEMENT OF LAND SERVICE DELIVERY	Mainly services related to Cadastral work	18,497,000
9	ZONING		1,296,000
10	OTHERS		57,146,000
Total			174,879,000

Source：NLCS

2.1.3 Geographic Information Standards

At the start of this project, Bhutan had a GI policy but no common rules for the specific management of Geospatial Information. Through this project, the C/P and the JPT aimed to standardize 3 items for effective distribution and GI utilization through NSDI: detailed description of GI content, Metadata-based search, and Data Quality Control. This standardization is based on ISO.

Following the guidance of the BSB, it was decided to establish a Bhutan National Standards using the ISO as the original standard, with no technical changes, and to separately develop draft guidelines for practical operation in the country. In addition, a subcommittee was established to study national standards for GI.

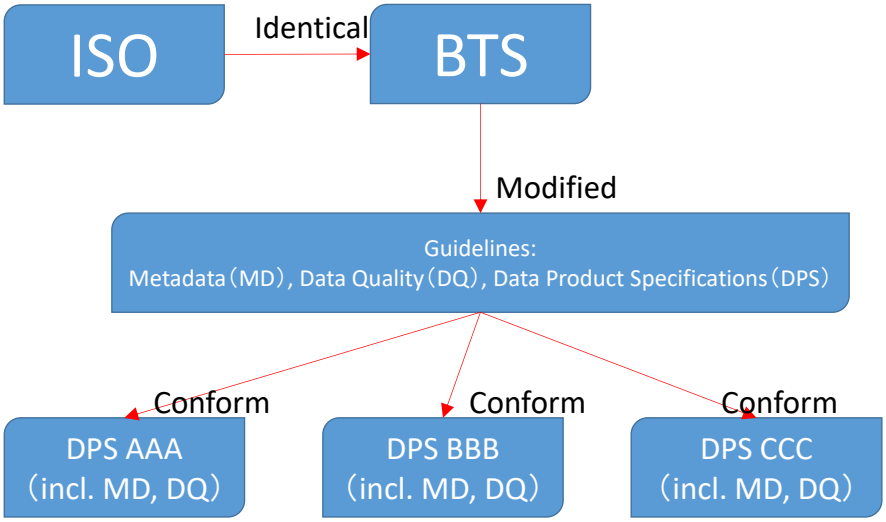


Figure 2.1.3　Relationship among ISO, Bhutan Standards for GI (BTS), Guidelines (Source: JPT)

(1)　Established Standards

The promotion of mutual use of Geospatial Information was achieved through the development of 3 common rules: "Data Product Specifications" that define the contents of GI in detail, "Metadata" for searching GI, and "Data Quality (DQ)" that ensures the quality of GI.

The activities proceeded as follows.

- The first step in the activity was to establish common rules for metadata. Based on the list of metadata in the appendix of the GI Policy Guidelines and the ISO 19115-1 Metadata, mandatory and optional items that match the actual situation in Bhutan were extracted. After consulting with related agencies, the NLCS took the initiative in developing draft guidelines for metadata.
- A draft metadata BTS was submitted to the BSB as a new work item along with the draft metadata guidelines in January 2024.
- The BSB and NLCS have been working to establish a subcommittee on GI for the Bhutan National Standards, and the first meeting of the subcommittee took place in August 2024. At the subcommittee meeting, the NLCS explained the contents of the draft BTS and the draft guidelines. Then consensus was reached to have the matter reviewed by a higher-level technical committee.
- In parallel with the work on metadata, a review of the content of ISO and the development of draft guidelines were conducted for “DPS” and “DQ” in the same way as for metadata. Draft guidelines have been outlined for “DPS” and “DQ”.

The NLCS plans to submit the two standards simultaneously as new work items to the subcommittee on GI. In addition, GI based on the above three standards will be developed. National standardization of other standards will be discussed at CGI member meetings based on the needs of the agencies concerned.

Table 2.1.5 Established GI Standards

#	GI Standards	Current Status
1	Metadata	It was decided that the draft BTS and draft guidelines would be discussed and confirmed by the subcommittee on GI and proposed to the higher-level Technical Committee.
2	Data Products Specifications	Reviewed draft BTS and developed draft guidelines.
3	Data Quality	Reviewed draft BTS and developed draft guidelines.

Source：C/P and JPT

(2) Relationship between GI Standards and data interoperability

The development of GI Standards as Bhutan's national standards based on ISOs is expected to promote the distribution and utilization of GI in Bhutan and abroad.

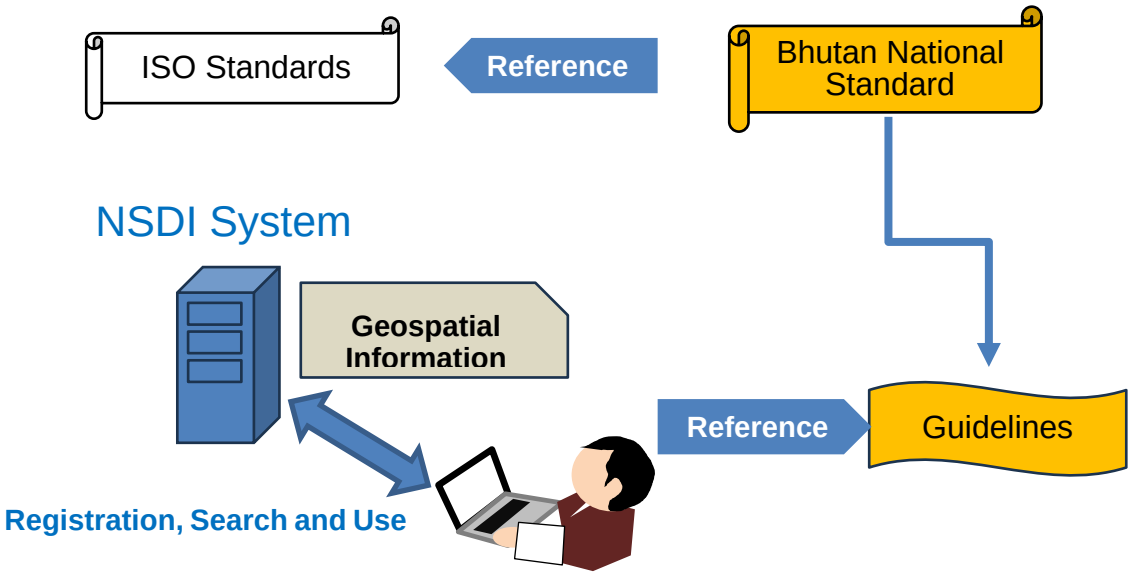


Figure 2.1.4 Relationship between GI Standards and Data Interoperability (Source: JPT)

(3) Relationship between National Standards and International Standards (ISO Standards)

As mentioned above, the Bhutan Standards for GI is technically identical to the ISO Standards. However, it has been adjusted to a level of compliance that contributes to the promotion of the distribution of Geospatial Information through the NSDI system such as the omission of UML class diagrams and the introduction of flexibility in coding, etc., to suit Bhutan's current situation.

- With regard to "DPS", ISO require "UML class" for the description of data content and structure, but the Guidelines substitute a list of names and definitions of feature attributes.
- Decided not to use XML in product specifications.
- ArcGIS Geodatabase and shapefiles are used for encoding, rather than XML/GML.

Although the relaxation of these conditions meant that the GI complying with the guidelines does not include data structure descriptions using UML class diagrams or encoding in XML/GML as used in ISO standards; however, priority was given to promoting the distribution of GI in Bhutan through the NSDI system.

2.1.4 NSDI system

The GI Policy 2018 envisions the creation of a Geo-Portal as a single, unified platform for managing and sharing geospatial data. To achieve this, the National Land Commission, in collaboration with International Centre for Integrated Mountain Development (ICIMOD), initially developed a Geo-Portal. However, due to technical issues, the system became non-functional.

In response, the current NSDI project prioritized building a new system without a designated budget. The counterpart team developed the NSDI system internally, utilizing ArcGIS Enterprise along with custom coding for the user interface. However, some functionalities, such as an intermediate database, could not be implemented, which enables the system's data versioning capabilities and makes tracking changes over time or maintaining historical data. Realizing these functionalities should be discussed for the future improvement of the NSDI system.

Additionally, technical issues including scalability largely rely on the vendor (ESRI India), so further understanding and acquiring skills on the system development and administration side will enhance the smooth operation of the NSDI system.

The system integrates data from various data-producing agencies through an agreed framework, including the GI Management, Sharing, and Update Framework, the NSDI System Operational Manual, SOPs for Data Categorization and the SSOT.

(1) Functions of the NSDI system

The following is a description of the Functions of the NSDI system. In the first session, functional requirement definition was explained, and from the second session onward, images and requests from the C/P were compiled into a requirement definition.

The First Session:

- Presentation on what is a functional requirements definition, explaining the importance and content of functional requirements (including non-functional requirements).
- Since it was difficult to come up with immediate ideas for what to include in the requirements document, the first step was to create a list of functions by referring to existing examples of similar services (Sri Lanka, Los Angeles, etc.).

The Second Session:

- Include the function to specify the area on the map where the user wants to download the map and cut it out (NLCS request).
- The requirements (drafts) listed as a list of functional requirements were checked one by one,

and it was determined that the functions considered necessary in the initial version were covered.

- The handling of XML will be decided based on the ideas in the activities (1-3) of the GI Standards.

The Third Session:

- Reviewed ideas of forms to be used in the functional requirements study. Since it is easier for C/P to proceed with the discussion if the functional classification is not classified in detail, only one level of classification was used.

The Forth Session:

- A review of the requirements document with non-functional requirements was conducted. The following revisions were completed.
  - The system will be realized in a single server configuration of ArcGIS Enterprise.
  - Items involving system customization (coding level) were not included due to budget and development resource limitations in this project.

Table 2.1.6 NSDI System Specifications and Functions

#	Type	Functional Requirements	#	Type	Functional Requirements
1	Top page	Home page, Links, NSDI information, etc.	15	Data	Content download
2	Map	Zoom IN/OUT Move, etc.	16	Data	Data search
3	Map	Layer ON/OFF	17	Data	Operation by User type (Register, Edit, Browse)
4	Map	Basemap Selection	18	User	User registration/Deletion
5	Map	Measurement (Distance, Surface area)	19	User	Registration of data administrator
6	Map	2D display	20	User	Log
7	Map	3D display	21	User	Data registration, deletion, and publication settings
8	Map	Feature selection	22	User	Setting access control for data collector
9	Map	Attribute display (pop-up)	23	User	Adding and deleting data acquirers
10	Map	Attribute display (table)	24	User	Registration and deletion of non-public data
11	Map	Scale display	25	User	Browsing and download of data
12	Map	Thematic drawing	26	User	Access control
13	Map	Image output (jpeg, pdf, etc.)	27	User administration	Sending e-mail to newly registered user
14	Data	Metadata registration	28	User administration	Password registration

Source：C/P and JPT
Note1) 3D display: 3D data will not be prepared for NSDI
Note2) Map: will be done by using other apps. Or do it without saving maps? Users do not have their accounts to save their maps. Download data -> create thematic maps with their own desktop / Web GIS.
Note3) User administration: users are not given their own ID/Password. They can access the system with no ID/Password

(2) Data managed by the NSDI System

About 58 data were registered from 11 agencies and about 15 data (82 layers) were released as downloadable data at the completion of the project.

Table 2.1.7 Examples of Data Managed by the NSDI System

#	Data Layer	Responsible Agency	Data Category	Number of Downloadable Layers
1	Medium Voltage Points	BPC	Common	
2	High Tension Points		Common	
3	Low Voltage Points		Not Assigned	
4	JOINTBOX	BTL	Not Assigned	
5	Pole		Not Assigned	
6	Hydropower Components	Department of Energy (MoENR)	Restricted	
7	Power System Master Plan 2040		Restricted	
8	Potential Solar Sites		Restricted	
9	Biological Corridor	Department of Forests and Park Services (MoENR)	Common	
10	Land Use Land Cover 2016		Common	
11	Conservation Parks		Common	
12	Key Biodiversity Area		Common	
13	Ramsar Site		Common	
14	Urban centers and towns for taxation	Department of Human Settlement (MoIT)	Not Assigned	
15	Buildings		Open	1
16	Dzongkhag Boundary	Department of Local Governance & Disaster Management (MoHA)	Not Assigned	
17	Water source	Department of Water (MoENR)	Common	
18	PES Site boundary		Common	
19	186 Watershed boundary		Open	1
20	National Highways of Bhutan	MoIT	Open	1
21	Topography 25k	NLCS	Open	61
22	Building footprint		Open	1
23	Topography 50k		Open	8
24	Secondary Control Points		Open	1
25	Chiwog Boundary		Open	1
26	Cadastral Boundary		Common	
27	Benchmarks		Open	1
28	Dzongkhag Boundary		Open	1
29	First Order Stations		Open	1
30	Education Centers		Open	1
31	CORS Stations		Common	
32	Gewog Boundary		Open	1
33	Geographic Names		Open	1
34	International Boundary		Open	1
35	Zero Order Stations		Restricted	
36	National Soil Map of Bhutan	National Soil Services Centre (MoAL)	Common	
37	Soil Total Exchangeable Bases Map of Bhutan		Common	
38	Soil Base Saturation Map of Bhutan		Common	
39	Available Soil Phosphorus Map of Bhutan		Common	
40	Soil Exchangeable Potassium Map of Bhutan		Common	
41	Soil Exchangeable Sodium Map of		Common	

#	Data Layer	Responsible Agency	Data Category	Number of Downloadable Layers
	Bhutan			
42	Soil Total Clay Map of Bhutan		Common	
43	Soil Total Sand Map of Bhutan		Common	
44	Total Soil Nitrogen Map of Bhutan		Common	
45	Soil pH Map of Bhutan		Common	
46	Soil Organic Carbon Map of Bhutan		Common	
47	Soil Exchangeable Calcium Map of Bhutan		Common	
48	Available Soil Potassium Map of Bhutan		Common	
49	Soil Cation Exchange Capacity Map of Bhutan		Common	
50	Soil Exchangeable Magnesium Map of Bhutan		Common	
51	Soil Total Silt Map of Bhutan		Common	
52	Soil Bulk Density Map of Bhutan		Common	
53	Total Soil Nitrogen Map of Bhutan		Common	
54	Soil Cation Exchange Capacity Map of Bhutan		Common	
55	Soil Exchangeable Calcium Map of Bhutan		Common	
56	Soil Exchangeable Potassium Map of Bhutan		Common	
57	Footpath thimphu thromde	Thimphu Thromde	Not Assigned	
58	Thromde Data as of_14_10_24		Not Assigned	

Source：CGI Office

(3) Other (System Management Structure)

The management structure of the NSDI system is shown in the table below. In addition, the JICA expert proposed to the C/P that it is also necessary to appoint a general manager or other person in charge of the NSDI system, and presented an image of the management structure.

Table 2.1.8 System Management Structure

#	Agency	Role	Remarks
1	CGI (NLCS)	System development	
2	CGI (NLCS)	NSDI system operation and management	
3	CGI (NLCS)	NSDI training operations	
4	GovTech Agency	Server infrastructure management	
5	NLCS and external agencies	Data management	Management of data published by the organization

Source：C/P and JPT

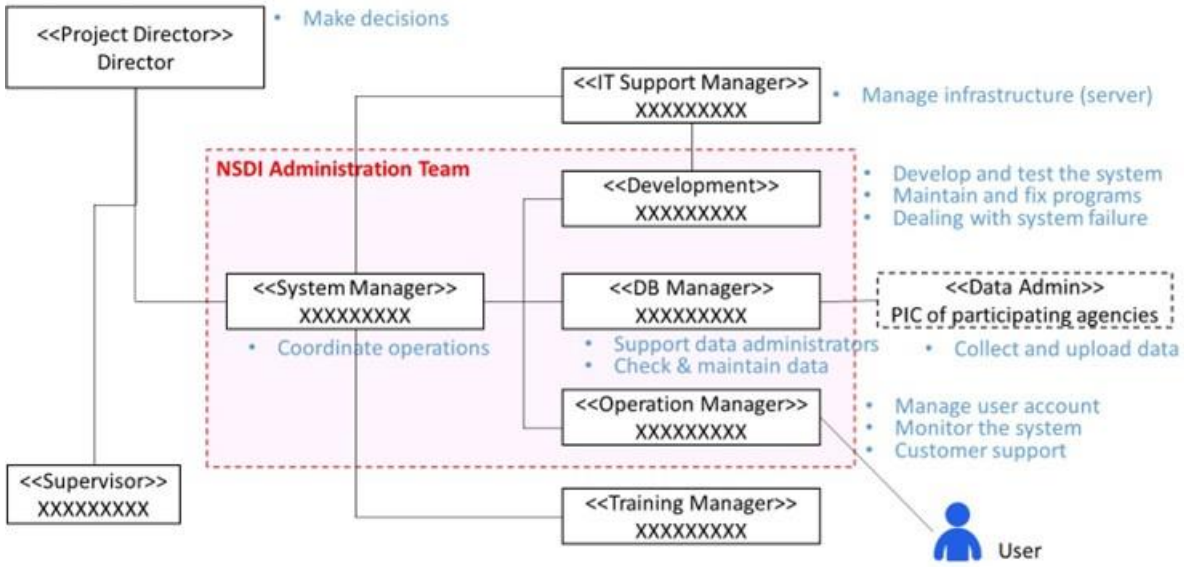


Figure 2.1.5 Image of the Management Structure and Roles of the NSDI System (proposed)
(Source: JPT)

2.2 Current status of “Maintenance”, “Updating”, “Management” and “Utilization” of digital topographic maps in Bhutan

2.2.1 Standards of surveying

The reference coordinate system for Bhutan is “DRUKREF_03_Bhutan_National_Grid” shown below. In addition, the height reference is “DRUK geoid 2022”.

Table 2.2.1 Coordinate System Referenced in Bhutan

#	Items	Contents
1	Projected Coordinate System	DRUKREF_03_Bhutan_National_Grid
2	Projection	Transverse Mercator
3	False Easting	250000.00000000
4	False Northing	0.00000000
5	Central Meridian	90.00000000
6	Scale Factor	1.0
7	Latitude of Origin	0.00000000
8	Linear Unit	Meter
9	Geographic Coordinate System	GCS_DRUKREF_03
10	Datum	D_Bhutan_National_Geodetic_Datum
11	Prime Meridian	Greenwich
12	Angular Unit	Degree
13	Reference Ellipsoid	GRS_1980

Source：NLCS

2.2.2 Digital topographic maps

(1) 1:50,000 and 1:25,000 digital topographic maps

1) History of support for the development of 1:50,000 and 1:25,000 topographic maps

The 1:50,000 topographic maps covering approximately 90% of the country were developed in the 1960s with the support of India, and are still in use as printed maps or raster data. A portion of 1:25,000 (8 map sheets, about 1,400 km^2) was also developed with Indian assistance during the same period.

JICA provided stereo satellite imagery covering approximately 11,000 km^2 of the southern region in "Project on Development of National Geo-Spatial Data" (hereinafter JICA Project 2015 - 2017), and prepared 1:25,000 digital topographic maps of approximately 9,870 km^2 of the area. The remaining area of approximately 1,130 km^2 was a pilot area where on-the-job training for NLCS technicians was conducted, resulting in the development of 1:25,000 digital topographic maps for approximately 11,000 km^2 of the southern region in 2017.

An eight-year WWF-supported project, starting in 2020, provided stereo satellite imagery covering approximately 10,000 km^2 of western and northwestern Bhutan. Since then, NLCS is currently preparing 1:25,000 digital topographic maps, utilizing the know-how transferred under the "JICA Project 2015 - 2017".

"JICA Grant Aid Project" will provide 1:25,000 digital topographic maps in 2025, based on stereo satellite images covering approximately 17,000 km^2 in the central region.

Table 2.2.2 History of Support for 1:50,000 and 1:25,000 Topographic Mapping in Bhutan

#	Donner	Period	Contents of Support
1	Government of India	1960s (partially updated in 1990)	Approximately 33,500 km^2 of 1:50,000 analog topographic maps and 1,400 km^2 of 1:25,000 analog topographic maps were prepared by stereo aerial photography. Provision of equipment is unknown.
2	JICA "Project on Development of National Geo-Spatial Data"	2015 - 2017	Target area: Southern region approx. 11,000 km^2 Provision of approximately 9,870 km^2 of 1:25,000 digital topographic maps and approximately 1,130 km^2 of pilot training/ Provided 8 sets of Stereo workstations and 1 A0 size printer.
3	WWF	2020 - 2028	Provision of stereo satellite images. Provision of a few sets of Stereo workstations.
4	JICA Grant Aid Project	2021 - 2025	Providing stereo satellite images and 1:25,000 digital topographic maps of approximately 17,000 km^2 in the central region.
5	This project	2022 - 2024	Provision of stereo satellite images of approximately 2,700 km^2 of the eastern region. Pilot training on approximately 1,200 km^2 of 1:25,000 digital topographic maps (complementary technology transfer for a previous "JICA project 2015 - 2017"). Provided 2 sets of Drones and 5 sets of Tablet PCs for field survey.

Source：JPT

2) Status of 1:50,000 digital topographic maps and 1:25,000 topographic maps

As mentioned above, although raster data or paper-based 1:50,000 topographic maps have been used for many years as base maps covering most of the territory of Bhutan, by JICA support through the ”Project on Establishment of National Geo-Spatial Data Infrastructure for Bhutan (2015 - 2017)”, “The Project (2019 - 2025)”, “JICA Grant Aid Project (2021 - 2025)”, approximately 90% of the country, excluding northern Bhutan, will be covered by 1:25,000 vector data by May 2025.

According to “SAZHI 2034 (A 10-YEAR STRATEGIC PLAN FOR LAND SECTOR: 2024 - 2034, NLCS)”, the remaining area will be serviced by the NLCS in the period 2025 - 2029.

The status of 1:25,000 topographic map development is shown in Figure 1.2.1 and Figure 2.2.1 (Chapter 1.2.4).

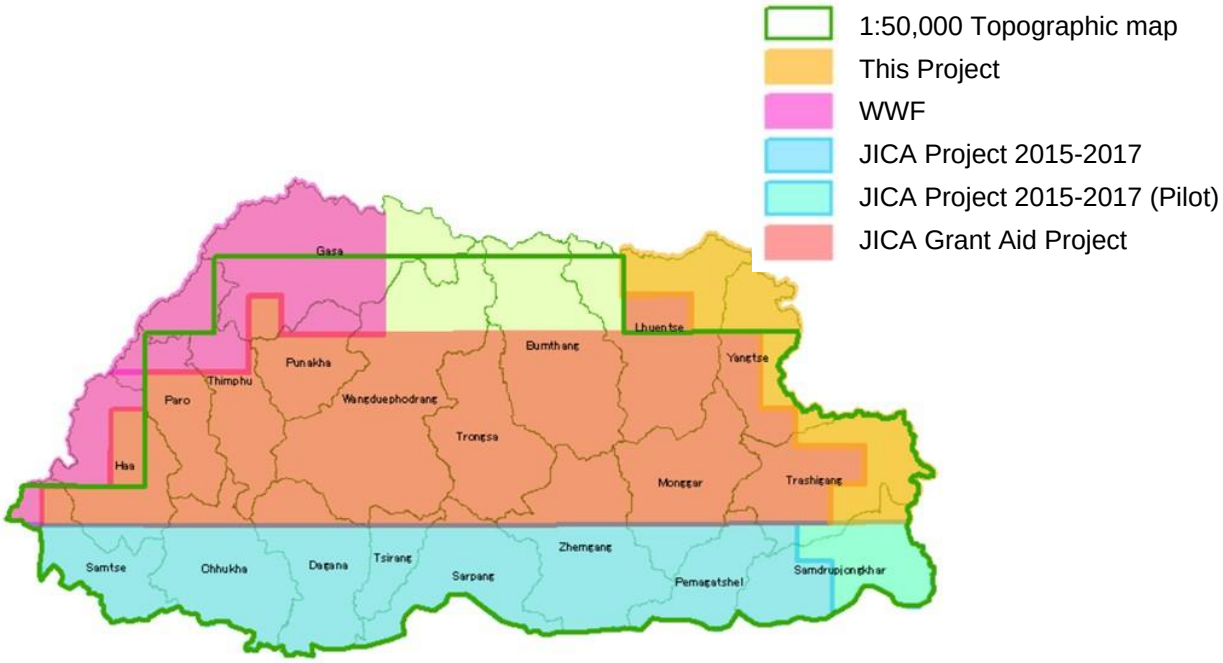


Figure 2.2.1 Preparation Status of 1:50,000 and 1:25,000 Topographic Map (Source: NLCS and JPT)

The developed 1:25,000 topographic maps will be shared as vector data with stakeholders, including private agencies, via the NSDI system in the future, It is expected to serve as basic data for various national-level plans, and the results of its measurement and analysis will lead to the improvement of various services and the creation of new services.

For example, NLCS provided the Department of Tourism (MoFA) with 1:50,000 topographic maps and technical support for course reviews for the Snowman Race, an event that began in 2022 and will be held annually from now on, with many international participants.

In the future, 1:25,000 digital topographic maps may be used, and tools related to tourism using Geospatial Information may be developed.

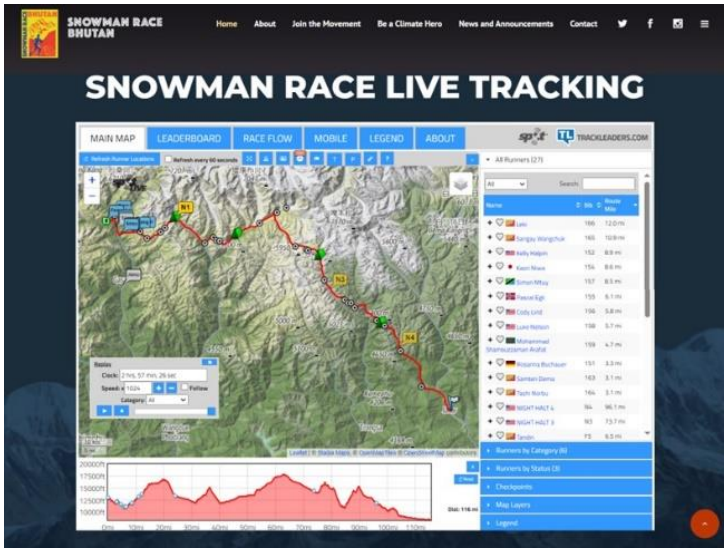


Figure 2.2.2 Course of the Snowman Race 2024 (Source: Snowman Race Secretariat Web Page)

(2) 1:5,000 topographic maps

The 1:5,000 digital topographic maps, which are mainly used for development planning in urban areas, will be prepared for approximately 400 km^2 by May 2025 as part of the “JICA Grant Aid Project”.

In addition, a 1:5,000 digital topographic map of approximately 240 km^2 of the Samtse area, for which DEM and satellite imagery ("Pleiades Neo" stereo pair or orthophoto) were provided in the project, will be prepared by the NLCS by 2029.

Figure 2.2.3 Preparation Status of 1:5,000 Topographic Map (Source: NLCS and JPT)

(3) Large-scale topographic maps

NLCS has produced approximately 3.2 km^2 of digital topographic maps at the scales of 1:500 and 1:1,000, using Drones provided in the project and existing total stations and other equipment.

Some of the areas have been developed through outsourcing, which includes covering the cost of on-site work from stakeholder agencies, and a financially sustainable mapping system is being put in place.

This method is expected to be used not only for the maintenance and updating of large-scale topographic maps, but also for updating 1:5,000 topographic maps through reduced-scale compilation.

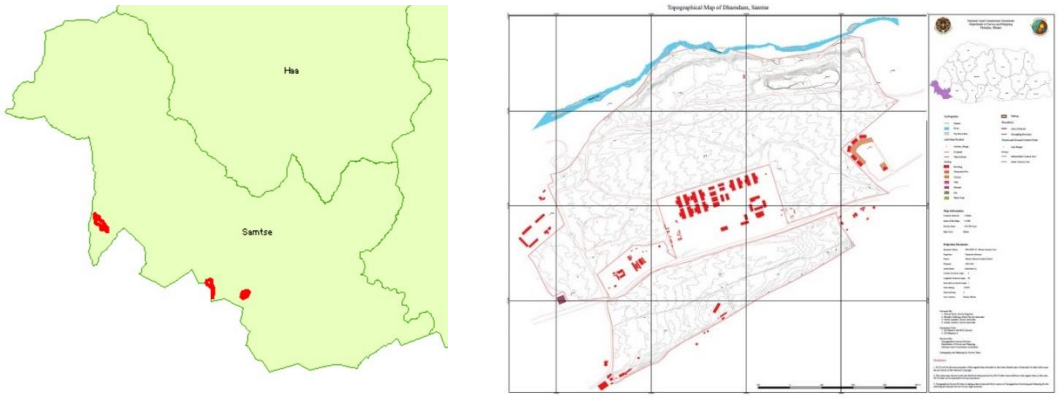


Figure 2.2.4 Mapped Areas by Drone (Red line in the Left) and Topographic Map (Right)
(Source: NLCS and JPT)

2.2.3 National geodetic points

(1) CORS

At the beginning of this project, there were 6 points, but they were later added by the NLCS, bringing the total to 14 points. NLCS issues IDs and passwords to users for a fee and provides distribution services and technical support.

(2) 0 order, 1st order, 2nd order geodetic network and benchmarks

There are 6 points of “0 order Stations” (1 point lost) whose coordinates were calculated by simultaneous observation with the International GNSS Service (IGS) Permanent Station. There are 33 points of 1st order stations observed based on class 0 order stations. Many Secondary control points are located around residential areas, mainly for use in cadastral surveying (more than 2,700 points).

The "benchmarks" were inspected and surveyed by NLCS from 2021 to 2023 and the results are currently being verified.

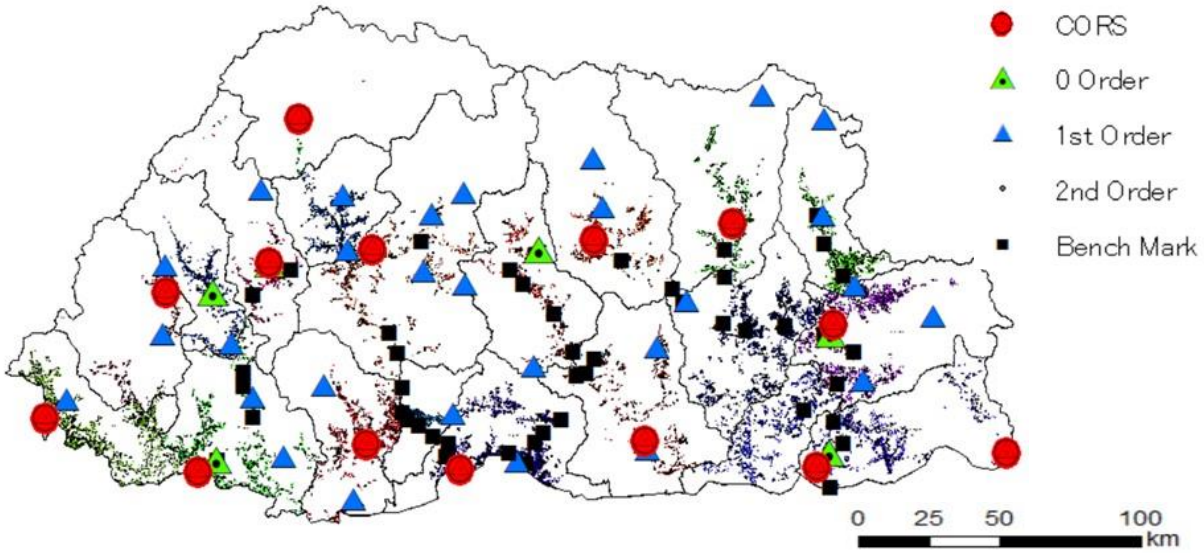


Figure 2.2.5 Geodetic Network (Source: NLCS and JPT)

Photo 2.2.1 National Geodetic Points (From Left: CORS, 0 and 1st order, 2nd order, Benchmark)

2.2.4 Equipment

The equipment used by NLCS to create digital topographic maps is listed below.

Table 2.2.3 Equipment Used by NLCS to Create Digital Topographic Maps

#	Equipment	Quantity	Remarks
1	Total Station	6	
2	GNSS receiver	9	
3	Digital Level	3	
4	RTK equipment	8	Base: 8, Rover: 8
5	Stere Workstation	5	Provided in the JICA project 2015 - 2017
6	Photogrammetric software	1	NLCS plans to procure 4 sets in 2024 - 2029
7	Stereo software	5	
8	Drone	With LiDAR sensor: 1 Without LiDAR sensor: 1	Provided in this Pproject NLCS plans to procure 2 sets of drones with LiDAR sensors in 2024 - 2029
9	Drone processing software	1	Provided in this project
10	Drone processing PC	1	Provided in this project

Source：NLCS

(1) Stereoscopic workstation

Five sets of Stereo workstations are currently in operation at NLCS. Most of the equipment was procured in 2015, and although several pieces of equipment show slow processing speeds due to breakdowns and wear and tear, NLCS plans to procure 4 sets of stereo workstations during the 13th FYP.

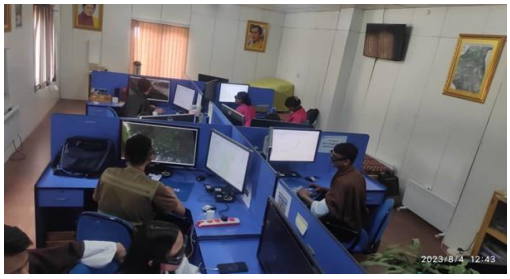


Photo 2.2.2 Mapping Laboratory in NLCS (Left) and Stereo Plotter (Right)

(2) Drones

NLCS manages 1 medium-sized drone and 1 large drone equipped with LiDAR sensors. Some of CGI member agencies other than NLCS also manage Drones.

With the development of 1:25,000 digital topographic maps covering most of the country as base maps, and the development of 1:5,000 digital topographic maps of major cities, the NLCS is expected to continue to implement partial updating of base maps and new and updated large-scale topographic maps for Bhutan to retain “reliable and accurate Geospatial Information” in the future.

NLCS has been conducting cadastral surveys for a long time and specializes in field surveying around residential areas with Total Stations and GNSS surveying equipment, and the addition of Drones alongside this equipment enables NLCS to acquire more data in the field more efficiently than before. In fact, large-scale topographic map data was created by Drones in the project, and it was seen that the technology can be implemented without increasing the NLCS engineers' processes in topographic mapping and at about half the time and cost of conventional methods.

Table 2.2.4 Comparison of Surveying Using Conventional Methods and Drones (Area: 1.6 km^2)

#	Items	Days		Cost (BTN)	
		Conventional method	With Drone	Conventional method	With Drone
1	Operators (including drivers)	43	21	723,000	357,000
2	Inspection of field work	7		17,500	
3	Instrument charge				120,000
4	Processing of data			5,000	10,000
5	Transportation / hire vehicle (2 vehicles) or fuel			300,000	57,604
6	Field liveries			350,000	27,000
Total		50	21	1,395,500	571,604

Source：NLCS

Currently, drone flight and filming permits can be obtained within a week after submitting a letter and fee to the Civil Aviation Authority with information on “Duration of work”, “Cultural / Security / Environmental protection zone”, and scope and area of work.

Photo 2.2.3 Drones Provided for this Project (Left) and Processing Software (Right)

2.2.5 Geospatial information management status

(1) GI management in agencies of the Royal Government of Bhutan

A survey was conducted to assess the current data management and sharing practices across various agencies. The findings reveal that most agencies lack formalized data management and sharing protocols.

Data is typically stored on individual PCs, and sharing occurs only upon user request, facilitated via email or shared drives. Additionally, there is no standardized data categorization across agencies (i.e., open, common, or restricted), resulting in inconsistent classification prior to data sharing. A figure generated from the survey illustrates these data management and sharing processes in detail.

The following diagrams are the summary of the results of the interviews regarding the status of GI data management at Agency 1 (Figure 2.2.6) and Agency 2 (Figure 2.2.7).

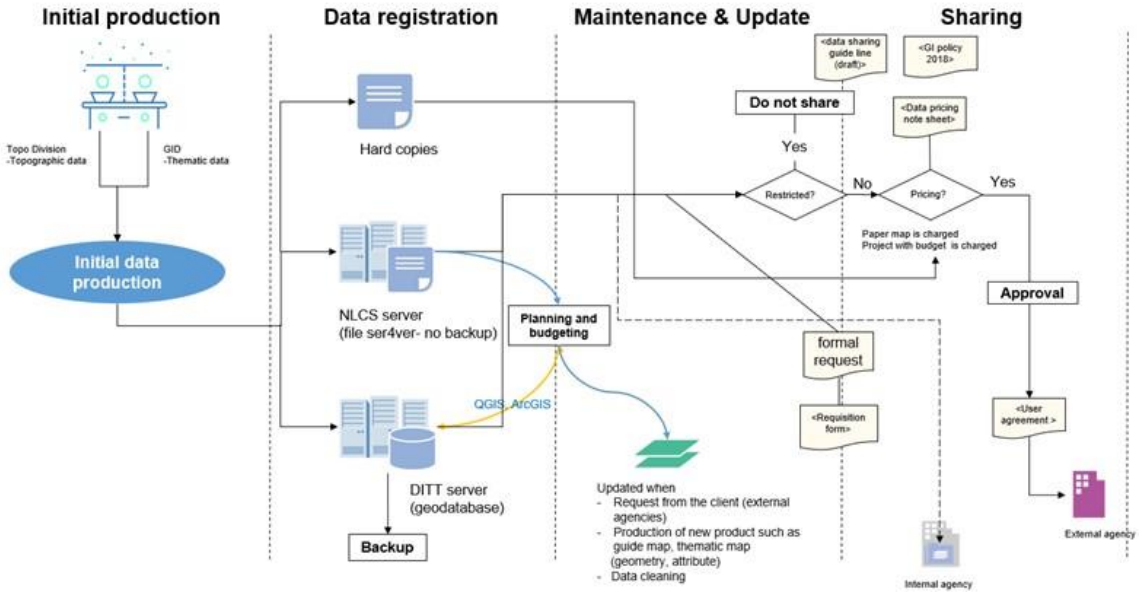


Figure 2.2.6 GI Management with Agency 1 (Source: C/P and JPT)

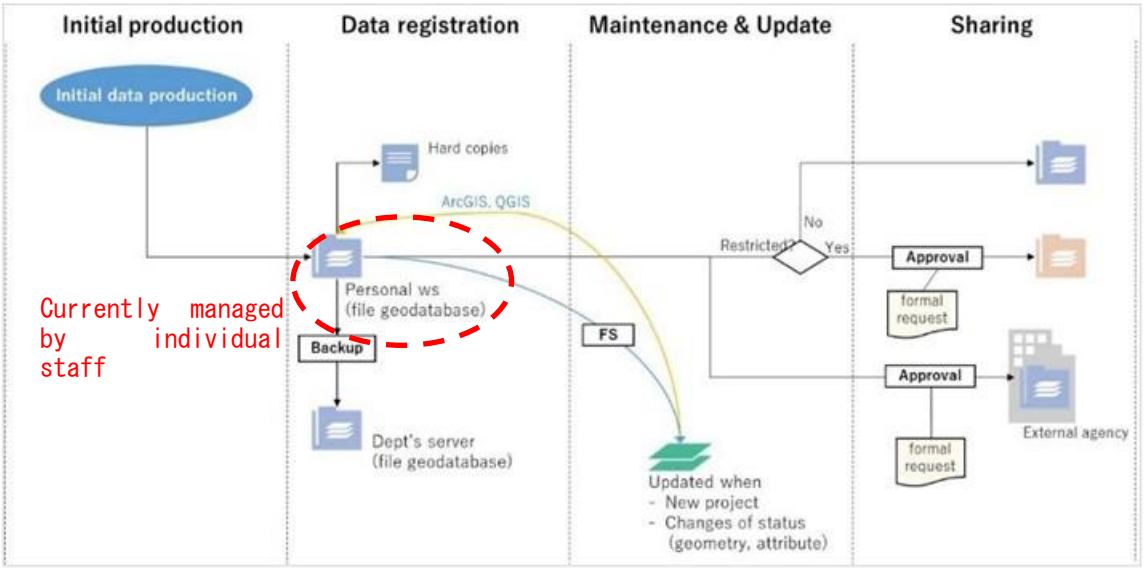


Figure 2.2.7 GI Management with Agency 2 (Source: C/P and JPT)

(2) Status of GI Management in NSDI systems

Each member agency is mandated to carry out SSOT implementation and data classification as per the Standard Operating Procedure developed by the Center for Geo-Information for all data in their custody before uploading the data in the NSDI system. Member agencies are responsible for maintaining all data for which they are the designated SSOT. They shall create and maintain Metadata in the NSDI system as follows:

1. For Restricted data, the agency shall not upload the data to the system but shall upload metadata for public viewing.
2. For Common data, the agency shall upload both the data and metadata to the NSDI system; however, the data shall not be available for public download.
3. For Open data, the agency shall upload both the data and metadata to the NSDI system, making available for public viewing and downloading the data.

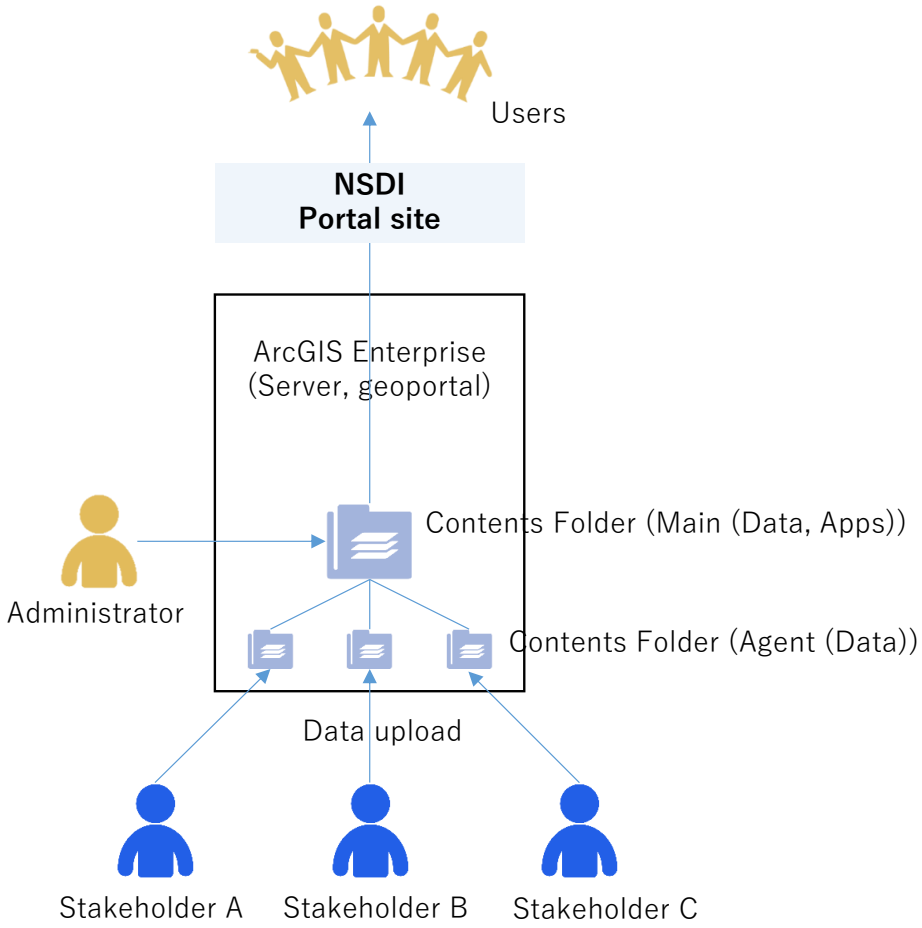


Figure 2.2.8 Image of Data Management in NSDI System (Source: C/P and JPT)

2.2.6 Status of utilization of Geospatial Information

(1) Capacity of GI utilization

The GIS Tools training covered the use of “WebGIS cloud”, “Mobile GIS”, and the creation and utilization of “Dashboards”. Details regarding the participants, training duration, anticipated benefits, and training modules are provided below (refer to the attached figure). The training aimed to build the capacity of trainers who, upon completion, were equipped to disseminate this knowledge within their respective agencies.

(2) Status of utilization

The following is a list of actual or planned post-project uses of Geospatial Information identified during this project that NLCS has provided to relevant agencies (including NLCS).

Table 2.2.5 Actual and Planned Utilization

#	Work and Utilizing Agencies	Region/Area	Data Provided	Provision Period	Use Case
1	New Town Planning (MoIT and Samtse Dzongkhak)	Tashicholing Belboti town (1.6 km^2)	1:1,000 topographic maps by Drone and Total Station (TS)	2024 March - April	Zoning for local area plan
2	New Town Planning (MoIT and Bhumtang Dzongkhak)	Bhumtang (5 km^2)	Ditto	2024 Aug - Sep	Ditto
3	Gelephu Mindfulness City (DHS)	Gelephu - Sarpang	A set of NLCS-owned data for the area, (1:25,000 topographic maps, satellite images, cadastral data, etc.)	2023	Creation of thematic maps with satellite images in the background
4	Linked Urban Centre (DHS)	Phuntsholing - Samtse (240 km^2)	DEM, satellite orthophotos, 1:5,000 topographic maps	2025 - 2029	Zoning for urban planning
5	Rehabilitation Program (NLCS)	All areas of Bhutan	DEM, 1:25,000 topographic map	2024	Survey of land available for residential development
6	Food Security Skilling (Gyalsung Program)	Around GMC Area	1:1,000 topographic maps by Drone & TS	2024	Structure planning
7	Snowman Race (Department of Tourism, MoFA)	Paro - Thimphu	1:50,000 topographic maps and technical support	2022 - 2023	Setting up trekking courses

Source：NLCS

Chapter3 Project Activities and Results

3.1 Japanese and Bhutanese input results

3.1.1 Japanese and Bhutanese input

(1) Input results of JICA experts

The following is a list of the results of the input of JICA experts.

The project was implemented by a Joint Venture consisting of PASCO Corporation and Kokusai Kogyo Co., Ltd.

The actual M/M is (Total: 38.78 M/M, in Bhutan: 30.48 M/M, in Japan: 8.30 M/M) compared to the planned M/M for all experts (Total: 38.68 M/M, in Bhutan: 31.77 M/M, in Japan: 6.91 M/M). The ratio of M/M in Japan to M/M in Bhutan increased compared to the original plan due to delays in travel to Bhutan due to COVID-19 and increased reassignments from Bhutan to Japan to increase the preparation for activities in Bhutan. Finally, the planned M/M were consumed without negatively impacting the quality or quantity of activities.

Table 3.1.1 Input Results of JICA Experts

#	Activity	Name of Expert	Operating Results (MM)		
			In Bhutan	In Japan / Online	Total
1	NSDI basic plan/ Digital topographic map establishment plan / Project leader	OTA Akira	5.40	1.64	7.04
2	Buildup of coordination of agencies	HATORI Tomohiko	2.00	0.60	2.60
3	Geographic Information Standards	HATORI Tomohiko	4.03	0.45	4.48
4	Utilization Promotion and Action plan of Geospatial Information	NAKANISHI Taira OCHI Ayako	3.70	1.60	5.30
5	NSDI ICT services	CHIBA Zenichi	0.67	0.60	5.08
		HOMMA Katsuya	3.36	0.45	
6	Digital topographic map creation / Human resource development	SATA Nobuhiro	4.29	0.60	4.89
7	GI Management / GIS Tools	HOMMA Katsuya	3.50	2.02	5.52
8	Training plan / Coordinator	SATO Kei	3.53	0.34	3.87
Total			**30.48**	**8.30**	**38.78**

Source：JPT

(2) Input equipment and materials

The equipment deployed during the project is listed below.

Although there were some changes in equipment specifications and procurement quantities from the original plan due to requests from C/P and the shortening of the operation period in Bhutan due to COVID-

19, all required equipment for all activities agreed with C/P was procured.

Although the procurement of equipment related to the server was delayed by about 2 months from the original plan, training and development were carried out using the existing server during the period until the server was procured so that activities would not be delayed.

Table 3.1.2 Materials and Equipment Procured

Equipment and Materials		Specifications, etc.	Quantity	Remarks
No.1	Desktop computer	For Equipment and Materials No.3 – No.7	3	
No.2	UPS	For Equipment and Materials No.1	3	
No.3	Office software	For document creation	3	
No.4		For document editing	3	
No.5		Anti-virus software	1	For No.1, No.21
No.6	UML modeling tool	For Geographic Information (Activity 1-3) Installed into No.1	3	
No.7	XML application creation software		3	
No.8	ISO documents	For Geographic Information (Activity 1-3)	2	
No.9	Laser printer	Multi-purpose, Color, A3 size	1	
No.10	Accessories for No.9	Toner (Black)	3	Coverage period is Shortened
		Toner (Cyan, Magenta, Yellow)	2 for each	
		Others (Fuser kit, etc.)	1	
No.11	Satellite images	For 1:25,000 eastern Pilot area training (GSD: 1.5m), New Shooting, Stereo pair	1,235 (km^2)	Multi-License
No.12		For 1:25,000 northern Pilot area training (GSD: 1.5m), Archive, Stereo pair	1,485 (km^2)	Single-License
No.13		For 1:5,000 Pilot area training (GSD: 0.3m), New shooting, Stereo pair	240 (km^2)	Multi-License
No.14		For additional Samtse area 1:5,000 (GSD: 0.3m)、Archive, Ortho	170 (km^2)	Single-License
No.15	DEM	Northern Pilot Area and Samtse Area	800 (km^2)	
No.16	Drone (body)	Middle size For large-scale topographic maps training	1	
No.17		Large size with “LiDAR sensor” For large-scale topographic maps training	1	Upgraded
No.18	Drone (software)	Including maintenance	1	
No.19	Digital Field Verification /Field Completion	Tablet PC	5	
No.20		Laser Measure	5	
No.21	Web meeting system	Laptop PC	1	
No.22		Projector	1	
No.23	GIS server	For NSDI system		
No.24	UPS for server			For No.23
No.25	OS for server	Windows server (5CAL)		For No.23

Source：JPT

3.1.2 Input results of Bhutanese side

The National Land Commission Secretariat (NLCS), as the C/P for developing and implementing project outputs, dedicated substantial time, resources, and financial support to ensure successful project completion. The contributions from NLCS are outlined as follows:

1. Human resources: The number of NLCS employees engaged as project managers and activity focal points corresponded to the number of planned project activities. Due to the extensive work required, additional personnel were deployed to support project execution.
2. Technical resources: NLCS provided essential human resources and technical equipment for creating and continuously updating digital topographic maps.
3. Stakeholder coordination: NLCS organized and facilitated stakeholder consultation meetings, seminars, and Joint Coordination Committees (JCCs) to ensure effective communication and collaboration among all parties.
4. Financial support: NLCS also incurred substantial financial expenses for various project-related activities, including stakeholder consultation meetings, JCCs, seminars, training sessions, and internal meetings held during visits by Japanese experts. These expenses covered logistical arrangements, venue rentals, materials, and facilitation to support effective collaboration and capacity building.

Given the involvement of multiple stakeholders, the contributions from various project participants included:

1. Consultation and collaboration: Active participation in stakeholder consultation meetings. Engagement in NSDI-related training sessions and seminars to enhance skill development.
2. Data and standards: Contribution to data creation and development, in adherence to the standards established for NSDI.

Table 3.1.3 Input Results of Bhutanese Side

#	Inputs	Result
1	C/P assignment and its personnel cost	Done
2	Assignment of engineers for NSDI and digital topographic maps	Done
3	Expenses for conducting field work such as GCP survey, field verification, and field completion, including transportation and per diem.	Done
4	Materials and equipment related to the creation and updating of digital topographic maps	Done
5	Project office and ancillary facilities	Done
6	Other expenses (water, electricity, etc.)	Done
7	Technology transfer space and ancillary facilities	Done

Source：JPT

3.2 Revision history of the PDM

The initial project period was 38 months from the dispatch of the JICA experts, and since the start of the project and the start of dispatch were planned at the same time, the project period was set for “November

2020 to January 2024". However, due to the impact of the quarantine policy in Bhutan following COVID-19, the first trip by JICA experts to Bhutan took place on November 2021. Therefore, at the request of the Bhutanese side, the JPT proposed to extend the project period by one year to January 28, 2025. This result was then agreed upon at the third JCC.

As for the Project purpose and Indicators for each activity, since some of the project components were new to C/P, it was difficult to set specific values at the beginning of the project. Therefore, as the activities progressed, when target values could be assumed according to C/P schedules and capabilities, they were updated as follows at the appropriate timing, and proposed and agreed upon by the JCC.

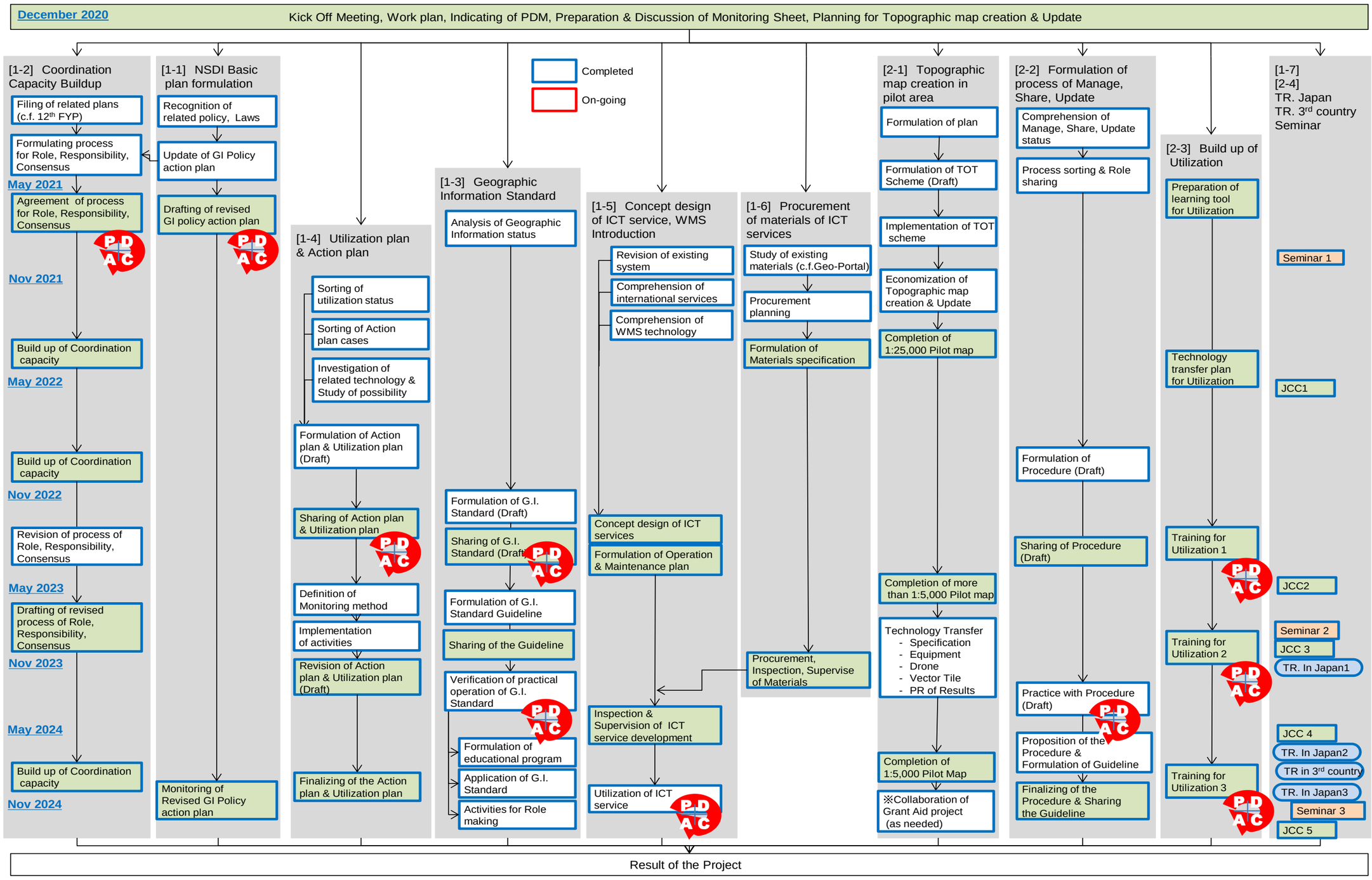
Table 3.2.1 Revision History of the PDM

Goals	Indicators	Means of Verification	Changes	Date of change
Project purpose	Amount of shared Geospatial Information	Server Log	"Means of Verification" has been modified to "Number of geospatial layers available for download by the general public". "Target value" is fixed at "50".	May 2024
		Report from each organization	"Means of Verification" has been modified to "Number of agreed agencies". "Target value" is fixed at "10".	May 2024
Output 1	Number of stakeholders of NSDI	CGI member list	"Target value" is fixed at "36 agencies".	July 2022
	Number of meetings and participants	Record of meeting	"Target value" is fixed at "2 / year".	May 2024
	Number of accesses to Web Map Service	Server Log	"Means of Verification" has been modified to "Number of geospatial layers registered with the Web maps". "Target value" is fixed at "10".	May 2024
Output 2	Pilot area described in the R/D	Area of developed topographic map	"Target value" is fixed 1:25,000 = 1,000 km^2, 1:5,000 = 50 km^2, Larger than 1:5,000 = 0.1 km^2	July 2022
	Number of qualified operators	Technical examination	"Target value" is fixed at "3".	May 2024
	Number of authorized procedures of GI for management	Confirmation by CGI	"Means of Verification" has been modified to "Number of training sessions for the implementation of authorized procedure". "Target value" is fixed at "3".	May 2024
	Number of proposed Action plans	Proposed action plans	To be Included in Output 1	May 2024
			"Target value" is fixed at "5".	May 2024

Source：JPT

3.3 Results of Activities

The workflow for the project is as follows.



Note: Workshops were conducted as needed.

Figure 3.3.1 Workflow of the Project (Source：JPT)

[Activity 0-1] Activities related to overall activities

3.3.1 Work plan preparation and discussion

(1) Preparation of Workplan (draft)

The JPT formulated a Workplan that includes the Basic policy, implementation method, activities, contents, implementation structure, workflow from sorting of existing materials, information, and data. The Workplan (draft) was discussed and agreed upon by JICA.

(2) Discussion and agreement over the Workplan (draft)

The JPT explained the Workplan (draft) to the NLCS. In the Kick-Off meeting (online) held on March 1, 2021. Subsequently, the work plan was discussed by both parties and an agreement was reached.

3.3.2 Preparation and discussion of “Project progress reports” and “Project completion report”

The “Work Plan”, “Project progress report”, “Project completion report” were prepared in the following quantities and schedules. After explanation and discussion with JICA and C/P, respectively, the report was submitted to JICA and the Government of Bhutan, reflecting the comments of JICA and C/P.

The “Project completion report” was revised after reflecting their comments of JICA, and finalized in consultation with the C/P.

Table 3.3.1 List of Reports

Reports	Quantity	Date of submission
Workplan	English (PDF): 1 copy	March 2021
Project progress reports	English (PDF): 1 copy	December 2022
Project completion report	English: 10 prints	January 2025
Project completion report (CD-R)	English (PDF): 2 copies	January 2025

Source：JPT

3.3.3 Holding the Joint Coordinating Committee (JCC)

The JCCs were held in the structure described in Chapter 1.2.6 to plan, review progress, monitor, and evaluate the work. Details of the contents of each JCC are described below.

Table 3.3.2 Main Agenda for Each JCC

Round	Output	Agenda
1	Common	Overall activity plan, major input by the Government of Bhutan, specifications of materials and equipment to be procured, and results of the kick-off seminar
	Output 1	Draft plan for NSDI promotion, roles, responsibilities, and coordination structure of core related agencies
	Output 2	Draft Workplan for Creating and Updating digital topographic maps
2	Output 1	GI Utilization Action Plan, NSDI system conceptual design, equipment procurement status
	Output 2	1:25,000 topographic mapping technology transfer results Utilization capacity improvement technology transfer status
3	Common	Interim seminar results, handover of procured equipment, plan for Training in Japan (first)
	Output 1	NSDI Plan, Action Plan for Utilization of Geospatial Information, GI Standards Guidelines
	Output 2	Result of "Drones", "Digital field survey", "Vector Tiles", draft Guidelines for data Management and Updating and Sharing, and ToT results on GIS Tools
4	Common	Finalization of PDM indicators, Plan of training in Japan (second), plan for the third country training
	Output 1	Explanation of the NSDI system, progress on GI Standards, and monitoring of the NSDI Plan and Action plan for GI utilization
	Output 2	Results of technology transfer of topographic mapping other than 1:5,000, and status of transfer of technology to improve utilization capacity related to the NSDI system.
5	Output 1	Overall report of activity results, demonstration of NSDI system, future NSDI promotion
	Output 2	Overall report of activities, results of technology transfer for 1:5,000 topographic maps, future policy for base map development

Source：C/P and JPT

(1) The first JCC

A summary of the first JCC is shown below. In the JCC, members were confirmed, and information was shared, discussed, and agreed upon regarding the role and positioning of the JCC in the project and how to proceed.

Table 3.3.3 Summary of the First JCC

Schedule	Contents
Date	July 25, 2022, 10:15 - 12:30
Venue	NLCS Executive Conference Hall (and Teams)
Objective	Confirm the progress of NSDI establishment and promotion, gain a common understanding of issues and measures to address them, and obtain approval for future activity plans.
Agenda	1) Share information about JCC members and the content of discussions 2) Progress, issues and measures of solution, Plans for future activities of Output 1 3) Progress, issues and measures of solution, Plans for future activities of Output 2
Matters decided	- The participants basically agreed on the activities and plans of this project. - The importance of early sharing and approval of the results of each activity by the GHLC was confirmed. - The data producing agency will collaborate and consult with stakeholders during data preparation to ensure that the data produced meets at least some agency requirements and is similar to the terrain base map.

Source：C/P and JPT

Attendees of the first JCC are listed below.

Table 3.3.4 Attendees of the First JCC

#	Name	Official position	Ministry / Agency	
1	Dasho Pema Chewang	Secretary (Chair)	National Land Commission (NLCS)	NLC
2	Kozo Watanabe	Chief Representative (Co-Chair)	JICA Bhutan Office	JICA
3	Phuntsho Namgay	Director	Department of Geology and Mines (DGM)	MoENR (former MoEA)
4	Lobzang Dorji	Director	Department of Forest and Park Services (DoFPS)	MoENR
5	Sonam Yarphel	Deputy Chief Planning Officer	Gross national Happiness Commission (GNHC)	GNHC
6	Tashi Penjor	Director	Department of Human Settlement (DHS)	MoIT (former MoWHS)
7	Tenzin Namgay	Director (Project Director)	Department of Survey and Mapping (DoSAM)	NLCS
8	Jigme Tenzing	Director	Department of Information Telecommunication and Technology (DITT)	GovTech Agency (former MoIC)
9	Samdrup Dorji	Project Manager of Output 1	Center for Geo-Information (CGI),	NLCS
10	Kinga Loday	Project Manager of Output 2	Topo Division	NLCS
11	Lhakpa Wangmo Thingh Tamang	GIS Officer	Center for Geo-Information (CGI)	NLCS
12	Pema Wangda			
13	JICA Project Team		JICA	JICA

Source：C/P and JPT

Photo 3.3.1 The First JCC

(2) The Second JCC

A summary of the second JCC is shown below. In the JCC, information on changes in members, explanation and current status of PDM and PO, and issues and technical trends of each activity were mainly shared, discussed, and agreed upon.

Table 3.3.5 Summary of the Second JCC

Schedule	Contents
Date	March 14, 2023, 10:15 – 12:30
Venue	NLCS Executive Conference Hall (and Teams)
Objective	Confirm the progress of NSDI establishment and promotion, gain a common understanding of issues and measures to address them, and obtain approval for future activity plans.
Agenda	1) Current status of PDM and PO 2) Progress, issues and measures of solution, plans for future activities of Output 1 3) Progress, issues and measures of solution, plans for future activities of Output 2
Matters decided	- The participants agreed in principle on the progress of this project. - It was agreed to consider acceleration of Activity 1-3, delayed GI Standards. - Shared the importance of assessing the readiness of stakeholders, including their technical capabilities and infrastructure, before developing the NSDI system. - The importance of proper planning and preparation for hosting NSDI systems in government data centers was shared. - Shared the importance of cooperation among all agencies that use drones and drone technology. - Regarding the areas targeted for 1:5,000 digital topographic mapping, the needs and utilization plans of related agencies were reconfirmed and it was decided to respond to them if possible.

Source：C/P and JPT

Attendees of the Second JCC are listed below.

Table 3.3.6 Attendees of the Second JCC

#	Name	Official Position	Ministry / Agency	
1	Tshering Gyaltshen Penjor	Secretary (Chair)	NLCS	NLCS
2	Yamada Tomoyuki	Chief Representative (Co-Chair)	JICA Bhutan Office	JICA Bhutan Office
3	Jigme Tenzing	Acting Secretary	GovTec Agency	GovTech Agency
4	Tashi Penjor	Director	DHS	MoIT
5	Chokila	Project Director	DoSAM	NLCS
6	Sonam Tobgay	Chief Forestry Officer	DoFPS	MoENR
7	Sonam Yarphel	Dy. Chief Planning Officer	Department of Macro Fiscal and development finance	Ministry of Finance
8	Jampel Gyeltshen	Dy. Chief Survey Engineer	DGM	MoENR
9	Samdrup Dorji	Project manager of Output 1	CGI Office	NLCS
10	Kinga Loday	Project manager of Output 2	DoSAM	NLCS
11	NLCS observers		Department of Survey and Mapping, CGI Office	
12	JICA observers		JICA Bhutan Office, JICA Project Team	

Source：C/P and JPT

(3) The Third JCC

A summary of the third JCC is shown below. In the JCC, information on policies for training in Japan, handover of equipment, reconfirmation of members, and GI utilization were mainly shared discussed, and agreed upon.

Table 3.3.7 Summary of the Third JCC

Schedule	Contents
Date	October 18, 2023, 10:00 – 12:00
Venue	NLCS Executive Conference Hall (and Teams)
Objective	Confirm the progress of NSDI establishment and promotion, gain a common understanding of issues and measures to address them, and obtain approval for future activity plans.
Agenda	1) Current status of PDM and PO, information sharing on the first training in Japan, Equipment handover 2) Progress, issues and measures of solution, plans for future activities of Output 1 3) Progress, issues and measures of solution, plans for future activities of Output 2
Matters decided	- Shared that the NSDI system will be hosted in a government data center. - It was suggested that only JCC members and the project management team should attend JCC, and the participants agreed to follow the suggestion from the next meeting. - The committee reviewed the request from the user, DHS, regarding the areas to be covered by the 1:5,000 digital topographic mapping. It was decided to consider the possibility.

Source：C/P and JPT

Attendees of the third JCC are listed below.

Table 3.3.8 Attendees of the Third JCC

#	Name	Official Position	Ministry / Agency	
1	Dasho Thinley Namgyel	Secretary (Chair)	Ministry of Agriculture and Livestock (MoAL)	
2	Yamada Tomoyuki	Chief Representative (Co-Chair)	JICA Bhutan Office	
3	Samten Dhendup	Project Director	DoSAM	NLCS
4	Lobzang Dorji	Director	DoFPS	MoENR
5	Phuentsho Namgay	Director	DGM	MoENR
6	Karma Sonam	Officiating Acting Secretary	GovTech Agency	GovTech Agency
7	Wangda Dorji	Chief	DHS	MoIT
8	Tenzin Norbu	Deputy chief survey engineer	DoSAM	NLCS
9	Samdrup Dorji	Project manager of Output 1	CGI Office	NLCS
10	Thinley Dorji	Project manager of Output 2	DoSAM	NLCS
11	NLCS observers		Department of Survey and Mapping, CGI Office	
12	JICA observers		JICA Bhutan Office, JICA Project Team	

Source：C/P and JPT

Photo 3.3.2 The Third JCC

(4) The fourth JCC

A summary of the fourth JCC is shown below. In the JCC, information mainly regarding the expected achievement of each goal of the project, training in Japan, handover of remaining equipment, and the schedule for Geospatial Information maintenance were shared, discussed, and agreed upon.

Table 3.3.9 Summary of the Fourth JCC

Schedule	Contents
Date	May 21, 2024, 10:00 – 12:00
Venue	NLCS Executive Conference Hall (and Teams)
Objective	Confirm the progress of NSDI establishment and promotion, gain a common understanding of issues and measures to address them, and obtain approval for future activity plans.
Agenda	1) Status of achievement of PDM and PO 2) Progress, issues and measures of solution, Plans for future activities of Output 1. 3) Progress, issues and measures of solution, Plans for future activities of Output 2.
Matters decided	- The possibility of achieving the PDM indicators was confirmed. - It was discussed and decided that the agencies concerned will share information on the specifics of the challenge regarding the promotion of GI standardization after the completion of the project and the Japanese experts should guide the C/P thoroughly. - The schedule for the creation of the 1:5,000 digital topographic maps was shared with the parties concerned.

Source：C/P and JPT

Attendees of the fourth JCC are listed below.

Table 3.3.10 Attendees of the Fourth JCC

#	Name	Official Position	Ministry / Agency	
1	Yamada Tomoyuki	Chief Representative	JICA Bhutan Office	JICA Bhutan Office
2	Jigme Tenzing	Secretary	GovTech Agency	GovTech Agency
3	Tashi Penjor	Director	DHS	MoIT
4	Samten Dhendup	Director	DoSAM	NLCS
5	Kinzang Duba	Dy. Chief Survey Engineer	DGM	MoENR
6	Rinzin Wangchuk	Dy. Chief Forestry Officer	DoFPS	MoENR
7	Samdrup Dorji	Project manager of Output 1	CGI Office	NLCS
8	Thinley Dorji	Project manager of Output 2	DoSAM	NLCS
9	NLCS observers		DoSAM, CGI Office	
10	JICA observers		JICA Bhutan Office, JICA Project Team	

Source：C/P and JPT

(5) The fifth JCC

A summary of the fifth JCC is shown below. The meeting primarily focused on reporting on completed project activities and sharing directions and issues related to future NSDI promotion.

Table 3.3.11 Summary of the Fifth JCC

Schedule	Contents
Date	December 2, 2024, 14:00 – 16:00
Venue	NLCS Executive Conference Hall (and Teams)
Objective	Confirmation of the status of achievement regarding the establishment and promotion of NSDI, common recognition of issues and measures to address them, and approval of the plan for sustainable activities in the future after this project.
Agenda	1) Final confirmation of PDM and PO 2) Overall Report on the results of Output 1 activities, level of achievement, and future plans 3) Overall Report on the results of Output 2 activities, level of achievement, and future plans
Matters decided	- Final confirmation of PDM and PO - Information sharing on NSDI system registration data and new entries - Information sharing on the status of future base map development - Utilization of Geospatial Information after the completion of the project

Source：C/P and JPT

Attendees of the fifth JCC are listed below.

Table 3.3.12 Attendees of the Fifth JCC

#	Name	Official Position	Ministry / Agency	
1	Yamada Tomoyuki	Chief Representative	JICA Bhutan Office	JICA Bhutan Office
2	Garab	Chief	GovTech Agency	GovTech Agency
3	Samten Dhendup	Director	DoSAM	NLCS
4	Phuntsho Namgay	Director	DGM	MoENR
5	Dawa Zangpo	Principal Forestry Officer	DoFPS	MoENR
6	Samdrup Dorji	Project manager of Output 1	CGI Office	NLCS
7	Pema Wangda	Sr. GIS Officer	CGI Office	NLCS
8	Thinley Dorji	Project manager of Output 2	DoSAM	NLCS
9	Sangay Nidup	GIS Officer	CGI Office	NLCS
10	Lobzang Tobgay	Superintendent Survey Engineer	DoSAM	NLCS
11	JICA observers		JICA Bhutan Office	
12			JICA Project Team (Online)	

Source：C/P and JPT

3.3.4 Monitoring and preparation of monitoring sheet summary

Monitoring sheet summaries for monitoring project activities and results, issues, etc., were prepared and submitted to NLCS and JICA Bhutan Office.

Table 3.3.13 Monitoring Sheet Submission History

Version of the Monitoring Sheet Summary	Target Period	Date of Submission to JICA Bhutan Office
Ver.1	Nov 2020 - June 2022	29 July 2022
Ver.2	June 2022 - March 2023	15 March 2023
Ver.3	March 2023 - Oct 2023	19 Oct 2023
Ver.4	Oct 2023 - May 2024	30 May 2024
Ver.5	May 2024 - Nov 2024	27 December 2024

Source：JPT

3.3.5 Output 1: Activities related to ”Capacity development for the operation planning and implementation for the strategic utilization and promotion of NSDI”

[Activity 1-1] To summarize legal framework, plans and policies related to NSDI and to create basic plan of NSDI in accordance with Geo-information policy

(1) Research GI Policy and related plans

To examine the vision and priority measures related to GI policy and NSDI promotion, issues related to NSDI establishment were surveyed and recognized (see Table 3.3.14) with Activity 1-2, Activity 1-4, and Activity 1-5.

(2) Discussion with related agencies about related laws (Copyrights, Personal information)

In collaboration with related activities such as Activity 1-4, Activity 1-5, Activity 2-3, etc., discussions were held with competent agencies regarding related legislation (e.g., copyright and personal information) and items to be included in materials related to NSDI promotion were reaffirmed.

Table 3.3.14 Results of Interviews for Relevant Plans and Laws and Regulations (example)

#	Plans / Laws / Policies		Questions	Answers
1	ICT guidelines / Acts	Information, Communications and Media Act of Bhutan 2018 (ICM 2018)	Does ”ICM Act 2018” apply to NSDI’s ICT services?	The ICM Act is a broad legislative framework. NSDI’s ICT services will be governed by e-governance policy which is further governed by the ICM Act.
			“ICM Act 2018” and Subjects of "Personal Information" and methods of protection	If NSDI requires user information such as name, age, gender, etc. It is personal information. Sharing of Geospatial Information through NSDI ICT services containing personal information shall be in accordance with ICM Act 2018.
2		Application development guidelines	Relevance of this guideline to ICT services. Experience in preparing a "Requirements Definition" as described in these guidelines.	These Guidelines only provide the best practices, and it is not mandatory to be followed. No experience in documentation.

#	Plans / Laws / Policies	Questions	Answers
3	Digital Drukyul	Are there any plans for Geospatial Information or NSDI to collaborate in these activities?	As of now, we have not received any information regarding the requirement of collaboration with the Digital Drukyul Project.
4	GI policy	Is it very difficult to revise it?	CGI shall review and propose necessary amendments in the changing context of technology, GI users and systems.
		Are GI policy and "e-Government Master Plan" consistent?	Yes
		Confirmation of Geo-portal features defined and expected in the GI policy	It will discuss the features / functions / requirements of the Geo-portal.
		What policy guidelines do we have to follow?	It only highlights the need for policy and guidelines to address the issues related to GI.
5	Rules & Regulations / Guidelines for Geo–Information Policy	Who or what agency is the decision-maker for this document?	Prepared by CGI. GHLC is the highest decision-making body
		Involvement of CGISC office members in the Geo-portal	For now, CGI Office does not have the capacity to carry out those functions
		Qualification of CGISC member (Definition of "GIS knowledge" and selection of TWG members)	There is no specific definition of "GIS knowledge". Both technical personnel and policymakers can be CGI members. TWG is limited to only GIS geospatial professionals with exception of ICT professionals.
6	Bhutan e-Government Master Plan	Ideas on contributing to citizen services and the private sector using NSDI	NSDI will support geo location-based services such as the location of schools, hospitals, ATMS, and common infrastructure like highways, hydropower dams, etc. NSDI will contribute to the utilization of Geo-Information by citizens and the private sector.
		How does NSDI achieve "Equal and Easy Access to Information"?	Since NSDI services are oriented towards the promotion and utilization of Geo-Information, the NSDI services will enhance easy access to Geo-Information to all the public.

Source：JPT

(3) Comprehension of Indexes from Japan and UN related to NSDI, Visions, Legal bases

In collaboration with related activities, the lecture on the promotion of NSDI introduced examples from Japan and neighboring countries where relevant legislation has been implemented and provided a lecture on the legal basis for the "Basic Plan for the Advancement of Utilizing Geospatial Information" in Japan (joint implementation with Activity 1-4).

(4) Sharing the progress and results of each activity

Referring to the existing GI Policy Action Plan, which provides a timetable of GI policy measures, and monitoring progress on activities that are common to this project, and the results were fed back to the participants through each activity.

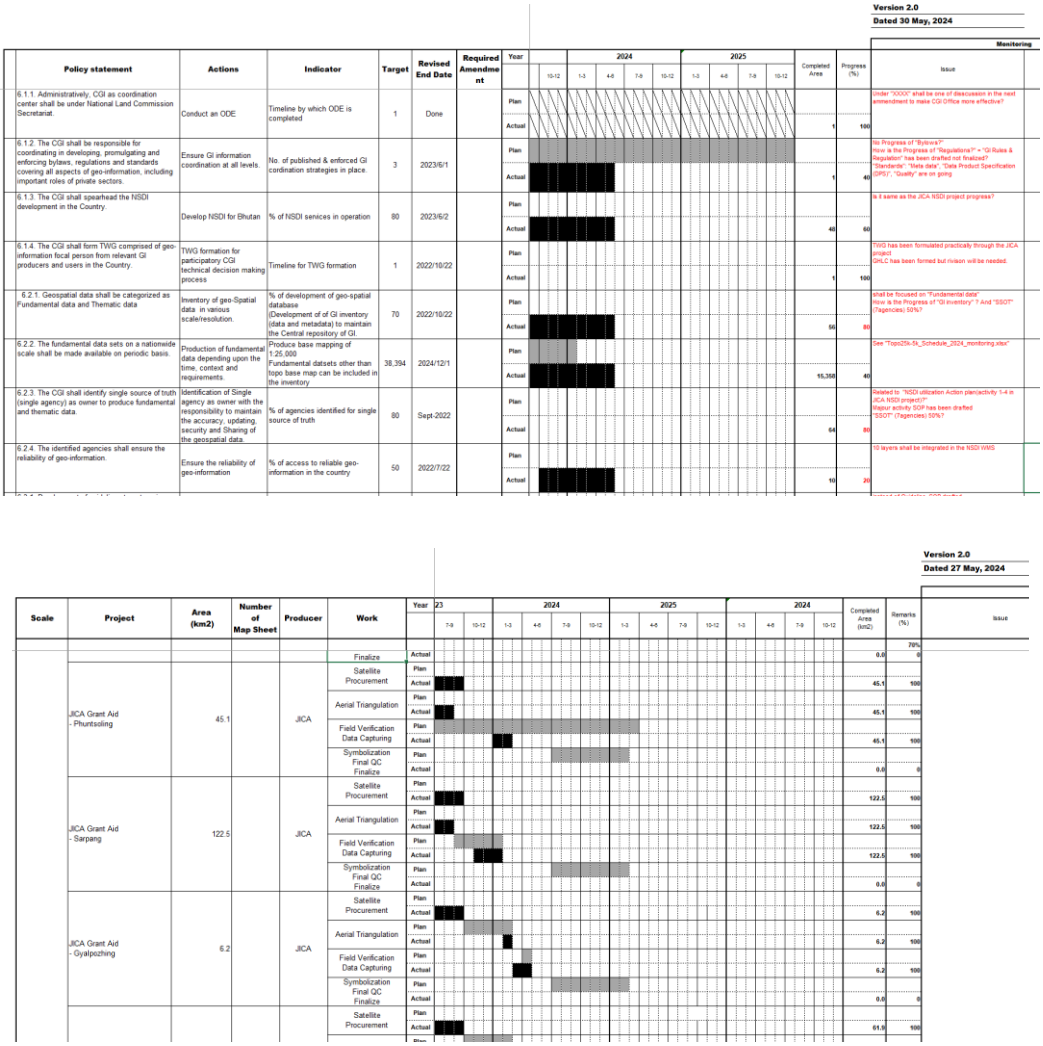


Figure 3.3.2 Status of Monitoring Activities Related to Promotion of NSDI and Topographic Maps (Upper: NSDI Promotion, Lower: Topographic Map, Source: CGI Office and JPT)

(5) Revise and update the GI Policy Action Plan, share and build consensus about NSDI promotion with relevant agencies

The C/P and the JPT discussed policies for promoting the plan (duration, structure, laws and regulations, coordination with other plans, and monitoring methods). The conclusion was reached that the GI Policy and the GI Policy Action Plan need to be reviewed and adapted to the situation even after the project is completed (It is also a measure of the NLCS' 13th Five-Year Plan).

[Activity 1-2] To summarize related organizations and their roles and responsibilities for the establishment and operation of NSDI and to enhance the cooperation among the related organizations

(1) Recognition of National policies related to GI

The contents of the GI Policy, Draft GI Rules and Regulation, and the 12th Five-Year Plan as policies and plans of the Government of Bhutan regarding GI were reviewed and recognized, including definitions of terms and confirmation of the duties of each agency.

(2) Sharing and clarification of roles and responsibilities of GHLC, CGISC, TWG, TF

As an organization for resolving issues related to GI, the division of roles among the CGI as a consultative body of related agencies, the TWG as a working group that deliberates especially on technical matters, the TF as a working unit for deliberations in the TWG, and the GHLC as the highest decision-making body in practice related to GI is documented according to the following policies to clarify inter-organizational relationships and job assignments.

GHLC: The GHLC will function as the highest decision-making committee in the field of Geospatial Information. The roles and responsibilities are documented in the "GHLC Terms of Reference (ToR)".

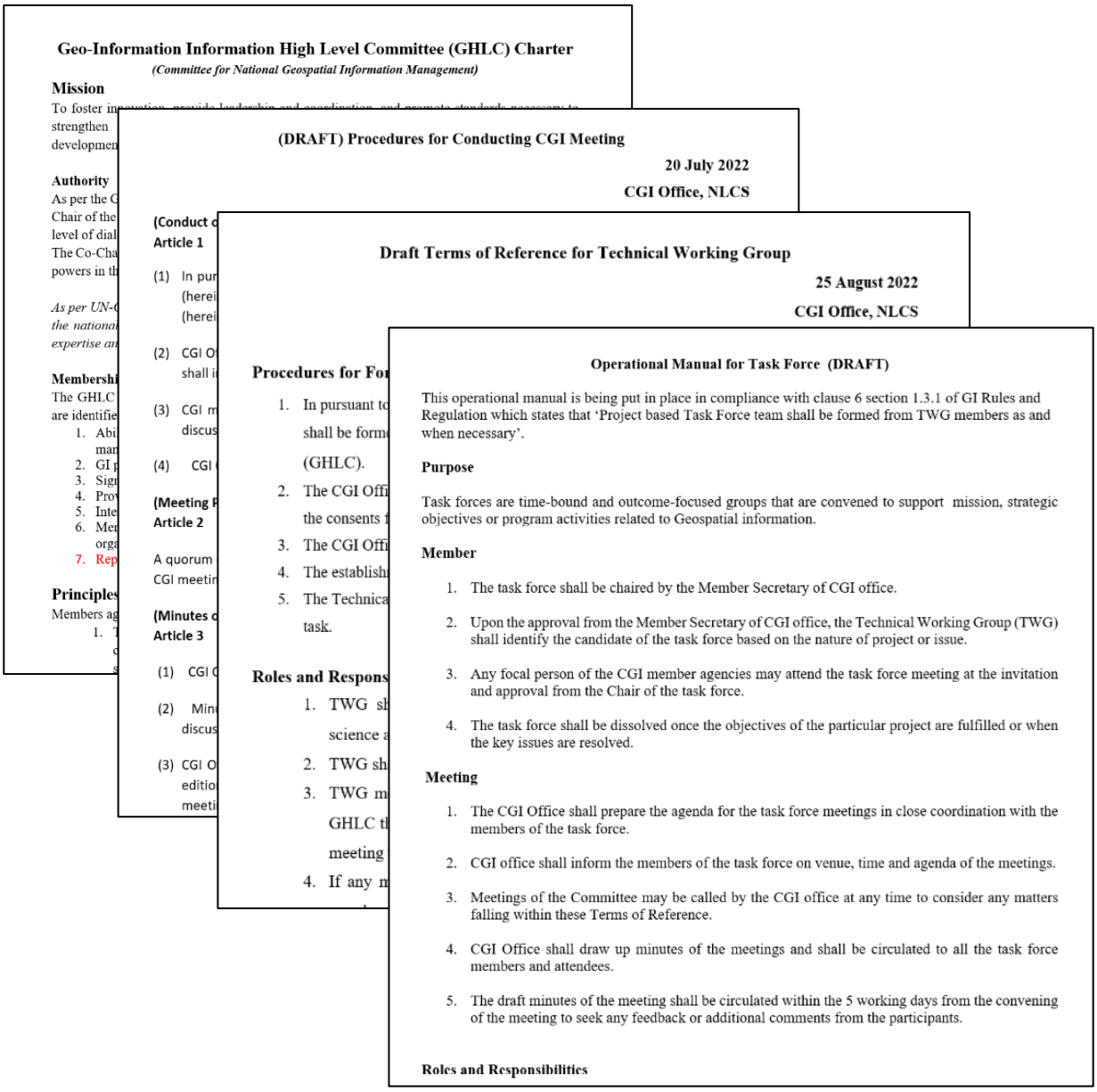
TWG: The establishment procedures, responsibilities and roles, and the organization of TWG meetings were documented as “Terms of Reference”.

TF: Although not included in the GI Policy, as described in the "Draft GI Rules and Regulations", it is necessary to formulate individual problem-solving proposals, and the procedures for its establishment are documented in the “Operational Manual for Task Force”. In the future, TF efforts on individual themes across multiple organizations, such as drone utilization, satellite image utilization, large-scale topographic maps utilization, and administrative boundaries, are desired.

Table 3.3.15 Documentation of Maintained Organizational Operations

#	Target Meeting body	Issues, Discussions, and Points of Support	Documents	Main contents
1	GHLC	Inactive	GHLC Terms of Reference (draft)	Roles, responsibilities, and codes of the GHLC as the highest decision-making body on Geospatial Information in Bhutan.
2	Technical Working Group	Inactive (Vague definition with TF)	ToR for TWG (draft)	Terms of References of the TWG as a coordinating body for all technical issues.
3	CGI Office	Active, but authority and frequency of activities are not clear.	Procedures for Conducting CGI Meeting (draft)	Administrative procedures for CGI member meetings in accordance with GI policy. In particular, the role of the CGI Office.
4	Task Force	Not active in the formal process (Vague definition with TWG)	Operation manual for TF (draft)	Operational manual for the TF as a body to study countermeasures for specific technical issues, including TF's relationship with CGI, and TWG.

Source：JPT



Geo-Information Information High Level Committee (GHLC) Charter

(Committee for National Geospatial Information Management)

Mission

(DRAFT) Procedures for Conducting CGI Meeting

20 July 2022

CGI Office, NLCS

Draft Terms of Reference for Technical Working Group

25 August 2022

CGI Office, NLCS

Operational Manual for Task Force (DRAFT)

This operational manual is being put in place in compliance with clause 6 section 1.3.1 of GI Rules and Regulation which states that 'Project based Task Force team shall be formed from TWG members as and when necessary'.

Purpose

Task forces are time-bound and outcome-focused groups that are convened to support mission, strategic objectives or program activities related to Geospatial information.

Member

1. The task force shall be chaired by the Member Secretary of CGI office.
2. Upon the approval from the Member Secretary of CGI office, the Technical Working Group (TWG) shall identify the candidate of the task force based on the nature of project or issue.
3. Any focal person of the CGI member agencies may attend the task force meeting at the invitation and approval from the Chair of the task force.
4. The task force shall be dissolved once the objectives of the particular project are fulfilled or when the key issues are resolved.

Meeting

1. The CGI Office shall prepare the agenda for the task force meetings in close coordination with the members of the task force.
2. CGI office shall inform the members of the task force on venue, time and agenda of the meetings.
3. Meetings of the Committee may be called by the CGI office at any time to consider any matters falling within these Terms of Reference.
4. CGI Office shall draw up minutes of the meetings and shall be circulated to all the task force members and attendees.
5. The draft minutes of the meeting shall be circulated within the 5 working days from the convening of the meeting to seek any feedback or additional comments from the participants.

Roles and Responsibilities

Figure 3.3.3 Manual for Organizational Operations (excerpts) (Source: CGI Office and JPT)

(3) Sharing and clarification of roles and responsibilities of agencies and capacity development of coordination

The CGI Office, located within the NLCS, is responsible for organizing CGI member meetings and communicating with CGI member agencies.

The role of the CGI Office is wide-ranging, including agenda setting and schedule coordination for CGI member meetings, SSOT workshops, and sharing the results of this project, but at this time, 2 NLCS staff are in charge of the CGI Secretariat's work. The JPT discussed the scope of operation and procedures of the CGI Office with the staff in charge and assisted them in compiling them into a document.

(4) Sharing of project materials

It is desirable to share documents and other information, including the results of this project and the agreement, with CGI member institutions, originally through the Website of NLCS or Bhutan NSDI. As an alternative, the CGI Office shares materials on “Google Drive,” for which it has access control authority. It also shares explanatory materials from this project, SSOT, and seminar presentations, which will be useful for future work, education, and training.

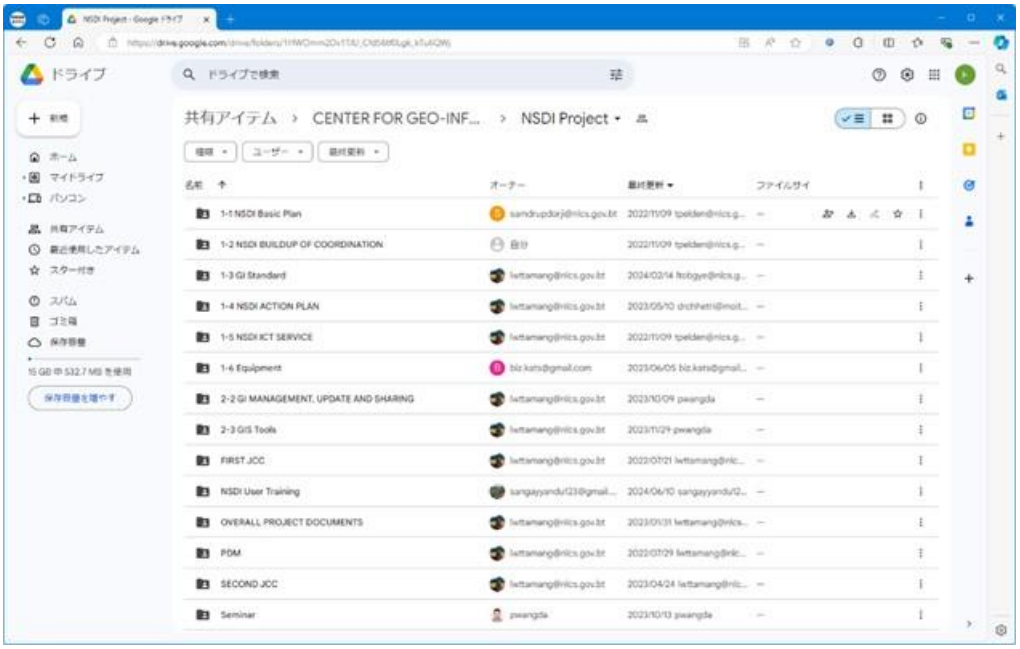


Figure 3.3.4 Sharing Status on Google Drive (Source: CGI Office)

[Activity 1-3] To establish draft of Geographic Information standards in Bhutan and to implement its promotion to related organizations

At the time of this project formulation, there were no common GI Standards established in Bhutan. It was clearly stated in the GI Policy 2018 of Bhutan that Geospatial data standards were necessary to ensure consistency, accuracy, and interoperability in the collection, storage, analysis, and sharing of geographic data that conform within the specific application domain providing a common platform for integration. Currently, with the absence of such data standards, it limits the actual use of geo-information in the country.

For this, the project aims to establish the GI Standards in Bhutan based on ISO/TC211 geographic standards and implement its promotion to related organizations. NLCS being the main C/P coordinated with relevant organizations and agencies to develop a GI Standards. Through this project, the C/P and JPT agreed and aimed to adopt and standardize three geographic standards; DPS, Metadata and DQ standards items based on ISO Standards for effective distribution and GI utilization through NSDI.

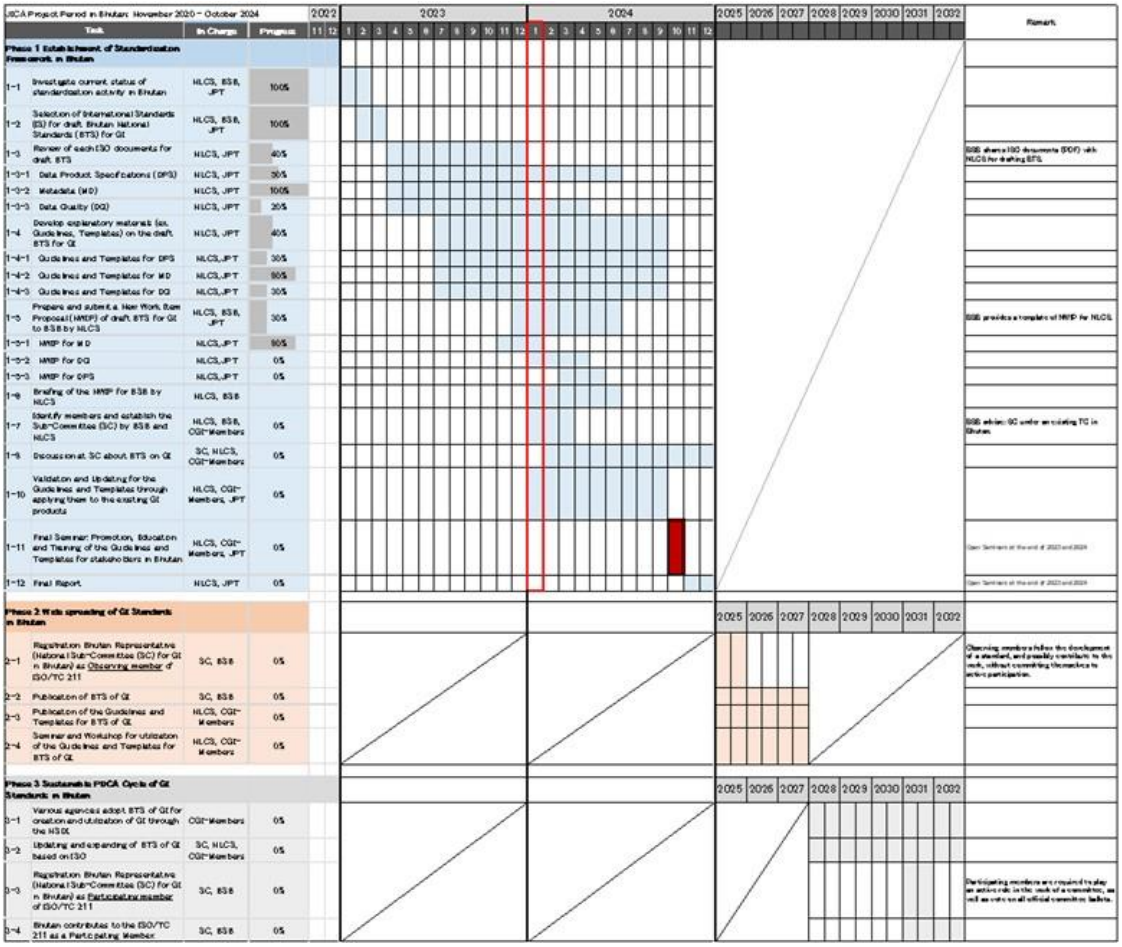


Figure 3.3.5 Roadmap for Technology Transfer of GI Standards (Source: JPT)

(1) Status analysis and consensus formation

Before the project began, Bhutan had no established standards for Geospatial Information. The counterparts and the JPT agreed to develop the Geographic Information standards in alignment with ISO. Since ISO provides around 70 volumes of standards for GI, incorporating all of them was not feasible due to the time limitation of the project. Drawing from best international practices and experience in Japan, the JPT and C/P decided to adopt three key standards during the project: Metadata, DPS and DQ.

(2) Formulation of Geographic Information Standards (draft) and Guideline (draft)

Before the formulation of the Geographic Information Standards, the JPT introduced the Japanese case study on the JPGIS standards including the Metadata standards. Accordingly, the C/P undertook initiatives, conducted a series of meetings, and reviewed the ISO documents. The C/P formulated the standards (draft) and drafted the guidelines for the easy use of the standards for three standards: Meta data standard, DPS and DQ.

Metadata is data that describes data and is essential for searching the data. The DPS is the design

document for data creation and is the data description document for users. DQ is a standard for data quality control, which specifies how to evaluate the level of correctness of data locations, attributes, etc., including methods. The DPS also include Metadata and DQ specifications. Both of these standards are essential for the creation and utilization of Geospatial Information (see respective Guidelines for details).

In reviewing the "Metadata" content of ISO, the JPT prepared materials on UML class diagrams and XML/GML basics in advance and explained them to C/P.

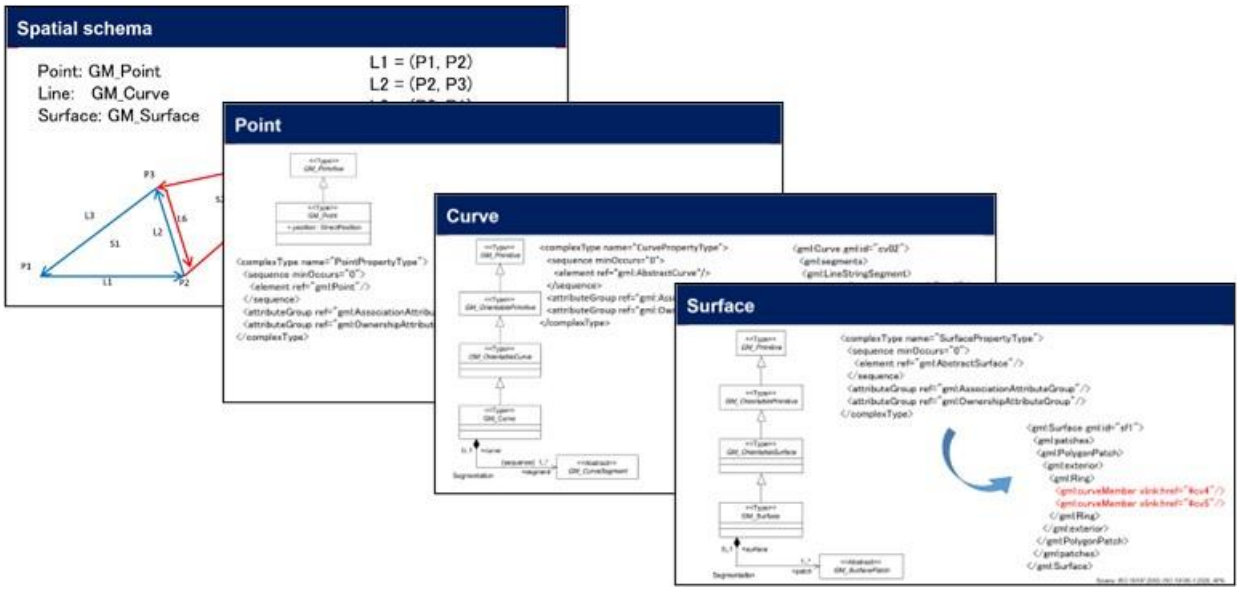


Figure 3.3.6 Spatial Schema, UML Class, GML Explanatory Material (excerpt) (Source: C/P and JPT)

The C/Ps then reviewed the metadata and gained experience in developing draft guidelines with practical content that is appropriate for the Bhutanese work environment, and conducted another review of the product specifications and data quality and draft guidelines.

In developing the draft Metadata Guidelines, the metadata structure is basically described with table templates rather than UML class diagrams. In addition, the XML encoding of metadata is conducted through registration in the NSDI system of the project, which is created on an ArcGIS basis. Therefore, the Metadata Guidelines also include procedures for registering metadata in the NSDI system for data creators. The NLCS discussed the above conditions internally, and the JPT provided advice and suggestions, which were eventually compiled into the final Metadata Guidelines.

Initially, the JPT introduced JPGIS, which extracts the practical part of GI Standards as a Japanese case study, and Bhutan considered introducing a similar GI Standards profile, but given the limited human resources of the C/P, the creation and enactment of the profile was postponed after consultation.

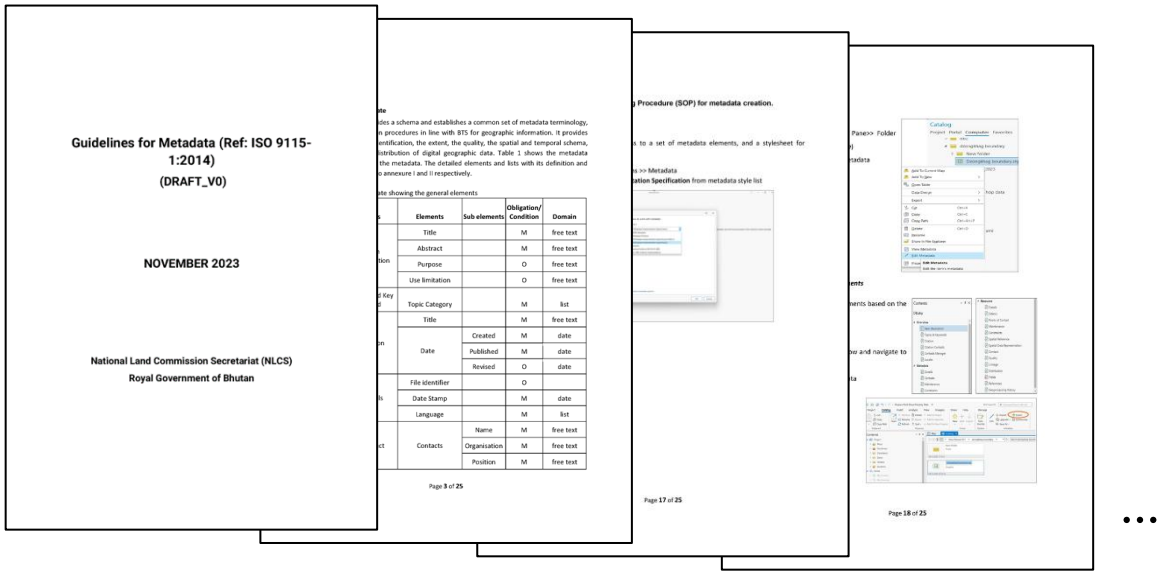


Figure 3.3.7 Guideline of Meta Data (excerpt) (Source: C/P and JPT)

(3) Validation of practical operation

A Series of consultation workshops with stakeholders (funded by NLCS) was initiated by the C/P on the practical operation and preparation of the metadata, DPS and DQ standards based on the prepared guidelines.

Following the initial development, the C/P engaged 16 stakeholder agencies through multiple consultation meetings to facilitate the adoption and familiarization of these standards. To ensure effective implementation, the counterpart also organized training sessions, led by in-house trainers, to guide stakeholders on the practical application of the adopted standards.

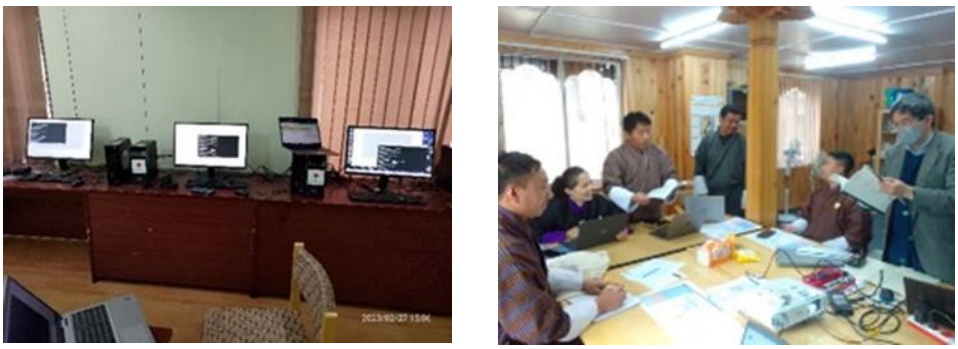


Photo 3.3.3 Training on GI Standards

(4) Discussion of educational program

The JPT supported the C/P to procure ISO documents essential for developing and adopting relevant GI Standards for NSDI and the C/P developed the training materials for the training programs regarding the ISO standards and Guidelines for GI.

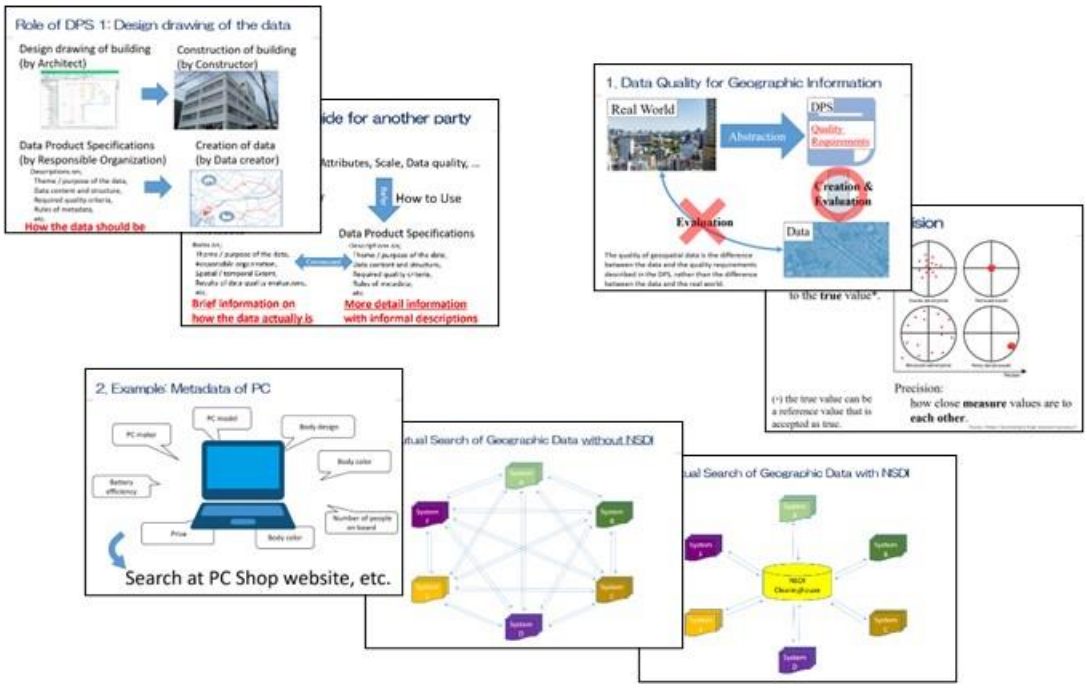


Figure 3.3.8 Educational Material for GI Standards (excerpt) (Source: JPT)

(5) Activities for standards implantation

For discussion and approval of the national standards, BSB recommended the formulation of the sub-committee. Accordingly, the BSB formed a sub-committee including from diverse entities.

The first sub-committee meeting was held on August 19, 2024, to discuss the draft Bhutan National Standards (BTS) for Metadata and the final endorsement to be made by a higher-level committee. The same procedures need to be followed for the approval of the other standards in future.

The list of member agencies comprising the subcommittee and the agenda for the first meeting are shown below.

Table 3.3.16 List of Members Present in the Subcommittee Meeting for Standard on Metadata

#	Member Agency	Remarks
1	Department of Water (DoW), MoENR	
2	Bhutan Power Corporation (BPC)	
3	Kheychok Geo-Infosys	Private survey company
4	National Land Commission Secretariat (NLCS)	

Source：C/P and JPT

འབྲུག་གི་གནས་ཚད་ལས་ཁུངས།
བཟོ་གྲྭ་ཚོང་ལས་དང་ལྷ་གཡོག་སྡེན་བས།
Bhutan Standards Bureau
Ministry of Industry, Commerce and Employment
Royal Government of Bhutan

SUBCOMITTEE ON GEOGRAPHIC INFORMATION STANDARD
DATE:19th AUGUST, 2024
VENUE: BSB CONFERENCE HALL

AGENDA

ITEM 0	WELCOME AND INTRODUCTORY REMARKS BY MS.BSB
ITEM 1	ADOPTION OF AGENDA BY SUBCOMMITTEE MEMBER
ITEM 2	INTRODUCTION OF MEMBERS
ITEM 3	BREIF BACKGROUND ON BSB
ITEM 4	BREIF BACKGROUND ON NSDI PROJECT
ITEM 5	ISO STANDARDS FOR META DATA BY NLCS
ITEM 6	ANY OTHER BSUINESS
ITEM 7	CLOSING REMARKS

Figure 3.3.9 Agenda for the First Meeting (Source: C/P)

The C/P in coordination with BSB conducted the stakeholder consultation meeting on the DPS and DQ standards.

[Activity 1-4] To develop action plans for utilization of Geospatial Information in member agencies and implement activities of the plans

After presenting the case examples of the Action Plan for Promotion of Utilization in Japan to the CGI Office and member agencies, the current status of GI utilization in Bhutan was examined. With support from the JPT, draft action plans were developed referencing Japan's case examples, and the planned individual measures were implemented. After initiating the individual measures, the progress of each measure was monitored and evaluated, and the action plan was finalized based on the evaluation results. At the same time, technical transfer was conducted on how to formulate action plans and how to monitor and evaluate measures through on-the-job training throughout a series of activities from action plan formulation to monitoring and evaluation.

The specific activities conducted in Activity 1-4 are described in (1) - (6) below.

(1) Organize activities, issues, and utilization plans for Geospatial Information of member agencies

In consultation with the focal persons of the CGI Office, 10 members were selected from different member agencies: 3 from NLCS, and 1 each from seven member agencies, Department of Disaster Management (DoDM in MoHA), Department of Roads (DoR in MoWHS, renamed DoST in MoIT), NSB,

Samdrup Jongkhar Municipality, Thimphu City Corporation, and Department of Forests and Park Service (DoFPS in MoENR). With the selected focal persons, the GI capacity of each agency, the data and activities they create and use, and the challenges they faced were reviewed, discussed, and documented using a common form (See Table 3.3.17 - 3.3.19).

It was confirmed that the number of officers in charge of Geospatial Information in each member agency is limited and that the data preparation and utilization depend largely on the capacity of the person in charge. On the other hand, it was also confirmed that these officers have a strong desire to improve their knowledge and skills related to the preparation and utilization of data in GIS and that each member agency is proceeding with the preparation of related data using GIS. Some member agencies utilize data prepared by other agencies. DoFPS, for example, prepares the large amount of data in GIS and actively utilizes the data. However, as mentioned above, data preparation depends largely on the capacity of the person in charge, and each member agency implied that to promote the use of Geospatial Information in the future, the development of common metadata, SOPs, and technical transfer would be needed.

Table 3.3.17 Engineers for Geospatial Information in C/P Agencies (As of 2021)

#	Agency	Engineer
1	NLCS	About 50-plus people including survey engineers, GIS officers, technicians and surveyors. All are distributed in different divisions of the technical department. This excludes surveyors in 20 districts and 4 urban areas.
2	DoDM (renamed DLGDM)	1 GIS officer
3	DoR (renamed DoST)	We have a Survey Unit under the Design Division of the Department with a staff of about 11. 3 officials using GIS under the Maintenance Division for the operation and management of Road Asset Management System.
4	NSB	Survey and Data Processing Division: Dy. Chief Mapping Officer (1) Agricultural Statistics Division: Dy. Chief GIS Officer (1), Sr. GIS Associate (1)
5	NEC (renamed DoECC)	No designated GIS personnel, however, some of my colleagues are interested in its application for their daily office work. Therefore, they are trying to learn through YouTube tutorials, etc.
6	Samdrup Jongkhar Thromde	GIS officer, urban planners, surveyors (around 5 people)
7	Thimphu City	1 Senior GIS officer 1 GIS officer 2 GIS-based surveyors
8	DoFPS (MoENR)	1 GIS officer

Source：C/P and JPT

Table 3.3.18 Geospatial Information Created and Used by C/P Agencies (As of 2021)

#	Agency	Geospatial Information	
		Created	Used
1	NLCS	Geodetic control points, CORS/PRS network, Cadastral, Topographic base maps of various scales, Administrative boundaries, Administrative points, Buildings and settlements points, Schools, Hospitals, Roads, Land use and land cover, Cultural and heritage sites, Track route maps, Bhutan height networks and benchmarks, Fallow land bank (A&D), city address, Geographical Names in collaboration with ECB (Election Commission of Bhutan), DDC (Dzongkha Development Commission), DoCDD (MoHA) and DLGDM (Department of Local Governance and Disaster Management, MoHA) etc.	Apart from Geospatial Information produced, NLCS uses Geospatial Information produced by other agencies such as transport networks, infrastructures, population data, Land use and land cover data, geology, soil data, hydropower data, schools, health centers, utilities, etc.
2	DoDM (renamed DLGDM)	None as of now. DoDM depend on other technical agencies for GI data	All the hazards (flood, landslide, and other data related to hazards) and vulnerability data like demographic data, socio-economic data, etc.)
3	DoR (renamed DoST)	Road alignment, Road asset information, Various maps	Road network inventory, Investment planning, risk assessment
4	NSB	Infrastructure mapping in 2008 and Enumeration maps produced at the Urban level for the census and household survey	Most of the Geo-data from NLC.
5	NEC (renamed DoECC)	Not much of a producer as of now	Due to the huge application of GIS in natural resources management. There are endless possibilities to use GIS in NEC. Examples of use cases are: GIS utilization in projects like integrated water resources management, plans to use for site selection under waste flagship program, use of GIS in climate change division.
6	Samdrup Jongkhar Thromde	Cadastral data, building data, transportation data, Utilities data	Cadastral data, building data, utilities data
7	Thimphu City	Building data, cadastral data, utilities data	Building data, cadastral data and utilities data
8	DoFPS (MoENR)	Forest-type maps for the national forest monitoring system with remote sensing analysis to understand the deforestation Many GIS spatial layers related to forest and wildlife conservation, forest management and forest and wildlife inventory A layer for watershed management and wetland conservation	

Source：C/P and JPT

Table 3.3.19 Activities Related to Geospatial Information in C/P Organizations (As of 2021)

#	Agency	Activity
1	NLCS	- Ongoing NSDI Project with JICA (with the involvement of relevant stakeholders) - Grant Aid Project by JICA - National Land Use Zoning Project (NLUZ) - Regular update of Cadastral maps - 5K and 25K base maps - Revamp of CORS networks - Ongoing trek route mapping
2	DoDM (renamed DLGDM)	- In the process of developing Multi-Hazard Risk Decision Support System (MHRDSS) which is GIS-based system - In final stage of developing 72-hour Rapid Assessment Approach system which also a GIS based system - Using Disaster Management Information System (DMIS), which is supposed to be GIS-based but has no GIS capability incorporated in it
3	DoR (renamed DoST)	- Operation and management of the Road Asset Management System
4	NSB	- We are currently working on listing and mapping exercises for rural areas.
5	NEC (renamed DoECC)	- 3Remarks: In the case of the utilization of Geospatial Information, some of the activities according to 12FYP, have plans to use geoinformation science while others don't. The reason being the lack of in-house capacity. Therefore, I still listed the activities because given the appropriate training, we will be able to utilize GIS in various ways for planned/unplanned activities in NEC. - Planned: downscaling of global climate data, climate change projection analysis for Bhutan and for sector assessment like agriculture, forest and biodiversity, water, etc., - Unplanned but needed: spatial multicriteria evaluation/ suitable site selection for waste facilities and air quality monitoring stations, mapping of water / air pollutant sources, identification of potential aspects and impacts of development - environmental impact assessment, informative visualization / cartography / poster making - making of very informative posters for information sharing that can be understood by both scientist and non-scientist (public) community.
6	Samdrup Jongkhar Thromde	- We are currently working on developing a building information system for the Samdrup Jongkhar Municipality. - As a local government, data related for planning infrastructure development is vital. Currently, the local government lacks such data, especially on utilities. So, planning to develop a complete set of database pertaining to planning and execution of infrastructure development.
7	Thimphu Thromde	- Currently, the GIS team is developing a GPS-based system for every city bus integrated with new bus routes, stops and terminals. We are now fully engaged in working with city bus route mapping and route testing. - We are also preparing a street addressing guideline and street address geodatabase for Thimphu Thromde. - We are also planning to develop a geodatabase for water pipelines and sewage pipelines for Thimphu Thromde using GIS.
8	DoFPS (MoENR)	- Daily activity includes geospatial activities for forest and wildlife conservation and management. Besides this, a spatial decision support system for issuing instructions on forestry clearance and maintenance for departmental spatial databases is carried out. - Our organization will be carrying out periodic forest cover mapping for national and international reporting, monitoring the deforestation and forest degradation through satellite land monitoring system. Our organization is also planning to develop forest biomass maps using radar data.

Source：C/P and JPT

(2) Understand planning and monitoring systems and action plans related to Japan's NSDI

Technical transfer on the contents of the "Basic Plan for the Advancement of Utilizing Geospatial Information" and existing action plans in Japan, as well as the background and legal basis of these plans was conducted. The structure of the Action plan developed in Activity 1-4 described below is based on the structure of Japan's Basic Plan and action plans with adjustments made in consultation with the C/P.

(3) Understand the latest Geospatial Information technologies

Relevant measures and technologies in various fields, including the latest technologies, were introduced from examples of Japan's action plans, considering the current situations and challenges in Bhutan. This aimed to help the C/P consider the measures to be taken when preparing an action plan.

(4) Discuss Feasibility of the action plans after organizing other technologies and information

The CGI Office and some of the member agencies were visited to discuss the contents and objectives of Activity 1-4. Taking into consideration the current situation and issues related to GI utilization in Bhutan, the overall goal and the five key outputs of the action plan to be developed in this activity were determined. The overall goal is to enhance the sharing of existing Geospatial Information between member agencies. The five key outputs include (1) Classification of GI, (2) Identification of a single responsible agency for Geospatial Data, (3) Foster collaboration among stakeholders, (4) Develop NSDI ICT services, and (5) Develop common data standards and formats. These key outputs are interdependent, and their implementation will ultimately contribute to the achievement of the overall goal of the action plan. For example, this action plan will develop ICT services that contribute to NSDI by standardizing data and establishing common formats, along with classifying GI and identifying SSOT, while promoting collaboration among member agencies. As a result, it aims to enhance the sharing of existing GI among the member agencies.

The figure below shows the location of the overall goal and the five key outputs.

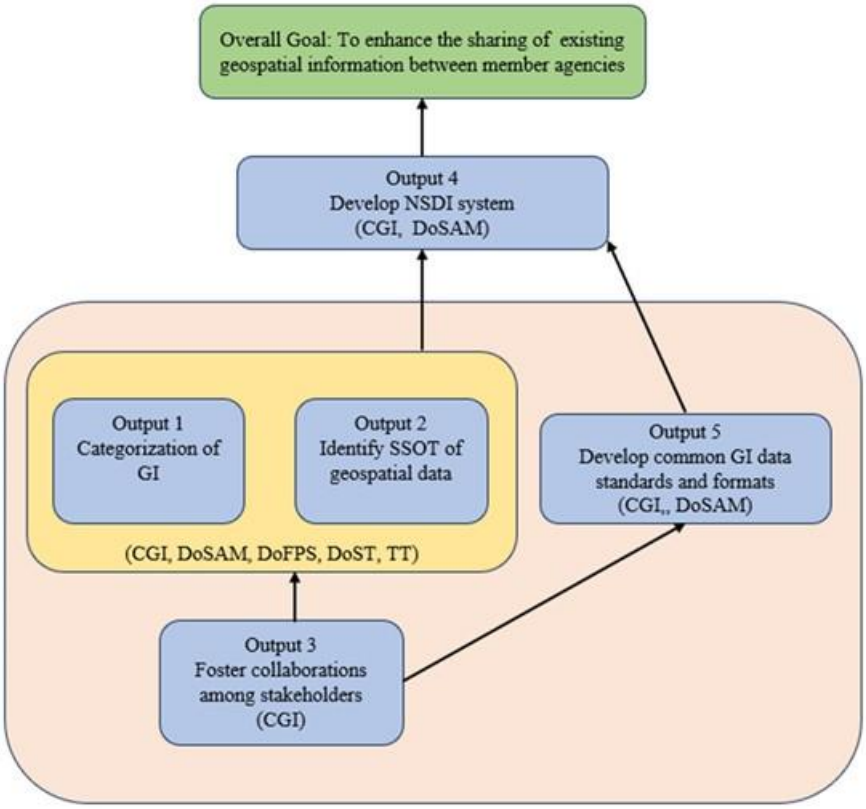


Figure 3.3.10 Relationship Between Overall Goals and Key Outputs (Source: CGI Office)

Note) Figures in parentheses indicate implementing agencies.

To achieve the key outputs identified in the action plan, the CGI Office and the member agencies involved implemented individual measures under the structure shown in the figure below. The CGI Office, which played a leading role in Activity 1-4, held quarterly monitoring meetings to share the progress of individual measures and issues with each member agency. The CGI Office also addressed issues with the advice of Japanese experts and reported progress and issues to the project manager as appropriate.

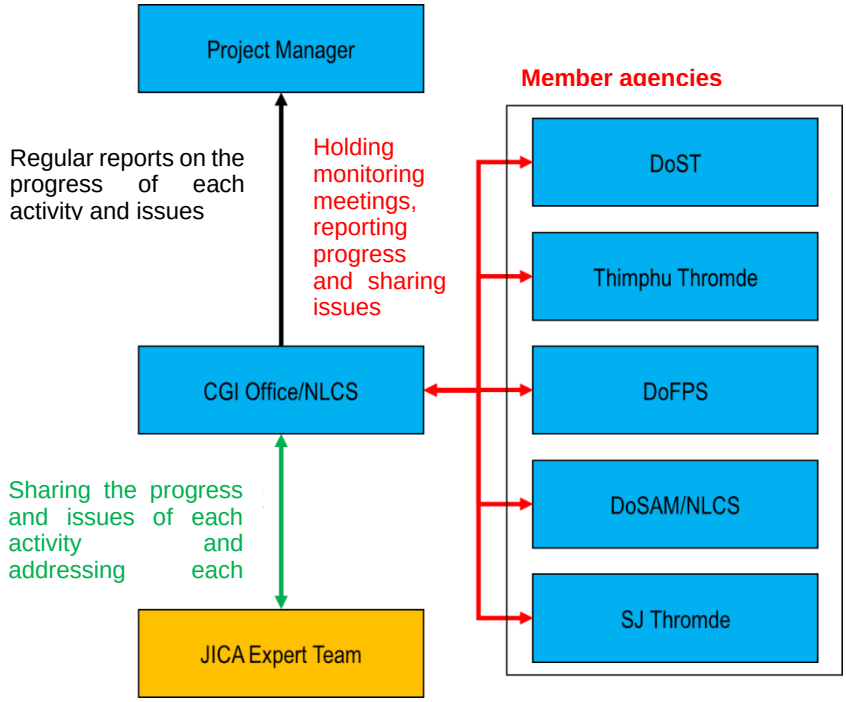


Figure 3.3.11 Implementation Structure for Each Output Identified in the Action Plan (Source: JPT)

(5) Share the action plans among the member agencies and determine monitoring methods

The draft action plan prepared by the CGI Office and the individual measures developed by each member agency were shared at the online meeting. Individual measures for each member agency involved were organized using a common form, which made it easier for the member agencies to share the contents of individual measures. The table below shows an example of a common form that organizes the proposed contents of the individual measures implemented by the CGI Office in this activity.

Table 3.3.20 Example of Common Form with Proposed Contents of Individual Measures (CGI Office)

Measure name	Categorization of Geospatial Information
Relevant NKRA	NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved.
Relevant AKRA	Sustainable land resources for human settlement managed.
Relevance in the GI Policy Action plan	**Clause 6.3.1**: Development of guidelines to categorize geo-information into restricted, common and open categories.
Outline of measure (background, purpose, target, effect, etc.)	Categorizing Data into Open, Common and Restricted can help individual agencies to manage access and use of data appropriately. The purpose of categorizing data into open, common, and restricted categories is to manage data according to its sensitivity level. Categorizing the Geospatial data helps organizations to make informed decisions about data access and sharing, which reduces the risk of unauthorized access and breaches and also ensures that data sharing and use complies with the legal framework.

<table>
<tr><td rowspan="6">Schedule (efforts in each year)</td><td>Financial year</td><td>Quarter</td><td colspan="2">Task</td></tr>
<tr><td rowspan="4">2023-24</td><td>1st</td><td colspan="2">• Conduct consultation meetings with pilot agencies to explain types of data category and develop a checklist to categorize data.
• Assign tasks to focal persons (FPs) to categorize their respective GI data into open, common and restricted.</td></tr>
<tr><td>2nd</td><td colspan="2">• Monitor and update progress of categorization tasks carried out by each member agency.</td></tr>
<tr><td>3rd</td><td colspan="2">• Collect and document the categorized spatial data in a formal agreement.</td></tr>
<tr><td>4th</td><td colspan="2">• Communicate the categorized data to all stakeholders through meetings or seminars to ensure that everyone is aware of types of data category and list of categorized datasets.</td></tr>
<tr><td>2024-25</td><td></td><td colspan="2">• Integrate the categorized data in the NSDI ICT Service</td></tr>
<tr><td>KPI</td><td colspan="2">The particular set of geospatial data that has been categorized with the approval from the head of the respective agency.</td><td>Means of Verification (Specific measurement method)</td><td>Timeline by which a particular set of geospatial data has been categorized and officially approved with the signature from the head of the respective agency.</td></tr>
<tr><td>Baseline</td><td colspan="2">Data listing and tentative data categorization is completed in consultation with FPs of pilot agencies.</td><td>Target</td><td>Compilation of list of approved data categories of datasets produced in various agencies.</td></tr>
<tr><td>Key interventions</td><td colspan="4">• Conduct consultation meetings with pilot agencies to explain types of data category, checklist to categorize data.
• Quarterly meeting to update on the progress of the activity.</td></tr>
<tr><td>Risk mitigation plan</td><td colspan="4">• Immediate replacement of focal person from the pilot agencies in case the focal person leaves their agency.
• Extend technical assistance to the new focal person assigned in case the previous person in charge leaves their agency.</td></tr>
<tr><td>Budget amount</td><td colspan="4">Nu. 0.05 million</td></tr>
<tr><td>Responsible agency</td><td colspan="2">Center for Geo-Information</td><td>Affiliation, position, and contact info of the person in charge</td><td>Name
Position
E_mail</td></tr>
</table>

Source：CGI Office

In addition, quarterly monitoring was conducted using a common form to monitor the progress of measures implemented by the CGI Office and the member agencies. The table below shows an example of a monitoring sheet that organizes the progress of individual measures and issues. In particular, when delays occurred, the causes of the delays were identified, and specific countermeasures were discussed.

Table 3.3.21 Example of a Monitoring Sheet that Organizes the Progress of Individual Measures and Issues (CGI Office)

Title	3rd Monitoring Meeting for FY 2023-2024
Date	June 13, 2024
Individual Measure Name	Categorization of Geospatial Information
Progress Status (Delays are written in bold.)	Monitored and updated progress of categorization tasks carried out by each member agency. Received the designated endorsement forms and checklist from all member agencies. Conducted the meeting/seminar and user training for ICT Service in June as scheduled using additional budget. **Could not organize the high-level meeting to communicate the categorized data to all stakeholders in May.** Found an issue that most of the data were categorized as Common or Restricted (65 % if data from NLCS are included, but only 20-30 % if data from NLCS are excluded). It may be needed to shift the data to Open as much as possible to make a lot of data available for the public.
Reasons for the delay	The high-level meeting could not be organized because many members participated in the training from NASA in the middle of May.
Way to recover from the delay (countermeasure, reschedule if necessary)	The high-level meeting will be organized in September as soon as the budget for the next fiscal year becomes available. This meeting has already been included in the annual plan, and necessary budget has been allocated.

Source：CGI Office

(6) Start activities of the member agencies following the action plan

Under the implementation structure described above, the CGI Office and the member agencies started individual measures in line with the Action plan. The PDCA cycle was followed in the activities, with monitoring meetings held three times throughout the year. The activities were mostly implemented without major delays. In addition, each measure was evaluated at the end of the fiscal year (Bhutan's fiscal year starts on July 1 and ends on June 30), and activities that caused delays and room for improvement were added to the following year's plan.

Photo 3.3.4 Monitoring Meeting Between CGI Office, Member Agencies, and the JICA Expert

[Activity 1-5] To conduct conceptual design for ICT services including Bhutan Geospatial Portal for NSDI and to provide Web Map Service as a part of NSDI

The goal of this activity was to achieve the implementation and utilization of a Web Map Service (WMS), by compiling the ICT (hereinafter NSDI system) service requirements and conceptual design for the NSDI after reviewing existing systems and understanding Japanese examples (GSI Maps, etc.). In addition, the original plan was to extend the existing system (Geo-Portal) to meet their needs (Because the existing system was unrecoverable due to the failure, it was necessary to change the way to proceed with this activity).

In this activity, a Task Force-like team for developing the NSDI system was formed to conduct technology transfer using the on-the-job training method and this was conducted in conjunction with 1-6.

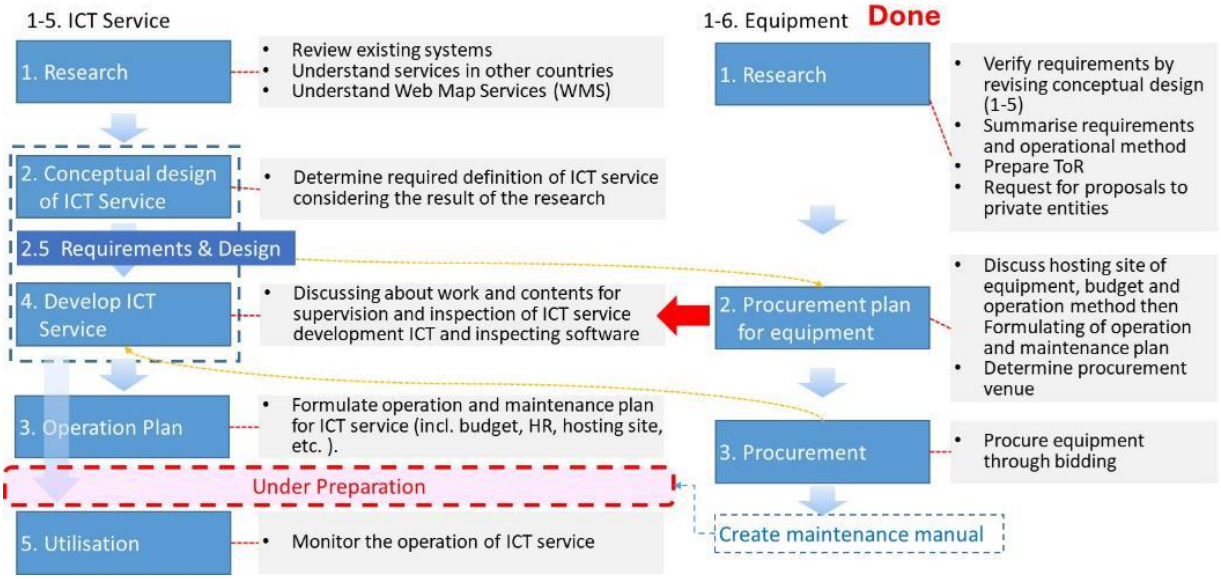


Figure 3.3.12 Workflow of the Activity 1-5 and Activity 1-6 (Source: JPT)

(1) Revising of the Geo-portal and confirmation of issues

To conduct a conceptual design (systemization plan) of the NSDI system, 1) Introduction of activities related to the NSDI system and exchange of opinions, 2) Confirmation of ICT policies and measures of the Royal Government of Bhutan, 3) ICT capacity of NLCS and the Government of Bhutan and capacity assessment of the ICT private sectors, 4) Study of ICT services needed for NSDI, 5) Case studies in Japan (GSI), Introduction and discussion of Japanese case studies (central ministries, local governments, open data), 6) Introduction and discussion of case studies from other countries (U.K., U.S., Indonesia). Through these activities, the knowledge required for technology transfer was strengthened.

Table 3.3.22 Research on Existing Systems (initial technology transfer)

#	Contents	Method
1	Introduction of activities related to the NSDI system and exchange of opinions	July 2021 (online)
2	Confirmation of ICT policies and measures of the Royal Government of Bhutan	August 2021 (online)
3	ICT capacity of NLCS and the Government of Bhutan	September 2021 (online) October 2021 (online)
	Capacity assessment of the private sector (ICT)	October 2021 (online) November 2021 (online)
4	Study of ICT services needed for NSDI	November 2021 (online) February 2022 (online) April 2022 (online)
5	Introduction and discussion of Japanese case studies (GSI, central ministries, etc.)	July 2022 (In-person in Bhutan)
6	Introduction and discussion of ICT services in third countries	November 2022 (In-person in Bhutan)

Source：JPT

The Geo-portal on that time was developed in 2014 with the assistance of ICIMOD, with the following specifications.

Table 3.3.23 Specifications of the Geo-portal (As of 2021)

#	Specifications		Remarks
1	Database management system	Microsoft SQL 2008	
2	Backend server software	ArcGIS server enterprise 10.2	Maintenance costs were high, and CGI was considering moving to open source
3	Spatial Metadata catalog	Geo network 2	CGI wanted to upgrade to add viewer functionality, but CGI lacked the technology and knowledge to upgrade.
4	Servlet containers	Tomcat 7	
5	HDD	300GB × 3	Stored about 500 GB of data

Source：NLCS

(2) Understanding of international Web Map Service, ICT services such as open data, platform, etc.

Training was conducted to enhance the understanding of ICT services around the world through accessing and using GSI Maps, etc. In particular, the program was effective in deepening understanding of vector tile and raster tile Web map technologies, which were technical specifications that would be adopted in the NSDI system in Bhutan in the future.

(3) Conceptual design (requirement definition level) for NSDI system development

Based on the results of the above activities, the NSDI system requirements for Bhutan were defined.

The development of an NSDI system begins with initial service design and involves activities such as system requirements definition, system design, and testing. In the technology transfer of the NSDI system, JPT explained what the system is, how the development work will proceed, what the CGI work area is, and what specific outputs will be developed using which methods and tools. Subsequently, based on the opinions of the C/P and related agency personnel, activities were developed, and services were established for each of the following items.

- Conceptual Design (Service Design)
- Requirements definition (Functional and non-functional requirements)
- External design (User Interface design, Functional design, etc.)
- System Development (Use ArcGIS Enterprise, a commercial package)

Table 3.3.24 Background of Discussions on Design and Development

#	Themes	Details of discussions and decisions
1	Conceptual Design (Service Design)	- Explanation on the service design was presented. - The architecture being considered (which idea is also based on the government policies) by the NLCS was shared (prerequisite: hosting the system in the government data center). - The NSDI administrator in NLCS does not check data created by other agencies before importing them to the NSDI system. - Problems caused by data errors shall be the responsibility of the data producer. - Direct access to the NSDI server from other systems is not permitted. - Each data-producing organization needs to create procedures for directly uploading data to the NSDI server.
2	Requirements definition (functional and non-functional requirements)	- A presentation on how to define functional requirements was given, explaining the importance and content of functional requirements. - Since it is difficult for NLCS staff to have an immediate idea of what to include in the requirements document, a list of functions should first be created by referring to existing examples of similar services (Sri Lanka, Los Angeles, etc.). - NLCS requested to include the function to specify the area on the map where the user wants to download the map. - Each item listed as the functional requirement was checked one by one, and it was judged that the required functions in the initial version were satisfied. - How to handle XML will be decided based on the ideas of the activities for Geographic Information standards (1-3). - The structure of document forms used for the functional requirements study was reviewed. The functional classification was set to only one level for the convenience of the C/Ps to discuss. - Referring to the list of non-functional requirements prepared by “IPA Japan”,

#	Themes	Details of discussions and decisions
		an overview of non-functional requirements and items were explained (The C/P, who will be reviewing non-functional requirements in the future, suggested that it would be easier to work with samples of IPA, so decided to search materials on the Web). - A review of the requirements document with non-functional requirements was conducted. - Work involving system customization (coding level) was not included due to budget and development resource limitations in this project.
3	External design (UI design)	- The design concept and documentation were explained. - NLCS and JPT decided to design and develop a prototype first, and then build a simple system. - NLCS and JPT decided to test if the UML software purchased for other activities worked to create Activity diagrams, but the software was not used because it was difficult to use. - No special database design is required, as it is only needed to store data following the procedures of the GIS software. - As the system is developed by using COTS software, C/P was advised to make the setting sheet first, then develop the system. Since the system can be modified on a Graphical User Interface (GUI) basis, the system can be modified exploratorily. If the system is modified before updating the system configuration document, the person who updated the system is always required to update the document. - The GUI images were reviewed to identify what should be prepared for each component. - Discussion of base map First, register a 1:50,000 topographic map as sample data (only available layers). Only the southern part of the country, where 1:25,000 data production has been completed, will be registered.
4	System development	- Practices on building an NSDI site using the development tools provided by ArcGIS Enterprise were conducted. - Creating a map viewer with "Experience Builder" - Creating a Web page with "Enterprise Sites" - Topographic data and road data were used for the prototype. - The concept of user management was discussed. - Each data creation agency is responsible for the registration and update of each data. The data administrator at each agency is given an account to access the system and is able to store data in the allocated space for each agency data. - The data update procedure was tested on the simulated environment, and the updated data was displayed on the map correctly. - NLCS and JPT reviewed and confirmed the collection status of the NSDI registration data. For data from other departments, we will register it after the situation is organized, such as by formulating an operational plan. We decided to start with the registration of data held by NLCS. - For the system development, we aim to complete the registration of the necessary data and documents using the current version being created as the base version. - NLCS and JPT configured the settings to reference non-spatial information content (documents). - NLCS updated the top page of the NSDI system. - The configuration methods for user management and data management were explained. - Test data were registered. - NLCS and JPT investigated the responses to system issues and shared the workarounds. - A system operation plan was prepared.

Source：C/P and JPT

Photo 3.3.5　Training on Conceptual Design of NSDI System

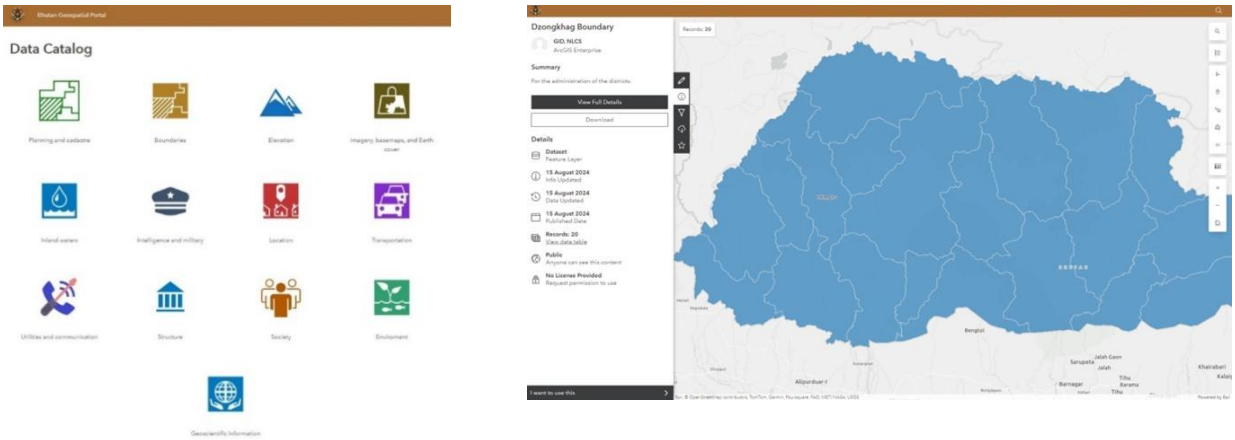


Figure 3.3.13 Designed NSDI System (Left: Catalog Selection Page, Right: Display of Searched Layer, Source: CGI Office)

(4)　Formulation of operation and maintenance plan for NSDI system

To ensure the smooth operation of the NSDI system, it is essential not only to have a user's manual, but also an operation and maintenance plan based on the definition of NSDI in Bhutan, and to implement it daily. To this end, JPT assisted in the creation of an NSDI operations manual, including SOP. Although the operation and maintenance plan should be updated as needed in response to changes in operational conditions, the plan is composed of the following contents based on the situation at the start of the operation.

Table 3.3.25　Structure of Operation Plan (Draft)

Item	Description
Title	Operation Plan for National Spatial Data Infrastructure System
Contents	Introduction
	System overview
	Legal and policy frameworks
	User roles
	Data management

Source：C/P

Table 3.3.26 Structure of User Manual

Item	Description
Title	User Manual for National Spatial Data Infrastructure System
Contents	Introduction
	System Overview
	Group creation for Member Agency
	Group Creation
	Configuration and member addition
	Data Upload and Configuration
	Folder Creation
	Data upload
	Configuration of Feature layer
	Creation of view layer
	Adding default visualization to the data view layer
	Configuration of data view layer
	Creation of Metadata using ArcGIS pro and Update
	Setting Metadata to ISO specification
	Creation of Metadata in ArcGIS Pro
	Publishing Metadata in the NSDI system
	Data and Metadata maintenance
	Data editing and updating
	Metadata update

Source：C/P

Photo 3.3.6 Training in Operation and Maintenance Planning for NSDI System

(5) NSDI system development supervision and software inspection

The Geo-portal on that time was unrecoverable and the NSDI system had to be rebuilt. Considering the following “Constraints” and the “Resources available”, C/P and the JPT decided to develop the system in-house using a commercial package. For this reason, the NLCS technical staff was instructed to develop the system using no-code tools, and OJT was provided to supervise the development and perform acceptance inspection work (checking the system created by the staff themselves is equivalent to acceptance inspection). The counterpart developed the system using the ArcGIS Enterprise and the User Interface was developed through coding. However, some of the functionalities of the system could not be developed due to the limited inbuilt functionalities of ArcGIS Enterprise.

【Constraints】

- Existing system instructions and design documents do not exist.
- Existing systems are not reusable, including source code
- No additional budget is allocated for new system development
- Lack of developers in NLCS who can undertake new system development

【Resources available】

- NLCS has a license agreement with ESRI to use their packages for building WebGIS, etc. without additional budget.
- Most of the functionalities could be developed using the enterprise environment. However, there were some limitations to meet all the functional requirements. So, the C/P developed the UI using code.
- NLCS staff has experience with ESRI desktop products and has prior knowledge and specification experience with the cloud version of the package used in this development, so they understand basic user and data management methods.
- GovTech Agency to grant access to data center facilities and help manage system infrastructure.

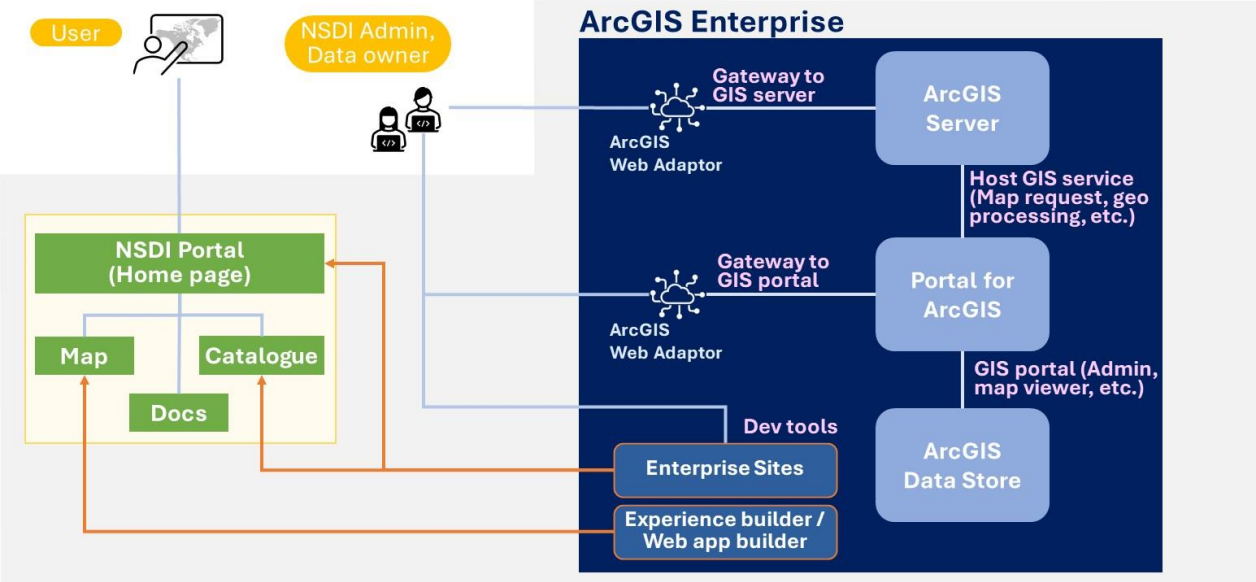


Figure 3.3.14 System Components and Their Relationships (Source: JPT)

[Activity 1-6] To identify the required equipment for the operation of NSDI and to decide the specification of the equipment

In Activity 1-6, the JPT supported the identification and specification of equipment needed for NSDI operations and procurement of equipment and materials, including bidding, in accordance with the conceptual design of ICT services developed in Activity 1-5. It should be noted that the C/P are not ICT

experts, but administrative officials. All materials and equipment were procured in Bhutan.

After the procurement of this equipment, the new arrangement between C/P and the GovTech Agency, the system was migrated to the government's data center, as it had a more secure environment, and sever functions and storage scalability.

(1) Review of Activity 1-5 and confirmation required for preparation of procurement specification of ICT equipment

Based on the conceptual design created in Activity 1-5, requirements were reviewed, necessary equipment and software were identified, and procurement specifications were prepared for ordering by the C/P. The specification was discussed thoroughly between the C/P and the JPT and the specification of the equipment was done based on requirement and the budget ceiling.

(2) Formulation of procurement plan of equipment

A plan for the procurement of materials and equipment, including procurement locations, was prepared by the C/P. The JPT organized the requirements and provided guidance on the procedures for procurement by bidding, which involves accepting proposals for equipment specifications from a couple of private companies.

(3) Formulation of operation and maintenance plan includes equipment installation location, budget, human resources and NSDI system

Advice was given from the Bhutanese side with the GovTech Agency on equipment installation locations and operational methods. As a result, it was decided that the procured equipment and materials would be installed in the server room in NLCS and operated by NLCS. Additionally, as the NSDI system (for actual services) will be operated at the data center managed by the GovTech Agency as mentioned above, the operation and maintenance follow the rules of the GovTech Agency (the operations manual on the NSDI side will note this).

(4) Preparation of specification of equipment

The procurement site was determined, and C/P prepared the equipment specifications. Although the equipment was imported, it was procured through a distributor in Bhutan.

Table 3.3.27 Specifications of Procured Equipment

#	Item	HW / SW	Requirements		Q'ty
1	Server	HW	CPU	64-bit CPUs with x86-64 architecture (Intel® Xeon processor) 8 core or above *Reference:* *Intel Xeon Silver 4208 8C 85W 2.1GHz*	1
			RAM	128GB **The system should have multiple slots for scalability*	
			Storage 1 (for data)	8TB (HDD (SAS)) *approx. Raid 1+0 **After RAID setting, available disk space is 4TB approx.* **The system should have multiple slots for scalability*	
			Storage 2 (for system)	128GB SSD M.2 enabled	
			Chassis	Tower	
			Other	Keyboard, Mouse,24 inches display, OS preloaded	
			Support	3 years (foundation level)	
2	OS	SW	Windows Server 2022 Standard ed. (latest update)		1
			5 client access licenses (package)		1
3	Anti-virus	SW	Installed to Microsoft Windows Server		1
4	UPS	HW	Minimum required for the use with above server		1

Source：JPT

(5) Procurement, Inspection, and Supervision

The equipment was procured through a bidding process and the NSDI system was put into operation. This equipment was used for backup, development, and testing as described above.

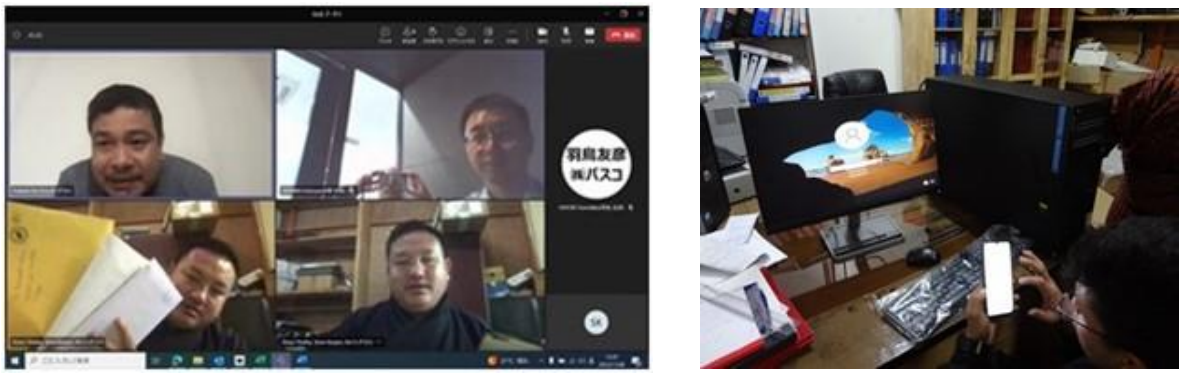


Photo 3.3.7 Bidding for NSDI System Equipment (Left: Online, Right: Inspection and Acceptance)

[Activity 1-7] To develop the strategy and policy for the promotion of NSDI and Geographic Information standards and to conduct awareness campaign such as seminar and training or workshop for the promotion of utilization

(1) Training in Japan and Training in the third country

Three training sessions were held in Japan to promote the establishment of Bhutan's NSDI and GI utilization. The places the trainees visited were mainly the GSI, Geospatial Information-related organizations (e.g., Japan Surveyors Association), local governments, and private companies. The sites visited, and lecture content were tailored to match the trainees' roles in NSDI promotion.

Each session was conducted for 16 trainees.

Table 3.3.28 Overview of Each Japanese Training Program

Period		Priority matter		Personnel Selection Considerations
1	December 2023 (14 days in Japan)	Training for Utilization of GI	Trend of NSDI establishment and operation in Japan Utilization cases of NSDI, cases of industry-government-academia collaboration, Comprehension of related activities	Mainly mid-level executives (Section Chief class in CGI)
2	June 2024 (11 days in Japan)	Training for Establishment and Updating of GI	Comprehension of ICT system in Japan, trends of current technologies, comprehension of related activities	Mainly technical personnel
3	November 2024 (10days in Japan)	Training for policy-making with GI	Background and status of NSDI establishment and operation in Japan Awareness activities, development method of human resource, discussion of NSDI in Bhutan, comprehension of related activities	Decision-making level (Chair, Vice chair class in GHLC, CGI)

Source：JPT

1) The first Training in Japan

The purpose of the program is to gain knowledge and experience in the utilization of GI by touching on the state of NSDI in Japan and how it is used in collaboration with various institutions, to discover points that can be applied in Bhutan and differences compared to Bhutan, and to propagate the knowledge gained by the participants in the training to the relevant institutions. The following themes were set and training was conducted with

- NSDI in Japan (including ”Basic Act on the Advancement of Utilizing Geospatial Information” and measures)
- Maintenance of basic electronic national land maps
- Various uses of Geospatial Information

The list of trainees, training schedule and curriculum for the first training course in Japan are shown in the table below.

Table 3.3.29 Trainee List of the First Training in Japan

#	Name	Official Position	Ministry / Agency
1	LHAMO Sonam	Deputy Chief ICT Officer	Division of Operation and Maintenance, GovTech Agency
2	ZANGPO Dawa	Deputy Chief Forestry Officer	Forest Monitoring and Information Division, DoFPS (MoENR)
3	DORJI Phuntsho	GIS Officer	Urban Planning Division, Thimphu Thromde
4	NIDUP Yeshi	GIS Officer	Geomatics and Logistics Division, DHS (MoIT)
5	DORJI Samdrup	Chief Survey Engineer	Cadastral Information Division, DoSAM (NLCS)
6	THINLEY Kinzang	Specialist II	Topographical Survey Division, DoSAM (NLCS)
7	TOBGYE Lobzang	Deputy Chief Survey Engineer	Topographical Survey Division, DoSAM (NLCS)
8	PELDON Tashi	Deputy Chief Survey Engineer	Cadastral Information Division, DoSAM (NLCS)
9	NAMGAY Tshewang	Chief Administration Officer	Administration and Finance Division, DoSAM (NLCS)
10	WANGDA Pema	GIS Officer	Centre for Geo-Information, DoSAM (NLCS)
11	RAI Prakash	Sr. Survey Engineer	Geoinformatics Division, DoSAM (NLCS)
12	DORJI Thinley	Survey Engineer	Topographical Survey Division, DoSAM (NLCS)
13	TSHERING Chencho	Survey Engineer	Geoinformatics Division, DoSAM (NLCS)
14	GYELTSHEN Jamphel	Sr. Surveyor	Topographical Survey Division, DoSAM (NLCS)
15	CHHETRI Dhan Raj	Deputy Executive Engineer	Maintenance Division, Department of Surface Transport, DoST (MoIT)
16	NAMGAY Kesang Phuntsho	Engineer	Standardization Division, BSB

Source：JPT

Table 3.3.30 Itinerary and Curriculum of the First Training in Japan

Date	Time	Training Contents	Place
12/9 (Sat) - 12/10 (Sun)		Arrival in Japan	JICA Tsukuba
12/11 (Mon)	10:00 - 12:00	- Briefing for the training	JICA Tsukuba
	14:00 - 16:00	- Greeting to GSI - Overview of GSI - Current situation of Geospatial Information in Bhutan, Q&A	Geospatial Information Authority of Japan (GSI)
12/12 (Tue)	09:30 - 16:30	- Basic Act on Promotion of Geospatial Information Utilization and - Promotion Measures - International Standard ISO/TC211 - Preparation and update of digital national basic map - Preparation and update of Geospatial Information by new technology - Disaster Prevention with Geospatial Information	GSI
12/13	09:30 - 15:00	- Introduction of GSI Maps	GSI

Date	Time	Training Contents	Place
(Wed)		- United Nations Open GIS Initiative - The Science Museum of Map and Survey	
12/14 (Thu)	10:00 - 17:00	- Urban modeling using mobile sensors	Topcon Training Center
12/15 (Fri)	13:30 - 15:00	- Current situation of Aerial photograph survey	KYORITSU AIR SURVEY
12/16 (Sat)		- Social Tour in Tokyo	
12/17 (Sun)			
12/18 (Mon)	09:30-11:30	- NSDI Today in Japan	Infrastructure Development Institute
	14:00-16:30	- Geospatial Information Science and Technology - Concepts and Applications	College of Bioresource Sciences, Nihon University
12/19 (Tue)	09:30-10:30	- Scheme of education and training for surveyor	Japan Association of Surveyors
	11:00-12:00	- Advanced utilization of GI for human dynamics analysis	Location Mind
	14:30-16:00	- Experience of disaster prevention	Disaster Prevention Center
12/20 (Wed)	09:30-11:30	- Introduction of GI initiatives in the private sector	KOKUSAI KOGYO
	13:30-16:00	- Introduction of PASCO - JICA's Cooperation on CORS in Asia - Utilization of GI for disaster prevention	PASCO
12/21 (Thu)	9:30-16:00	- Geospatial information services for local government - Open Data Policy and 3D City Modeling - Utilization of Geospatial Information for forestry - Utilization of satellite data for application of GI - Introduce of PASCO's advanced technology	PASCO
12/22 (Fri)	10:00-14:00	- Preparation of training summary for all training	PASCO
	14:30-15:30	- Reporting session to JICA	
12/23 (Sat)		Leaving Japan	

Source：JPT

At the GSI Japan, starting with a courtesy visit, the trainees were introduced to the GSI, the "Basic Act on the Advancement of Utilizing Geospatial Information" and its promotion policies and the role of the GSI, the GSI's efforts toward international standardization, the maintenance and updating of the Basic National Electronic Maps conducted by the GSI, an overview of GSI Maps, and the UN Open GIS Initiative. In addition, the trainees gave a presentation on the current status of Geospatial Information in Bhutan and exchanged opinions.

At the "Infrastructure Development Institute", lectures on the legal framework and open policy were given along with a history on NDSI, while at the "Japan Association of Surveyors", lectures on education for surveying engineers were given.

In the private sector, trainees observed demonstrations of actual measurement and ICT construction using CORS as examples of the utilization of Geospatial Information, inspection of an aircraft equipped with an actual sensor for aerial photography showing the current status of aerial photography in Japan, and lectures

on GI utilization in forestry, disaster prevention, and 3D urban fields were given.

The trainees mentioned that their stay was meaningful as they were exposed to the state of the NSDI and its various applications, and commented that they would like to share with their colleagues the many insights they gained. The main questions and answers are listed below.

Table 3.3.31 Summary of Questions and Answers in the First Training in Japan

#	Theme	Main Purpose of Questions	Summary of Responses
1	Japan case study on NSDI	Lessons and teachings from the success stories in Japan that can be applied to Bhutan	- The establishment of the GI Center as a hub for fundamental map information, Quasi-Zenith Satellite, and GI distribution. - The ability to improve accuracy and services related to the CORS network.
2		Establishment and Updating of GI in Japan	- Establishing a Basic Act for promoting GI utilization and managing progress through an annual action plan so that maintenance and updating can be promoted comprehensively and systematically in each ministry and agency.
3	GI Standards	How to properly organize large volumes of documents	- The incorporation of international standards into JIS. - GSI has developed a manual on GI utilization.
4	Application of AI technology	Processing contour lines	- Many are in the testing phase at this time. - Research on the application of AI is being conducted not only by the GSI, but also in cooperation with other private companies.
5		AI technology in the private sector	- For those that are externally available, they are published as scientific papers.
6	Disaster prevention	Hazard mapping agencies	- It is prepared by the local government managing the target area. - GSI provides the basic information for the creation.
7		Photography in the event of a disaster	- Private companies that have signed disaster agreements with the national and local governments for photography in times of disaster, and are photographed as needed. - Standby to start photography at any time in the event of an anticipated disaster.
8	Others	Certification of surveying instruments	- Procedures were explained.
9		GIS for forest analysis and garbage collection	- The history of the model's development and case studies were presented.
10		MMS, Plateau	- Examples of utilization and equipment selection were explained.

Source：JPT

Photo 3.3.8 The First Training in Japan

2) The second Training in Japan

The purpose of this training course is to obtain knowledge and experience on the ideal state of NSDI in Japan and policies on its maintenance and updating, and on the application of the latest technology to GI, to see if there are any points that can be applied in Bhutan, to become aware of differences compared to Bhutan, and to disseminate the knowledge gained by the trainees in the training to relevant organizations. The following themes were set, and training was conducted.

- NSDI and related technical services in Japan
- Establishment and update of basic electronic national land maps
- Application of state-of-the-art technology to Geospatial Information

The list of trainees, training schedule and curriculum for the second training in Japan are shown in the table below.

Table 3.3.32 Trainee List of the Second Training in Japan

#	Name	Official Position	Ministry / Agency
1	Kiba	Chief Survey Engineer	Cadastral Information Division, DoSAM (NLCS)
2	Chime Dem	Deputy Chief SE	
3	Tshering Pelzang	Surveyor	Topographical Survey Division, DoSAM (NLCS)
4	Census Bdr. Subba	Survey Associate	
5	Yenten Jamtsho	Survey Associate	
6	Ganeshman Ghalley	Survey Associate	
7	Ugyen Dorji	Surveyor	
8	Yeshey Tshomo	GIS Technician	Geo-Informatics Division, DoSAM (NLCS)
9	Choki Wangmo	GIS Technician	
10	Dendup Tshering	GIS Technician	
11	Tika Chhetri	GIS Technician	
12	Dorji Phuntsho	GIS Technician	
13	Chencho Nidup	GIS Technician	
14	Tenzin Wangchuk	Deputy Chief Map Production Technician	GI utilization, NSB
15	Ugyen Tshering	GIS Officer	GI utilization, MoEA
16	Chador	Assistant Land Register Officer	GI utilization, Samtse Thromde

Source：JPT

Table 3.3.33 Itinerary and Curriculum of the Second Training in Japan

Date	Time	Training Contents	Place
6/19 (Wed)		Arrival in Japan	
6/20 (Thu)	10:00 - 12:00	- Briefing for the training	JICA Tsukuba
	14:00 - 16:00	- Greeting to GSI and Overview of GSI - Visiting to Science "The Science Museum of Map and Survey"	GSI
6/21 (Fri)	10:00 - 16:00	- Introduction of Topcon, advanced technology of survey tools - Demonstration of GNSS Survey, mmGPS survey, Robotic TS with Laser scanner, MMS, ICT construction	Topcon Training Center
6/22 (Sat)		- Social tour in Tokyo	
6/23 (Sun)			
6/24 (Mon)	09:30 - 15:00	- Preparation and Updating of the Digital Japan Basic Map - Utilization of new technologies to maintain and update GI - Introduction of GSI Maps - Introduction of CORS in JAPAN	GSI
	15:50 - 16:20	- Visit Mt. Tsukuba	JICA Tsukuba
6/25 (Tue)	10:00 - 12:00	- Visit Inoh Tadataka Museum	Katori City
	15:00 - 16:00	- Introduction of PASCO and Geospatial services	PASCO
6/26 (Wed)	10:00 - 12:00	- Acquisition and Utilization of Laser Point Cloud information - Aviation ALB Overview - Overview of LP by UAV, MMS	ASIA AIR SURVEY CO., LTD.
	14:00 - 16:00	- Utilizing satellite data as Geospatial Information - Introduction of leading-edge Geospatial technology in PASCO	PASCO
6/27 (Thu)	09:30 - 11:30	- Introduction of mapping services and GI services - Introduction of in-house developed GIS - Inspection of GI production area	Tokyo Cartographic Co., Ltd.
	14:00 - 16:00	- Promotion of Open Access to GI - Toward the introduction of Integrated GIS	PASCO
6/28 (Fri)	10:00 - 14:00	- Preparation of training summary for all training	PASCO
	14:00 - 15:00	- Reporting session to JICA	
6/29 (Sat)		Departure from Japan	

Source：JPT

At the GSI, lectures on the maintenance and updating of Electronic National Base Maps, an introduction to the maintenance and updating of GI using new technology, an overview of GSI Maps, and an introduction to CORS in Japan were given. During the visit to "The Science Museum of Map and Survey", the trainees listened to the explanation with great interest in a relaxed atmosphere, and showed particular interest in the highly accurate mapping by Inoh Tadataka based on his foot measurements.

The training at private companies included not only lectures on the latest surveying equipment, but also demonstrations using the latest equipment and hands-on use by the trainees.

As a measuring instrument for the latest technology, such as Onboard Aircraft LiDAR, Airborne LiDAR Bathymetry (ALB) developed for deep and shallow surveying, Laser surveying by UAV (Drone), Mobile Mapping System (MMS) with lasers and cameras mounted on vehicles, the lecture covered various measurement methods using lasers and introduced various applications of GI. In particular, there was great

interest shown in the introduction of GI educational tools for upper secondary schools, and the trainees expressed a desire to use such tools in Bhutan.

The training related to education included a visit to the "Inoh Tadataka Museum". At the Science Museum of Map and Survey, the trainees learned about the history of Japanese cartography conducted more than 200 years ago and the years it took to create the maps.

Table 3.3.34 Summary of Questions and Answers in the Second Training in Japan

#	Theme	Main Purpose of Questions	Summary of Responses
1	Data sharing and publication	Publication of topographic maps by GSI and examples of use by general users	- Not only through the Web, but also through the GSI version application, which is available to the public. - Case studies of utilization
2		Platform	- Description of Web services used
3	Aerial photography	Aircraft for photography	- Description of current status
4		Photographing institution	- Explanation of GSI's role in aerial photography
5	New technologies	UAV, MMS	- A description of each technology, including its advantages and disadvantages
6	Cadastral survey	GSI involvement	- Explanation of the situation in Japan
7	CORS / GNSS	Troubleshooting	- Introducing the Japanese case study
8		“Kui-Navi” and GNSS observation	- Explanation of the differences between each technology
9		Mechanism of GNSS position acquisition in MMS	- Advantages and disadvantages of GNSS, explanation of SLAM (Simultaneous Localization and Mapping)
10	Information and Communication Technology (ICT)	Cost	- Explain the general concept
11		Referenced positional information	- Explain the implementation of the demonstration and the referenced positional information
12	Software	Software for GIS and cartography	- Introducing software developed by private Japanese companies
13	Others	Land use map	- Case studies
14		Use of satellite imagery in disasters	- Case studies and explanation of disaster agreement
15		Renewable energy	- Case studies

Source：JPT

Photo 3.3.9 The Second Training in Japan

3) The third Training in Japan

In this training course, participants learned about policies related to national land base maps in Japan, the role of the government, and efforts by the government to disseminate Geospatial Information, and gained knowledge and experience on how Geospatial Information is used.

The following themes were then set and implemented, with the aim of disseminating the knowledge gained from the training to relevant organizations as policy makers and contributing to the promotion of NSDI in Bhutan in the future, by discovering points that can be applied to Bhutan and differences compared to Bhutan.

- Policy and administrative roles for the National Land Base Map in Japan
- Efforts by the government to disseminate Geospatial Information
- Utilization of various Geospatial Information

The list of trainees, training schedule and curriculum for the third training course in Japan are shown in the table below.

Table 3.3.35 Trainee List of the Third Training in Japan

#	Name	Official Position	Ministry / Agency
1	Tshering Gyaltshen Penjor	Secretary	National Land Commission
2	Tashi Penjor	Director	DHS (MoIT)
3	Phuntsho Namgyel	Director	DGM (MoENR)
4	Samten Dhendup	Director	DoSAM, NLCS
5	Kuenzang	Program Director	National Rehabilitation Program, NLCS
6	Gonpo Tenzin	Chief Planning Officer	NLCS
7	Sangay Tenzin	Chief Land Registrar	DoLAM, NLCS
8	Chokila	Super Intendent Survey Engineer	DoSAM, NLCS
9	Dorji Wangdi	Land Registrar	DoLAM, NLCS
10	Karma Tshomo	Officiating Chief Land Registrar	DoLAM, NLCS
11	Dema Choki	Officiating Chief Legal Officer	NLCS
12	Kinzang Duba	Dy. Chief Survey Engineer	DGM (MoENR)
13	Mani Tshering	Dy. Chief Procurement Officer	NLCS
14	Bijay Gurung	Surveyor	DoSAM, NLCS
15	Bomit Lepcha	Map technician	DoSAM, NLCS
16	Nima Wangchuk	Asst. ICT Officer	Data Science and AI Division, GovTech Agency

Source：JPT

Table 3.3.36 Itinerary and Curriculum of the Third Training in Japan

Date	Time	Training Contents	Place
11/6 (Wed)		Arrival in Japan	
11/7 (Thu)	10:00 - 12:00	- Briefing for the training	JICA Tsukuba
	14:00 - 16:00	- Greeting to GSI - Overview of GSI - Visiting to Science "The Science Museum of Map and Survey"	GSI
11/8 (Fri)	10:00 - 16:00	- Utilization of Geospatial Information in agricultural field	Topcon Training Center
11/9 (Sat)			
11/10 (Sun)		- Social Tour in Tokyo	
11/11 (Mon)	09:30 - 15:00	- The Role of GSI in the Survey Administration in Japan and "Basic Act on the Advancement of Utilizing Geospatial Information" and Promotion measures - Management and provision of survey results - GSI's efforts to disseminate Geospatial Information	GSI
	15:50 - 16:20	- Visiti Mt. Tsukuba	JICA Tsukuba
11/12 (Tue)	10:00 - 12:00	- Introduction of "Ibaraki Digital Map"	Ibaraki Prefecture
	14:30 - 15:30	- Mamiya Rinzo Museum	Tsukubamirai City
11/13 (Wed)	10:00 - 12:00	- Visit Inoh Tadataka Museum	Katori City
	14:30 - 16:00	- PASCO Geospatial Information Services for Municipalities	PASCO
11/14 (Thu)	10:00 - 14:00	- Preparation of training summary for all training	JICA Tokyo
	14:00 - 15:00	- Reporting session to JICA	
11/15 (Fri)		Departure from Japan	

Source：JPT

At the GSI, lectures were given on the role of the GSI in Japan's surveying administration and its long-term plan for basic surveying, on the NSDI Act and its promotion measures, and on the GSI's management and provision of survey results and dissemination of Geospatial Information.

In addition, the GSI arranged for a visit to "The Science Museum of Map and Survey" to include a visit to CORS, as some trainees were involved with CORS, and the GSI was able to respond to various interests expressed by the trainees.

The training at private companies (Topcon and PASCO) included not only lectures on the latest surveying equipment, but also demonstrations using the latest equipment and a demonstration of self-propelled agricultural machinery (cultivators) using Geospatial Information without human intervention, and the trainees were given hands-on experience using these machines.

In addition, GI services for local governments were introduced, and interest was shown in various examples of utilization of GI by local governments. The participants visited Ibaraki Prefecture to learn about the use of GI by local governments. The system for internal use by local governments and the system for the general public were introduced, as well as the content of the services and how information is disclosed.

In this session, participants visited not only "the Inoh Tadataka Museum" but also "the Mamiya Rinzo Museum", where they learned about the surveying of unknown lands conducted more than 200 years ago, when surveying equipment was not available as it is today, and were surprised and interested in the history

of Japanese cartography and the years required for its creation.

Table 3.3.37 Summary of Questions and Answers in the Third Training in Japan

Theme		Main purpose of Questions	Summary of Responses
1	Survey Act	Types and updates of laws related to surveying	Explanation of the current situation and introduction of the English version
2	Coordinate system	Measurements and updates	Explanation of update history and Geoid measurement method
3	Basic Act on the Advancement of Utilizing GI	Lead agency for promotion	Answers regarding being state-led, cooperation and meetings with related organizations including the private sector.
4		Role of GSI and related agencies	Explanation of the status of mutual cooperation between the government and the private sector and the role of the GSI
5		Challenging	Explanation of the difficulties in coordinating with the various agencies involved in reflecting the plan
6	GSI Maps	Authority to make decisions	Explanation of the authorization mechanism
7		Data management	Explanation of data management methods, including archiving Explanation of symbols and legends on 1:25,000 digital topographic maps
8		Publish, Browse, Download	Explanation of the status of publication, including analog information, as well as registration and fees. Explanation of downloads and privacy policy
9		Standards	Explanation of the GSI's standards, its publication, and local government involvement in topographic mapping
10		Background maps	Case studies on updates
11		Database	Brief explanation of management in GSI and local governments
12	CORS	Maintenance	Explanation of management status and involvement of private contractors in the management
13		Cost	Explanation of conditions affecting costs, etc.
14		Monitoring	Explanation of earthquake and volcano monitoring and parameter updates
15	Surveying equipment	Latest equipment	Answers on automated leveling equipment, drones, total stations, laser scanners
16	Internet map distribution service of local governments	Challenging	Explain the challenges of different data and system consistency in each local government
17		Publication and downloads	Explanation of classifications related to publication and means of acquisition of data by the user
18		Create and update systems and data	Explanation of the type of data, the system, and the producer of the data Explanation of methods and frequency of data updates, and data creation and utilization by the public, local government officials, and the private sectors.
19		Utilization	Introduction to construction, garbage collection, and use in disaster management
20		System contract type	Explanation of subscription agreement
21	Plateau	Software and utilization	Share information on 3D visualization software and 3D cadastral projects outside the country

Source：JPT

Photo 3.3.10 The Third Training in Japan

4) Training in the third country

At the beginning of the project, it was planned to participate in the UN-GGIM-AP with the aim of disseminating both nationally and internationally the efforts related to NSDI and digital topographic map development and vector data deployment in Bhutan. However, the timing (November 2024) of the United Nations Global Geospatial Information Management for Asia and the Pacific (UN-GGIM-AP) is near the end of the project and may also coincide with the third training in Japan. After discussions with the NLCS, it was decided to conduct the training program by visiting a government organization in Thailand, which is also active in providing assistance to Bhutan and is a neighbor country, to share information between the two countries regarding NSDI promotion and to build a relationship for future assistance.

For this reason, the following 3 organizations that handle GI in Thailand were selected as destinations to visit, and they were approached with a request for acceptance and training content to enable the NLCS to exchange the information and opinions it needs.

- Geo-Informatics and Space Technology Development Agency (GISTDA): the agency responsible for Geospatial Information and space technology development
- Department of Lands (DOL): the agency responsible for cadastral surveying and cadastral mapping as land management
- Royal Thai Survey Department (RTSD): the agency responsible for the basic map of all of Thailand.

Table 3.3.38 Trainee List of the Third Country

#	Name	Official Position	Ministry / Agency
1	Samdrup Dorji	Chief Survey Engineer	Geoinformatics Division, DoSAM, NLCS
2	Sangay Nidup	GIS Officer	Center for Geoinformation, Geoinformatics Division, NLCS
3	Kuenzang Lhamo	Planning Officer	Policy and Planning Division, NLCS
4	Kinley Tshering	Senior Surveyor	Topographic Division, DoSAM, NLCS

Source：JPT

Table 3.3.39 Itinerary and Curriculum of the Training in the Third Country

Date	Time	Training Contents	Place
7/29 (Mon)		Arrival in Thailand	
7/30 (Tue)	10:00 - 11:00	- Briefing for third country training	
	13:30 - 16:00	- Introduction of Pasco Thailand - Introduction of MMS Service in Thailand - Observation of Geospatial Production in Thailand	PASCO Thailand
7/31 (Wed)	10:00 - 12:00	- Welcome by Director of Strategic Alliance Development - Overview of GISTDA by representative of Strategic Alliance - Thailand NGIS (NSDI) by representative of Corporate Strategy Office - Space and GI applications by representative of Geo-Informatics Management and Solutions Office - Cubesat Development by representative of National Satellite Manufacturing Center - Products and services by representative of Strategic Alliance Development Office	GISTDA
	14:30 - 16:30	- Welcome speech by Mr. Pornpoth Penpas, Director General, group photo, and overview presentation of the Department of Lands - Presentation of Cadastral Survey and Mapping by Director of Mapping Technology Division or representative - Presentation of Land Database and Information Systems Development by Director of Information Technology Bureau or representative	DOL
8/1 (Thu)	13:00 - 15:30	- Visit to the Mapping Division - Visit to the Mapping Information Center	RTSD
8/2 (Fri)		Departure from Thailand	

Source：JPT

Private GI provider (Pasco Thailand) was visited as well as a Thai government agency. During the visit to Pasco Thailand, questions were asked about the measurement services provided by MMS and the use of CORS in Thailand. During the site visit to the GI production sector, strong interest was expressed in securing and improving the skills of operators engaged in mapping, orthophoto, and laser point cloud filtering operations, and in acquiring multi-skilling for technicians.

< GISTDA >

The training began with a greeting from the Public Organization GISTDA, which previously had an exchange program with NLCS, and this visit was the start of a new relationship. GISTDA introduced the role of the agency and talked about the establishment of “The National Geo-Informatic Commission” as a promotion of NSDI in Thailand, as well as the development and GI utilization. The trainees showed great interest in the GI Standards and information disclosure platforms, and asked many questions.

<DOL>

The friendship between Bhutan and Thailand was discussed, and the hope was expressed that the mutual exchange of ideas would generate some innovative ideas. In addition to a video introduction of DOL itself, DOL's cadastral surveying and cadastral mapping activities, as well as the development of an information system to disseminate information were explained. The trainees were particularly interested in Digital

Transformation (DX) through its information dissemination system.

<RTSD>

A visit to the “Base Mapping Department” and the “Map Information Center” was conducted. In the “Base Mapping Department”, there were explanations about target scale, workflow, inspection system, etc. and the trainees asked about the acquisition of photographed data in the border area, cooperation with GISTDA in the use of satellite data, and collaboration with other ministries and agencies. In addition, interest was shown in CORS in Thailand, and a number of questions were asked.

The “Map Information Center” explained the role of the center as well as the data processing performed at the center, the various services (One Stop Service, Military Service, Civilian Service), and GI applications for defense and national security. The NSDI Committee (with the participation of relevant ministries and agencies), headed by the Prime Minister of Thailand, was also explained, including an explanation of the current situation in Bhutan by the trainees, there was a lively exchange of views on the relationship between the base maps developed by RTSD and the maps prepared by the relevant ministries for various purposes, and the portal for information disclosure and access from various ministries.

Photo 3.3.11 Third Country Training (Left: DOL, Centre: GISTDA, Right: RTSD)

(2) Seminar

Three seminars were held to disseminate strategies and policies for the promotion of NSDI and GI Standards, and to promote the use of Geospatial Information.

Table 3.3.40 Overview of Each Seminar

Seminar	Contents	
Kick-off (the 1st) Date: 23 December 2021 Venue:Thimphu	Objective	Sharing information on the current status of NSDI in Bhutan, its goals, and the project
	Theme	- Project overview:by NLCS, JPT - Current situation and issues surrounding GI in Bhutan: by NLCS - Requests for collaboration with related agencies: by NLCS, JPT - NSDI Efforts in Japan: JPT
	Participants	- About 50 people from Bhutan-related agencies (ministries, educational institutions, private sectors, media) - JICA, JPT, international donors

Seminar	Contents	
Interim (the 2nd) Date: 11 October 2023 Venue: Thimphu	Objective	Sharing of progress and challenges in promoting NSDI in Bhutan
	Theme	- Progress of activity (each result) and future plans: by NLCS, JPT - Report on the results of Training in Japan : by trainee representative - Case studies of GI utilization: by CGI member agencies
	Participants	- About 50 people from Bhutan-related organizations (ministries, government agencies, private parties) - JICA, JPT, international donors
Final (the 3rd) Date: 21 November 2024 Venue: Thimphu	Objective	Sharing of project results and future challenges and recommendations for the promotion of NSDI in Bhutan
	Theme	- Final report: by CGI, NLCS - Reporting of technology transfer results: by CGI, NLCS - Report on the results of Training in Japan / 3rd Country : by trainee representative - Proposals and recommendations to promote GI utilization: by CGI, NLCS - Future direction of NSDI: by CGI
	Participants	- About 50 people from Bhutan-related agencies (ministries, educational institutions, private sectors, media) - JICA, JPT

Source: C/P and JPT

1) Kick-off seminar

The first seminar was held on December 23, 2021, with an overview of the project and presentations on Output 1 and Output 2, their progress, and the future.

The seminar was attended by 20 agencies, including relevant ministries, public agencies, local governments, and private parties, and the participants recognized the content and progress of the project, technology transfer, and the roles of relevant agencies among the parties concerned according to the work plan.

In particular, it was noted that each activity will be implemented on the initiative of the Bhutanese side, that cooperation among related agencies is important for the promotion of NSDI, and that the Bhutanese side's inputs were shared as points to be noted.

Table 3.3.41 Participant List for the Kick-off Seminar

#	Ministry / Agency	Official Position	Number of Participants
1	Guests	Gross National Happiness Commission (GNHC), Secretary	1
2		National Land Commission Secretariat (NLCS), Secretary	1
3		DGM (MoENR), Director	1
4		JICA Bhutan Office, Chief Representative	1
5	Ministries	Gross National Happiness Commission (GNHC)	1
6		Druk Holding and Investment (DHI)	1
7		MoIT (former MoWHS)	1
8		MoAL (former MoAF)	2
9		MoENR (former MoEA)	2
10		DITT / GovTech Agency (former MoIC)	1
11		Ministry of Home Affairs (former MoHCA)	1
12	Local Governments	Thimphu Thromde	1

#	Ministry / Agency	Official Position	Number of Participants
13	Autonomous Agencies	NLCS	18
14		Bhutan Standards Bureau (BSB)	1
15		Royal Society for Protection of Nature (RSPN)	1
16		National Center for Hydrology and Meteorology (NCHM)	1
17		Royal Monetary Authority (RMA)	1
18	Academic institution	Royal Thimphu College (RTC)	1
19	Private sector	National Housing Development Corporation Limited (NHDCL)	1
20		Bhutan Telecom Limited (BTL)	2
21		Bhutan Power Corporation (BPC)	1
22		Private surveying company	2
23	JICA	Bhutan Office	2
24		Project Team	3

Source：C/P and JPT

Photo 3.3.12　Kick-off Seminar

2)　Interim Seminar

The second seminar was held on October 11, 2023. The seminar was attended by 21 organizations, including related ministries and agencies, public institutions, local governments, and the private sectors, and presentations were made on the results and progress of technology transfer in their respective activities. In addition, new technologies were introduced, as well as Web Map Services being worked on by related agencies.

Participants asked about the NSDI databases, and it was mentioned that the CGI member agencies are considering “GI inventory” and “GI categorize” for all the databases each institution has in the activities they are conducting.

It was also reaffirmed that the purpose of the NSDI is to understand GI utilization by all stakeholders to apply GI for various planning and policy-making purposes.

Regarding the unification of data formats underway in Activity 1-3, it was suggested that the data to be ISO compliant. Regarding the NSDI system-related activities 1-5 and 1-6, some people were concerned about the cost burden for system development, NLCS responded that sustainability is important, and that by

using “ArcGIS” and “ArcGIS Enterprise”, sustainability is ensured and all stakeholders can use a common system.

NLCS stated that when utilizing open source, it is important to invest in human resources to strengthen the capacity of IT personnel.

Table 3.3.42 Participant List of the Interim Seminar

#	Ministry / Agency	Official Position	Number of Participants
1	Ministries	Department of Culture and Dzongkha Development (DoCDD), MoHA	2
2		Ministry of Agriculture and Livestock (MoAL)	6
3		MoENR	4
4		Department of Surface Transport (DoST), MoIT	2
5		Department of human settlement (DHS), MoIT (former MoWHS)	1
6			
7	Local Governments	Thimphu Thromde	1
8	Autonomous Agencies	NLCS	23
9		Bhutan Standards Bureau (BSB)	2
10		National Center for Hydrology and Meteorology (NCHM)	1
11		GovTech Agency	1
12		Election Commission of Bhutan (ECB)	1
13		National Statistics Bureau (NSB)	1
14	Private sector	National Housing Development Corporation Limited (NHDCL)	1
15		Bhutan Telecom Limited (BTL)	1
16		Bhutan Power Corporation (BPC)	1
17		Private surveying company	1
18	International donor	United Nations (UN), WFP	1
19		United Nations (UN) Institute for Training and Research (UNITAR)	1
20	JICA	Bhutan Office	2
21		Project Team	4

Source：C/P and JPT

Table 3.3.43 Presentations of the Interim Seminars

#	Presentations	Presenter
1	Address by guest of honor	Guest of honor
2	Progress and issues in activities 1-1, 1-2, and 1-4	CGI (NLCS)
3	Progress and issues in activity 1-3	Topographical Survey Division (NLCS)
4	Progress and issues in activities 1-5, 1-6	CGI (NLCS)
5	Progress and issues in activity 2-1	Topographical Survey Division (NLCS)
6	Progress and issues in activities 2-2, 2-3	GID (NLCS)
7	Progress and issues in activities 1-7, 2-4	JICA Expert
8	Topographic mapping with Drone technology case study	NLCS
9	Introduction of WebGIS application in Thimphu Thromde	Thimphu Thromde
10	Introduction of WebGIS applications for local government and disaster management	DLGDM (MoHA)
11	Q&A	

Source：C/P and JPT

Photo 3.3.13 Interim Seminar

3) Final seminar

The final seminar was held on November 21, 2024. The seminar was attended by 19 organizations from the Bhutanese side, including relevant ministries, public institutions, local governments, private institutions, and academic institutions. The results of each activity, introduction of the design and functions of the NSDI system, demonstration of the NSDI system, results of training in Japan and third countries, and examples of utilization of Geospatial Information were presented.

During the Q&A session, there were many questions, especially from academic institutions and private companies, and a participant from the Royal Thimphu College, an academic institution, asked about collaboration between related agencies and academic institutions regarding the future promotion of NSDI.

A private institution, Bhutan National Bank, asked about the pricing of shared data, the status of cadastral data sharing, and how to join a CGI member institution.

CGI member agencies asked questions from the GovTech Agency about ISO Standards and Open Geospatial Consortium, and from the Department of Agriculture (MoAL) about the agencies and costs of outsourcing drone photography and data preparation to NLCS.

Table 3.3.44 Participant List of the Final Seminar

#	Ministry / Agency	Official Position	Number of Participants
1	Ministries	Department of Human Settlement (DHS), MoIT	1
2		Department of Infrastructure Development (DoID), MoIT	2
3		Department of Air Transport (DoAT), MoIT	1
4		Department of Agriculture (DoA), MoAL	1
5		National Soil Services Center (NSSC), MoAL	1
6		DCDD, MoHA	
7		Department of Local Governance & Disaster Management (DLGDM), MoHA	1
8		Department of Energy (DoE), MoENR	1
9		Department of Geology and Mines (DGM), MoENR	1
10		Department of Water (DoW), MoENR	3
11		Ministry of Health (MoH)	1

#	Ministry / Agency	Official Position	Number of Participants
12		Department of Tourism (DoT), MoFA	1
13	Local Governments	Thimphu Thromde	1
14	Autonomous Agencies	NLCS	24
15		Bhutan Standards Bureau (BSB)	2
16		GovTech Agency	1
17	Private sector	Bhutan Telecom Limited (BTL)	1
18		Bhutan National Bank Limited (BNBL)	1
19		Druk Green Power Corporation Limited (DGPL)	1
20		Construction Development Corporation Limited (CDCL)	1
21		Bhutan Power Corporation Limited (BPC)	3
22	Academic institutions	Royal University of Bhutan (RUB)	1
23		Royal Thimphu College (RTC)	1
24	JICA	Bhutan Office	4
25		Project Team	3
26	Media	Bhutan Broadcasting Service (BBS)	1

Source：C/P and JPT

Table 3.3.45　Presentations of the Final Seminars

#	Presentations	Presenter
1	Address by guest of honor	Guest of honor
2	Progress and Achievements of Output 1	CGI (NLCS)
3	Progress and Achievements of Output 2	Topographical Survey Division (NLCS)
4	Bhutan Standards for Geographic Information	Geo-Informatics Division (NLCS)
5	NSDI system design and operation	Geo-Informatics Division (NLCS)
6	NSDI system demonstration	Geo-Informatics Division (NLCS)
7	Report of Training in Japan and 3rd country	Geo-Informatics Division (NLCS)
8	Example of GI utilization National Land Use Zoning	Geo-Informatics Division (NLCS)
9	The Critical Role of Data Collection in Developing Effective Data Product Specifications (DPS)	Department of Geology and Mines (MoENR)
10	Q&A	

Source：C/P and JPT

Photo 3.3.14 Final Seminar

(3) Other meetings, workshops, etc.

1) Workshops with NSDI stakeholders

In addition to CGI member meetings, CGI continues to hold seminars and workshops on GI when appropriate. At the beginning of this project, due to COVID-19, it was not possible to hold regular in-person meetings as before, so online meetings were increased. Since the CGI members meeting in December 2021 after the start of this project, meetings have been held regularly either in-person or online.

Below is a summary of CGI member meetings conducted from 2021 to the present. The meetings are held at least twice a year.

Table 3.3.46 Summary of Stakeholders Meetings During the Project

#	Period		Contents / Theme	Remarks
1	2021	December	Explanation and sharing of this project Current status of GI utilization by related agencies Metadata explanation	In-person
2	2022	June	GI inventory Single-Source-of-Truth (SSOT)	In-person Held concurrently with workshops
3		August	Progress of NSDI and summary of GI Inventory Classification and SSOT workshop Progress of Base Maps establishment Management of CGI	Online
4		September	SSOT	In-person
5	2023	June	Action Plan for GI utilization	Online
6		October	Progress of each activity in this project Introduction of the NSDI system and associated GI utilization Introduction to Drone technology	In-person Held concurrently with the 2nd seminar
7	2024	March	GI Standards, SSOT, Data cleaning	In-person Held concurrently with workshop
6		November	GI Standards, SSOT, Data cleaning	In-person Held concurrently with the 3rd seminar

Source：C/P

2) Workshop on NSDI promotion

To promote NSDI, workshops were held under this project, bringing together relevant agencies according to each activity related to Output 1 and Output 2. Comprehensive efforts to promote NSDI, including common rules, system building, action plans, data preparation, etc., are essential, and individual efforts must be made in parallel with overall information-sharing and consensus-building efforts such as CGI member meetings.

Workshops included technical training, mainly in the form of exercises, and study sessions to assist inexperienced agencies involved (e.g., personnel transfers, etc., who are new to the program). The following workshops were conducted during the project period under the active self-management of the Bhutanese side.

Table 3.3.47 History of Workshops on NSDI Promotion

#	Period		Contents / Theme	Related Activities	Remarks
1	2023	July	Metadata (the First, the Second)	1-3 1-5	JICA Experts to NLCS (DoSAM) Key members (In-person and online)
2	2023	June	Action Plan	1-4	NLCS staff Thimphu Thromde, DoFPS (MoENR), DoST (MoIT), DLGDM (MoHA) (Online)
3	2023	January	ICT System design	1-5	CGI and NLCS staffs
4	2023	February	Functional requirement	1-5	
5	2023	March	Non-functional requirement	1-5	JICA experts to NLCS (DoSAM) Key members (In-person)
6	2023	June	Design (documentation)	1-5	
7	2023	June	Development tool	1-5	
	2023	July	Metadata registration methods	2-2, 2-3	
8	2023	November	GI Standards	1-3	Voluntary implementation by C/P
9	2024	March	GI Standards, SSOT, Data cleaning	1-3 1-5	
10	2024	June	NSDI system	1-5	CGI office to relevant agencies
11	2024	October	Executive level meeting (MoU for Geospatial data management and sharing through NSDI)	All	17 related agencies
12	2024	November	GI Standards, GI data integration	All	CGI office to relevant agencies

Source：C/P

3.3.6 Output 2: Activities related to ”Capacity development for making, updating, management and utilization of digital topographic map”

[Activity 2-1] To enhance the capacity of making and updating the digital topographic map on scale 1:25,000 and 1:5,000 or larger (includes Vector Tile focusing advancement to Web Map Service) in pilot area

OJT and ToT in the pilot area provided technology transfer to improve capacities for creating and updating digital topographic maps.

(1) Training results in the "JICA project 2015 - 2017" and the target capacity to be strengthened in this project

In the "JICA project 2015 - 2017", the following training was conducted for the preparation of 1:25,000 digital topographic maps. As a result, 4 individuals participated in all the trainings (11 in total) and 4 reached the following levels.

Table 3.3.48 Details of Technology Transfer in "JICA project 2015 - 2017"

Theme / Process	Scope / Content / Technology	Period / Timing	Result
Specifications discussion	Feature catalogue	At the beginning of the project, before and after the Field Verification	C/P has reached a level where content can be discussed
	DPS (draft)	At the end of the project	C/P understood the need for it
	Marginal design	At the beginning of the project, during quality evaluation	C/P has reached a level where content can be discussed
Control point survey	Southern part GNSS survey: 9 points, Leveling (direct and GNSS): 26 points, Network adjustment	Approx. 6 weeks after procurement of satellite images	C/P has reached a level where work can be carried out without problems
Aerial Triangulation / DEM / Orthophoto	Aerial Triangulation: 1 Stereo pair, GCP 8 points	Theory (4 days), Software operation (10 days), Exercises (5 days), Evaluation (1 day)	C/P has reached a level where it can work on a small portion (1-2 stereo pairs) (issues with troubleshooting)
	DEM / Orthophoto：1 Stereo pair	Theory (3 days), Software operation (11 days), Exercises (14 days), Evaluation (7 days)	
Field Verification	Southern part	Approx. 9 weeks after Digital Plotting	C/P has reached a level where work can be carried out without problems
Digital Plotting	Planimetric Features: Pilot area	Theory (5 days), Software operation (22 days), Exercises (5 days), Evaluation (5 days)	C/P has reached a level where work can be carried out without problems
	Contour Line: Pilot area	Theory (3 days), Exercises (40 days), Evaluation (5 days)	Work speed is an issue, but C/P has reached a level where it can be worked on
	Accuracy control: Pilot area	13 days	Level of continued support needed
Digital Editing	Pilot area (including accuracy control)	Theory (2 days), Exercises (16 days), Evaluation (1 day)	C/P has reached a level where it can work on a small portion (1-2 stereo pairs)
Symbolization	Pilot area (including accuracy control)	Theory (10 days), Exercises (33 days), Evaluation (1 day)	C/P has reached a level where work can be carried out without problems

Source：C/P and JPT

(2) Formulation and implementation of ToT scheme

As for capacity building for 1:25,000 and 1:5,000 scale digital topographic maps, as mentioned above, a certain amount of training results was achieved in the “JICA project 2015 - 2017”, so the training content for 1:25,000 digital topographic maps focused on strengthening weak points at the practical level, improving

work efficiency, and strengthening the capacity required for outsourcing.

For the 1:5,000 digital topographic maps, the training content was designed to be aware of the differences from the 1:25,000 digital topographic maps, excluding the overlapping areas with the 1:25,000 digital topographic maps. The training conducted is shown in Table 3.3.49.

In addition, consideration was given to the development of engineers after the project, and technology transfer through OJT was implemented to develop trainers.

Three candidates for lecturers were selected from the technology transfer targets of the previous project to conduct the training. After the training for lecturers was conducted, training was provided by the trainers to other technicians.

In converting educational materials to online content, training on ArcGIS Online was conducted as part of the ToT implemented in Activity 2-3, which included map operations on ArcGIS Online and the creation of maps and simple applications, and the technology is now being shared through staff members who participated in the training. Similarly, workshops for data managers are also available to share their skills.

Table 3.3.49 Contents of ToT on Topographic Maps Establishment and Updating

Theme / Process	Contents / Technologies	Training Methods
Satellite images	Specification and procurement of satellite Imagery	Lectures (Online / In-person)
	Satellite image inspection	Lectures (In-person)
	Creation of satellite pan-sharpened images	Exercise (In-person)
Control point survey	Operation plan	Lectures (In-person)
	Evaluation and feedback of survey results	Lectures (In-person)
Aerial triangulation	GCP allocation plan	Lectures and Exercise (In-person)
	Evaluation of results and feedback	Lectures (In-person)
DEM and Contour lines	Automatic generation and editing	Exercise (In-person)
	Contour generation method from DEM	Lectures and Exercise (In-person)
	Quality assessment of commercial DEM	Lectures and Exercise (In-person)
Topographic map	Evaluation and feedback of 3D Plotting and editing results	Lectures and Exercise (In-person)
	Symbolization templates	Lectures (In-person)
Field survey	Technology transfer using digital equipment	Exercise (In-person)

Source：JPT

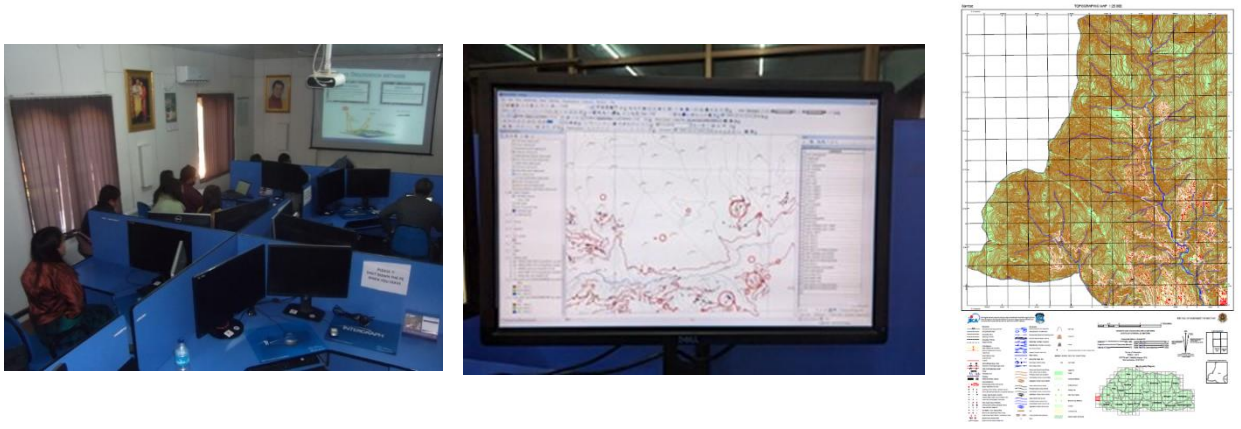


Figure 3.3.15 ToT (From Left: Satellite search, Quality Control, 1:25,000 topographic map)
(Source: JPT)

(3) Technology transfer for digital field surveys

In November 2022, a digital field survey technology transfer was conducted using GPS-equipped tablets, according to the following schedule. Six participants from NLCS were divided into three teams.

The pilot area was the eastern region of Bhutan, as well as the 1:25,000 topographic coverage. The major cities in the range were “Phongmey” and “Sakteng”.

The training included a work plan, and the work was completed on the planned dates. The work could also be completed in a shorter period of time than with the conventional analog (by printed) method, proving the efficiency effect.

Table 3.3.50 Schedule of Digital Field Survey Training

Schedule	Work
Day 1	Preparation, Explanation of QField manipulation, Demonstration
Day 2	Work Planning
Day 3	Travel day (Thimphu → Bhumthang)
Day 4	Travel day (Bhumthang → Trashigang)
Day 5	Travel and Training (Trashigang → Sakteng)
Day 6	Training (Sakteng Area)
Day 7	Training (Sakteng / Phongmey Area)
Day 8	Training (Phongmey Area)
Day 9	Training (Phongmey Area)
Day 10	Travel day (Phongmey → Bhumthang)
Day 11	Travel day (Bhumthang → Thimphu)
Day 12	Result filing, Evaluation of the Technology transfer

Source：JPT

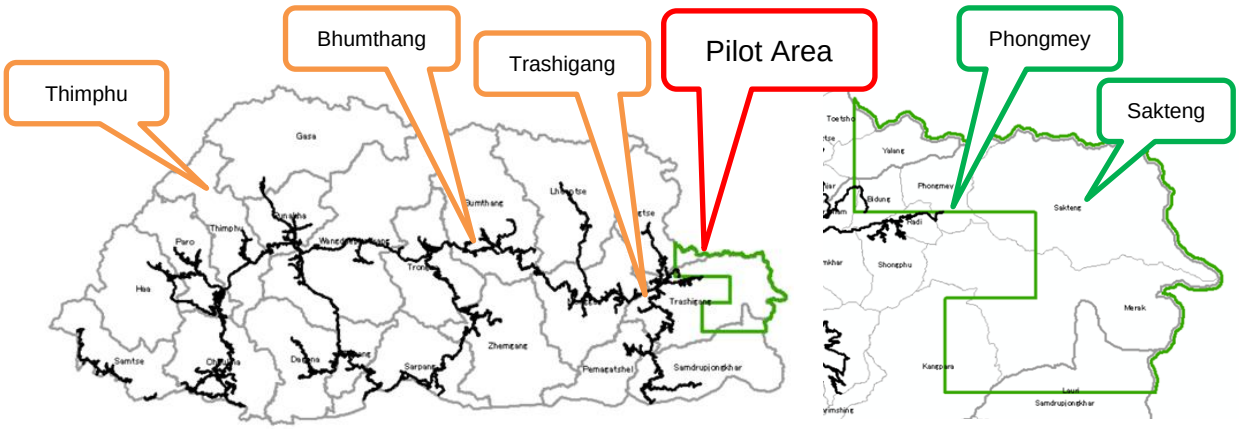


Figure 3.3.16 Pilot Area of Digital Field Survey Training

Instead of using the conventional method of printed drawings, a digital method was adopted in which the plotted data, orthophotos, existing raster map (1:50,000), etc., are stored in the Tablet PC as digital data, and positional information is input with a drawing tool while the Tablet displays the area around the surveyor’s location using the built-in GPS.

The benefits of being able to efficiently conduct field surveys and directly capture results as digital data

were understood by using a QGIS-based tool called “Qfield” to display the data and using QGIS functionality to enter the geometry of the target features directly in the field with data or by entering attributes in text.

Table 3.3.51 Equipment and Data Used for Digital Field Survey Training

Equipment and Data		Details
Tablet PC	Hardware	Android Tablet with GPS
QField	Software	QGIS-compatible tools for fieldwork
Orthophoto	Data (raster)	Image created from SPOT satellite image
Rough drawing map	Data (vector)	Data generated by stereo mapping of satellite images
1:50,000 existing map	Data (raster)	Scanned and geo-rectified image of an existing map

Source：JPT

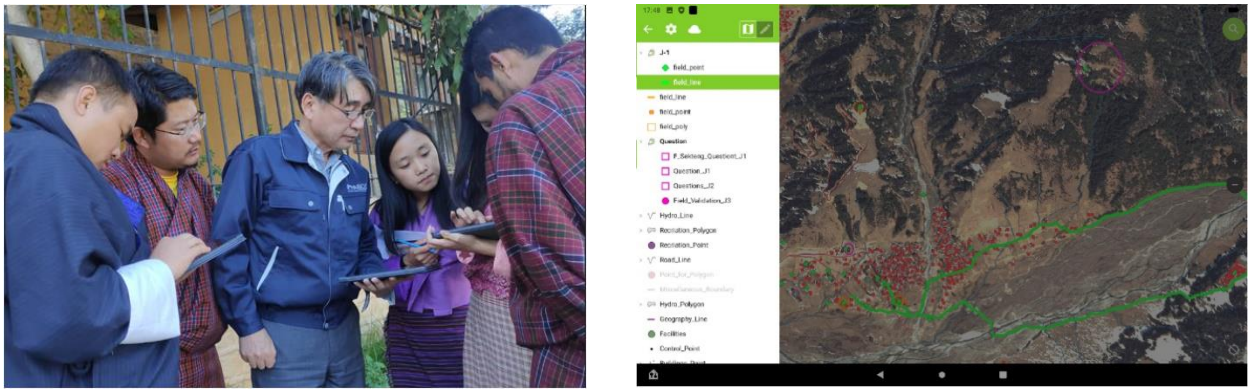


Photo 3.3.15 Digital Field Survey Training

(4) Technology transfer for efficient establishment and updating of 1:25,000, 1:5,000 and other large-scale topographic maps

To implement GI development and updating that is less burdensome and more sustainable for NLCS after the project, the JPT introduced and provided relevant training on technologies that are appropriate and effective for Bhutan's characteristics in financial, technical, production, and quality aspects.

1) Drones

One set of “DJI Phantom 4”, 1 set of “DJI Matrice 300 RTK” with LiDAR sensor and processing software (DJI TERRA) procured for the project, NLCS had already trained in basic operations from a private company in Bhutan and trainees had the capacity to perform a series of tasks related to planning, photographing, and processing acquired data.

Therefore, the JPT provided technical support with emphasis on the part of creating large-scale digital topographic maps from drone-captured images and elevation data from LiDAR.

2) Utilization of DEM

The most labor-intensive part of topographic map data preparation and updating in Bhutan is the creation of contour lines, and 3D equipment is essential for stereo mapping of contour lines. In other words, the more efficient the creation of contour lines, the more efficient the topographic map data maintenance and updating process will be.

As noted in Chapter 2.2.1, the 1:25,000 digital topographic map will be largely in place by 2025, with the remaining portion to be developed by the NLCS by 2029. The area is a mountainous region with many bare areas, and compared to forested areas, the ground surface is visible, making it the easiest area to use DEM to create contour lines. To verify the feasibility of using DEMs at the practical level in this area, the JPT procured commercial DEMs and conducted a quality evaluation of commercial DEMs by comparing them with the conventional method of obtaining contour lines through stereo mapping, as well as training on methods of creating and editing contour lines from DEM.

Table 3.3.52 Advantages and Disadvantages of DEM Contour Lines against Stereo Mapping

Theme		Details
Advantage	Work efficiency in bare land	The mesh spacing of the DEM is 5 m, although supplemental information is needed for narrow ridges and summit areas, in other bare areas, the created contours could be used without requiring major editing.
	Support as reference data	In forested areas, it can be used to identify topographic trends (ridge and valley shapes) during stereo mapping, thereby improving work efficiency (especially effective for inexperienced operators in contour mapping).
Disadvantage	Quality in forest areas	In the forest area, there were many height errors that did not meet the required accuracy.
		Contour lines along rivers in forested areas especially required a lot of modification.

Source：JPT

3) Use of existing materials and equipment

As ideas to reduce the workload (days, personnel, equipment, and costs) of aerial triangulation using satellite imagery and stereo / single-image mapping of satellite imagery, while maintaining quality, the JPT reviewed and organized materials about technologies that utilizes "Cadastral data (building footprints)", "Secondary Control Points", "Existing 1:5,000 topographic maps", and the Stereo pair of Geo-Eye satellite images provided by an international donor in 2009, and lectures and exercises on quality were conducted.

Photo 3.3.16 Efficiency Training for Topographic Maps (Left: Drone, Right: DEM Contour Lines)

(5) Technology transfer for procurement of materials and equipment

There may be an option to procure commercially available “Satellite imagery” or “DEM” for post-project, large-scale topographic map extension and update work at 1:25,000 and 1:5,000 by the NLCS. Here, the JPT introduced the types of topographic maps that can be produced quality-wise, price-wise, etc., for commercially available “Satellite imagery” and “DEM”, and provided training on searching and procurement.

(6) Other trainings

The JPT supported the C/P on the following.

1) Collaboration with the “JICA Grant Aid Project” and WWF project

The JPT provided lectures on DPS and advice on process control, based in part on the content of the training in “GI Standards” in Activity 1-3, a technology transfer specializing in quality control about the 1:25,000 and 1:5,000 topographic maps to be developed by “JICA Grant Aid Project”.

In addition, although the case for assistance by WWF, which was underway at the same time as this project, included the procurement of satellite imagery and equipment for the creation of a 1:25,000 topographic map, JPT provided technical assistance to NLCS during these specification studies. In this WWF project, each of the topographic mapping tasks was performed by NLCS, and JPT provided technical advice as needed on work planning and process and quality control.

2) Training on Vector Tiles

Training on Vector Tiles was conducted as a technique to effectively use digital topographic maps at scales of 1:25,000 and 1:5,000 as background data for the Internet Map Distribution Service in the NSDI system.

There are several types of vector tile creation methods, for example, United Nations Vector Tile Toolkit (UNVT) and ESRI package. The appropriate one was selected in consultation with the C/P, considering the actual situation in Bhutan, the level of technology, and the affinity with the NSDI system.

The vector tile creation for this project was done using the ESRI product (ArcGIS Pro) methodology for the reason that the NSDI system developed in the project was composed of ESRI products (see Activity 1-5 in Chapter 3.3.5 for details), and the ESRI methodology is simpler and does not require knowledge of coding, etc., and can be processed by the same software used by the NLCS to create and manage digital topographic maps.

However, the JPT also carefully explained the other Vector Tile method using UNVT to the C/P, including its advantages and disadvantages and comparison with the creation method using ESRI products, and finally decided on the method based on C/P's request.

The target topographic map scales covered were 1:25,000, 1:5,000, and 1:5,000 and larger.

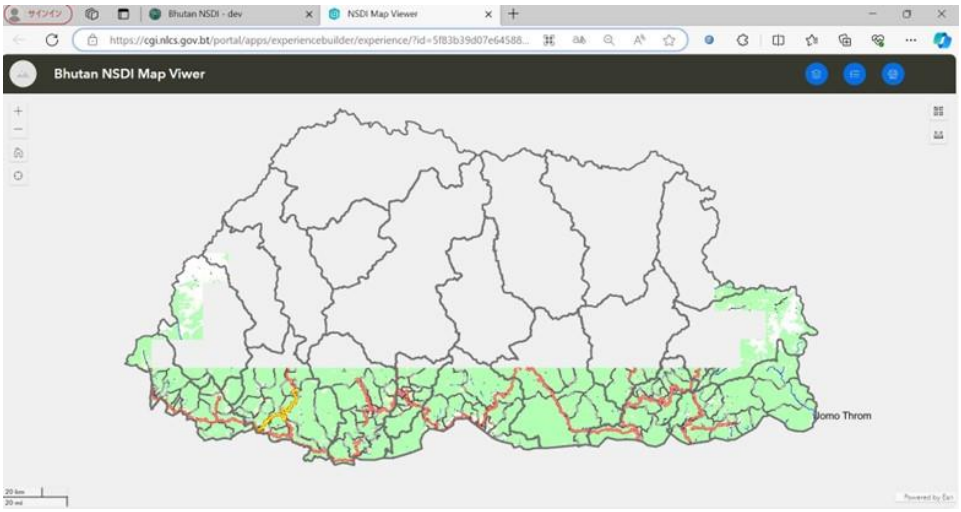


Figure 3.3.17 Vector Tiled Topographic Map on NSDI System

3) Support for publicizing results

The JPT supported the C/P in organizing information and preparing materials to publicize the digital topographic mapping technology, maintenance status, and utilization status at seminars and workshops.

As a result, for example, there were “Drone” photography and topographic mapping requests to NLCS from stakeholder agencies during the project. Another request was for a 1:5,000 digital topographic map of the Samtse area, which will be utilized by Department of Human Settlement (DHS, MoIT) during the 13th Five-Year Plan and for which satellite imagery and DEM were provided during the OJT of this project.

[Activity 2-2] To clarify the authorized organization for the management of Geospatial Information and to develop the efficient process of data management, sharing and updating of each piece of Geospatial Information

In this activity, although the goal was to create comprehensive guidelines for Managing, Sharing, and Updating data, a framework was created by the C/P to present a concept for data management, sharing, and updating that is universally used regardless of the software used for the system, since there was an overlap of the output created in Activity 1-5, which is the operation manual including data management.

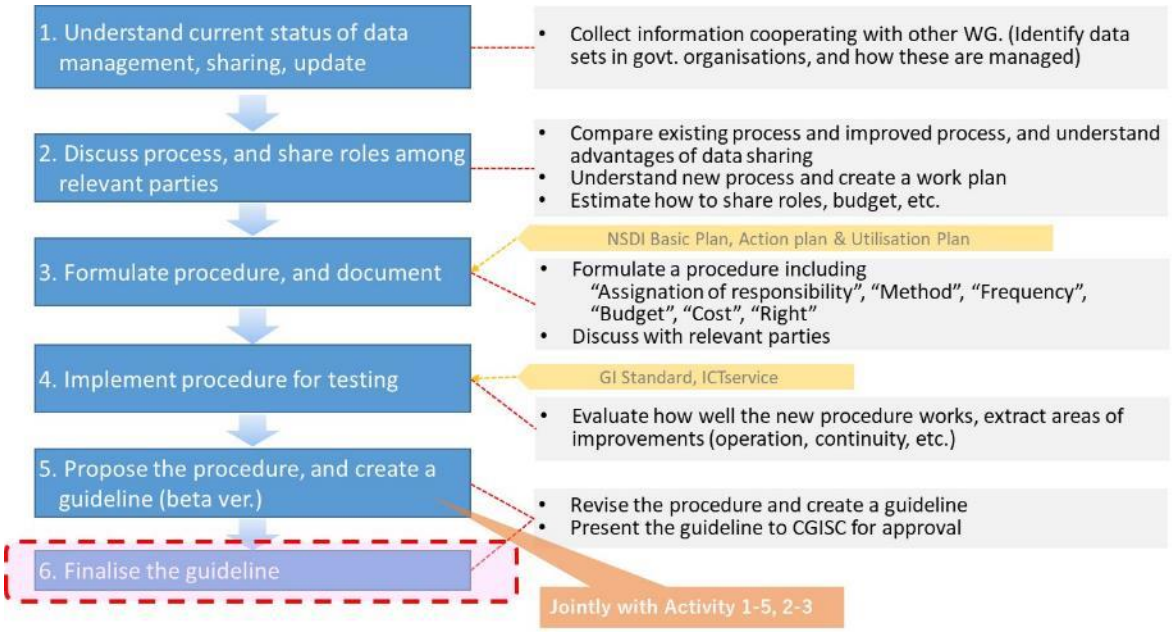


Figure 3.3.18 Approaches to the Creation of Guidelines for the Management of GI

(1) Surveying of current status

Questionnaires and interviews were carried out with agencies that are members of this activity to understand the current status of data management, including the status of NLCS and agencies other than NLCS, and to get a concrete image of what they want to achieve and the effects and benefits of their efforts. The current status of managed data, data management and distribution procedures, and issues and needs were reviewed. The results are described in Chapter 2.2.5.

(2) Organizing of process and consensus of role sharing

Processes and role assignments are discussed in the principal context of the NSDI, and the general framework for data management is based on it. For individual data, the responsibility of the system administrator and the data administrator are differentiated, with the agency that creates and manages the data having direct responsibility for costs, quality, updates, etc. The process of the NSDI system is shown in the SOP organized in Activity 1-5.

(3) Planning for formulation of "Data management, sharing and updating framework (draft)"

Led by the person in charge from the C/P and CGI members of NLCS, drafts for the data management, updating, and sharing framework were developed, after the presentation, the draft was updated with feedback from the data management staff at each agency.

The created framework includes the following contents, and the framework will be updated by the C/P from time to time.

- Introduction
- Scope
- Goals and Objectives
- Data Management, Sharing and Update
  - Data Creation
  - Data Standards
  - Data Categorization
    - Standard Operating Procedure (SOP) for Data Categorization
  - Data Sharing
    - Data Access
    - Operation and User Manual for Data Sharing
  - Data Integrity
    - Update
    - Data Backup and Archiving
  - Data Use
    - Integration
    - Terms of Use
    - Report

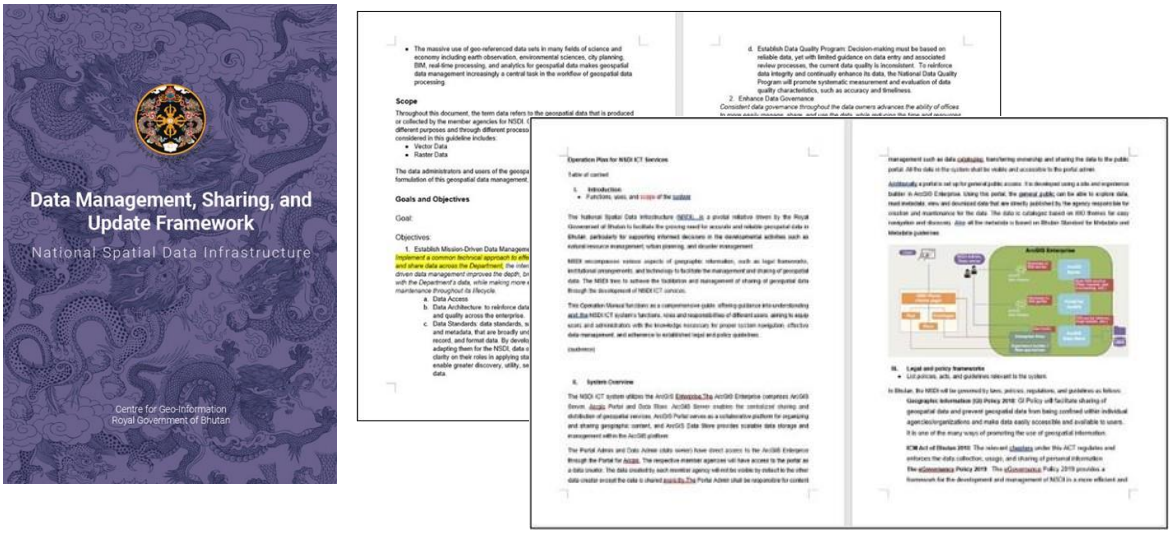


Figure 3.3.19 Guidelines for Data Management, Updating, and Sharing (Draft) (Source: NCS)

(4) Pilot training with ”Data management, sharing and updating Guidelines (draft)”

The data management, updating, and sharing framework created for this activity and the SOPs created in Activity 1-5 were implemented in the workshop, and no problems were found regarding the procedures. If problems arise in the future when the system is fully operationalized by the data administrators of each agency, it will be revised from time to time. During the project period, the final draft will be compiled, and

then submitted to the GHLC through the CGI at an appropriate time, depending on the coordination of the Bhutanese side.

[Activity 2-3] To enhance the capacity to utilize digital topographic maps in related organizations (mechanism of digital topographic map is understood by related agencies in Bhutan and utilization capacity of Geospatial Information with GIS Tools is strengthened)

The trainers trained the participating agency staff and supported the creation of an environment in which the staff could train autonomously. Training was conducted according to the following procedures.

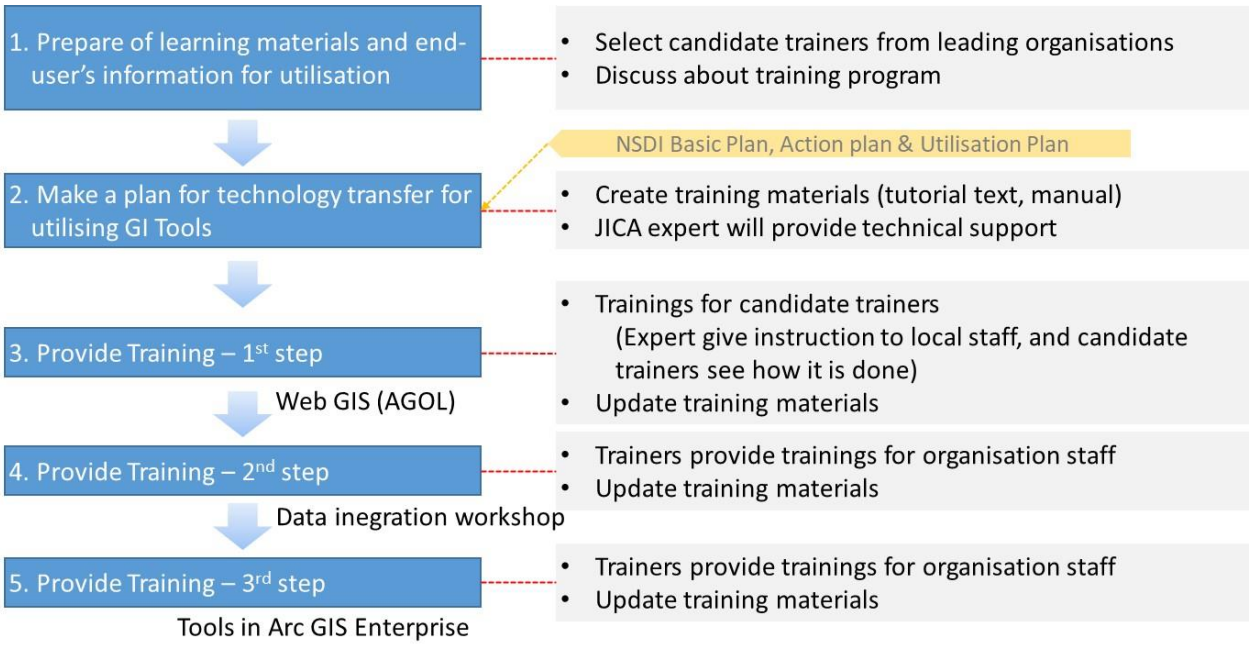


Figure 3.3.20 Approaches for Building a System That Can Establish a ToT

(1) Knowledge and handling method of data format, structure, accuracy of digital topographic maps and satellite images

ToT of NSDI was provided to staff members who use digital topographic maps and other data as a background and then overlay their own department's data to create their Geospatial Information. Therefore, the training focused on the explanation of the NSDI and the handled data, including topographic maps and satellite data, showing examples of other countries, and how the topographic map layer provided by the NSDI can be imported to a Web map and overlaid with other thematic data such as survey results during the training, the JPT tried to support participants' understanding by showing the topographic maps produced by NLCS that meet the quality standards in Bhutan and what makes them different from other internet map distribution services.

(2) Collaboration with Activities 1-1, 1-2, 1-4, 1-5

Since this activity will be developed based on the results of Activity 1-5, which is specifically the conceptual design and development of the NSDI system, and Activity 2-2, which defines a framework for data management, sharing, and updating, training was conducted in collaboration with those activity groups. In particular, since it is necessary for data administrators to have a correct understanding of the NSDI system SOP and data management framework in the training for data administrators, members of Activities 1-5 and 2-2 served as trainers to provide training.

The data management procedures to be performed in Activity 2-2 were also incorporated into the training content of the joint training by Activities 1-5, 2-2, and 2-3, as it was difficult to conduct the training in Activity 2-2 by itself.

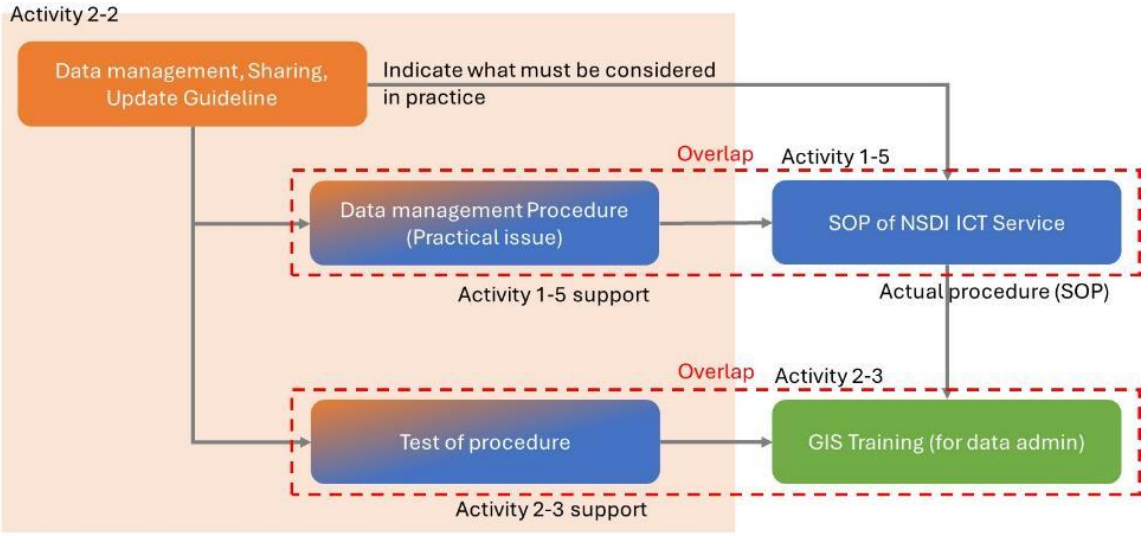


Figure 3.3.21 Coordination of Various Activities Related to Data Management

(3) Understanding utilization of Geospatial Information with GIS tools in advanced countries and Bhutan

The JPT provided information on how other countries provide GI and training in the ToT on WebGIS and the C/P and the JPT discussed how to plan a sustainable training program to continue ToT after this project.

The results were organized with C/P personnel and documented as a plan for sustainable training.

(4) Acquisition of capability to create thematic map with data from NSDI and participating organizations, and method of data analysis

Basic ToT on thematic mapping was conducted using WebGIS, which has a similar interface to the NSDI system. Since the participants were GIS trainers at their respective institutions, they had already learned how to create thematic maps, etc., or had mastered data analysis and other methods to some extent through their study experience abroad. However, they did not have sufficient experience in teaching WebGIS to

others and needed to acquire trainer skills, so the ToT was presented from the perspective that these staff members would be able to return to their own agencies and teach them how to create thematic maps by overlaying NSDI data with data from their respective working units.

Photo 3.3.17 GIS Trainers (for ToT) Gathered from NLCS and Other Agencies

Below is the curriculum for the training.

Table 3.3.53 Curriculum and participants for the ToT

#	Date	Course	Target Organization	Master Trainer	Number of Participants	
					People (Include Trainers)	Section
1	8 Feb 2023	Web GIS (Basic)	NLCS	Tashi Perdon, Katsuya Homma	5	5
2	28 Feb 2023	Web GIS (Basic)	NLCS	Lhakpa	1	1
3	9 Mar 2023	Web GIS (Basic)	NLCS	Tashi Perdon	2	2
4	28 Mar 2023	Web GIS (Basic)	Department of Energy (MoENR)	Ugyen Tshering	8	4
5	19 Mar 2014	Portal (for admin)	NLCS	Homma	3	2
6	3 June 2024	NSDI system	CGI member agencies	Homma, Pema Wangda, Prakashi Rai	22	15
7	2 Sep 2024	ArcGIS Enterprise GIS tools (Day1 – Quick capture)	NLCS	Homma	5	3
8	3 Sep 2024	ArcGIS Enterprise GIS tools (Day2 – Field maps and Dashboard)	NLCS	Homma	3	3
Total					49	35

Source：C/P and JPT

(5) Creation of education materials for utilization of GIS Tools (e.g., ArcGIS)

Training using the GIS Tool was conducted based on the C/P's needs, and included content that was assumed to be used in the actual work environment, such as building a simple application provided by the NSDI system and using it to conduct field surveys and deploying the results on a map (displayed in a dashboard format) in the form of statistical information.

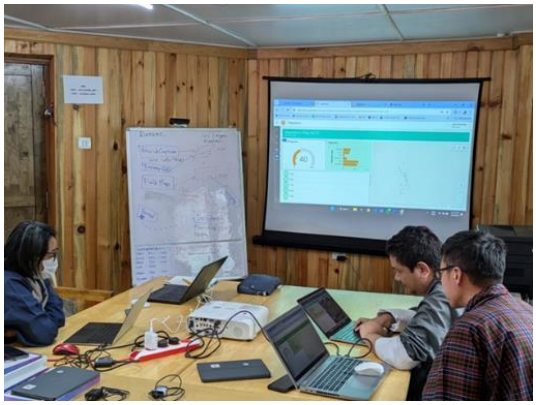


Photo 3.3.18 Training with GIS Tools (Creation of a Dashboard that Statistically Displays the Data Collected by the Field Survey Application)

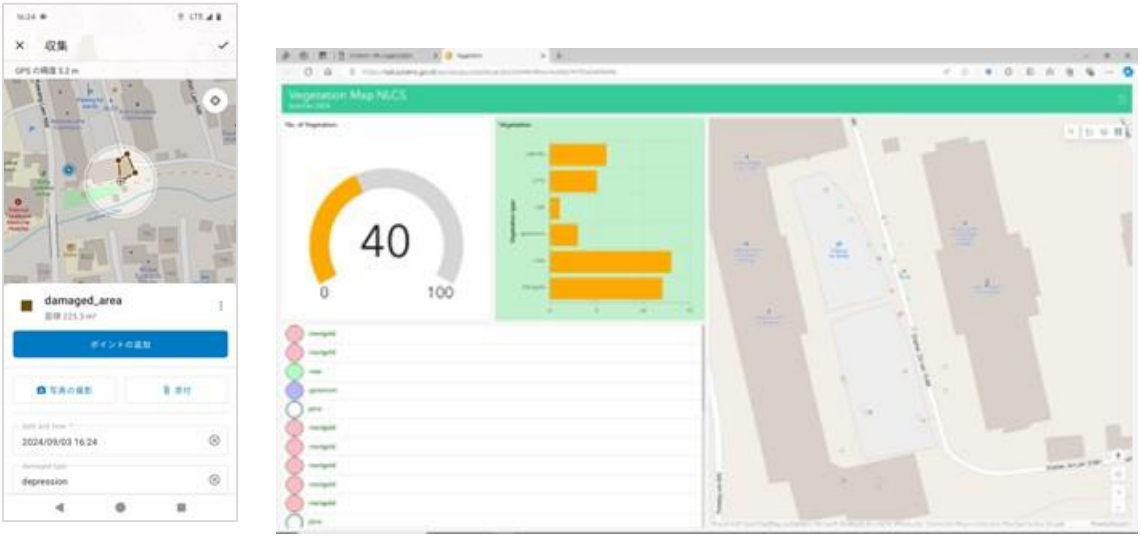


Figure 3.3.22 Mobile App (Left) and Dashboard (Right) Created During the Training (Source: NLCS)

[Activity 2-4] To conduct awareness campaigns such as seminars and training or workshops for the promotion of utilization of Geospatial Information including digital topographic maps

The following activities were conducted to promote GI utilization.

(1) Awareness-raising activities conducted

The following workshops were held as awareness-raising activities to promote GI utilization. In particular, Bhutan's interest in drones was high, as evidenced by the introduction of Drone applications by related agencies at the CGI member meeting and the technology introduction by NLCS at the interim (the 2nd) seminar, and the country was also active in educational activities.

Table 3.3.54 History of Workshop on Promotion of GI Utilization

#	Period		Contents / Theme	Related Activities	Remarks
1	2022	June	Basic drone operation	2-1	Conducted by UNITAR Project (In-person)
2	2022	October	Symbolization	2-1	To NLCS technicians (TSD, GID) from JICA experts (In-person)
3	2022	October	Digital Field Survey	2-1	To NLCS technicians (TSD) from JICA experts (In-person)
4	2023	June	Vector Tile (Comparison of UNVT and ESRI Vector Tiles)	2-1	To NLCS technicians (TSD, GID) from JICA experts (Online)
5	2023	October	Vector Tile exercise (1:25,000 topographic maps)	1-5 2-1, 2-3	To NLCS technicians (TSD, GID) from JICA experts (In-person)
6	2024	May	Vector Tile exercise (Larger than 1:5,000 topographic maps)	1-5 2-1, 2-3	
7	2023	February	GIS Tools (ToT: WebGIS basic)	2-3	From ToT instructor candidate to technician at other agencies
8	2023	May	Metadata	1-3, 1-5	To NLCS technicians (TSD, GID) from JICA experts (In-person)
9	2024	June	Data registration training	1-5 2-2, 2-3	External stakeholders (i.e., data admins) on the NSDI system
10	2024	Nov	Data integration, GI Standards	1-3, 1-5 2-2, 2-3	19 member agencies (including BPC, BTL, private companies)

Source：C/P and JPT

Chapter4 Project Achievements

4.1 Achievement of Project purpose and Indicators of each output

4.1.1 Achievement of Project purpose

The indicator of the Project purpose "To share the reliable and precise Geospatial Information with related organizations including the private sectors utilizing NSDI established and operated by the Royal Government of Bhutan" is "The number of geospatial layers available for download by the general public (Target Value: 50)" and "Agreement from each organization (target value: 10)".

As for the registration of layers in the NSDI system, more than 10 agencies have registered data into the NSDI system, and more than 50 layers have already been made downloadable by general public as of the completion of the project.

Based on the above, it can be evaluated that the project purposes were achieved by the end of the project.

4.1.2 Achievement of Output 1

Regarding the Goal of Output 1: "Capacity development for the operation planning and implementation for the strategic utilization and promotion of NSDI", indicators and target values, as well as the status of achievement, are shown in the table below.

Table 4.1.1 Indicators and Target Values for Output 1

#	Indicator	Target Value	Related Activities	Status of Achievement
1	Number of stakeholders of NSDI	CGI member list (36 agencies)	1-2	Achieved
2	Number of meetings and participants	2times/yea (10 agencies each)	1-2	Achieved
3	Number of accesses to Web Map Service	The number of geospatial layers registered with the WMS (10 layers)	1-5	Achieved
4	Number of proposed action plans	Proposed action plans (5)	1-4	Achieved

Source：JPT

4.1.3 Evaluation of each activity in Output 1

The indicators and target values for each activity proposed in the Work Plan and updated based on C/P input throughout the activities during the project are as follows.

(1) Evaluation of the achievement of the goals of Activity 1-1

The evaluation method and results of Activity 1-1 are shown below.

Table 4.1.2 Evaluation of the Achievement of Activity 1-1

#	Evaluation Item	Indicators and Target Values	Status of Achievement
1	Review of GI Policy Action Plan	Approval level of updated GI policy action plan (by CGI Office)	Achieved The GI Policy Action Plan was tentatively updated by the CGI Office.
2	Share updated GI policy action plan	1 each at seminars and workshops	Achieved The tentatively updated GI Policy Action Plan has been uploaded to the shared servers of relevant agencies and information has also been shared at JCCs and seminars

Source：JPT

(2) Evaluation of the achievement of the goals of Activity 1-2

The evaluation method and results of Activity 1-2 are shown below.

Table 4.1.3 Evaluation of the Achievement of Activity 1-2

#	Evaluation Item	Indicators and Target Values	Status of Achievement
1	CGISC meeting	The number of meetings (1 / 2 months)	Achieved including workshops
2	CGISC operation manual (draft)	Draft operation manual (1)	Achieved
3	Establishment of TWG	The number of established TWG (6)	Achieved Draft theme as TF has been discussed
4	TWG establishment and operation manual (draft)	Draft establishment and operation manual (1)	Achieved
5	GHLC operation manual (draft)	Draft operation manual (1)	Achieved
6	Result sharing	Publication of presentation, reports (2 / year)	Achieved Set up Google Drive to achieve information sharing among CGI member agencies.

Source：JPT

(3) Evaluation of the achievement of the goals of Activity 1-3

The evaluation method and results of Activity 1-3 are shown below.

Table 4.1.4 Evaluation of the Achievement of Activity 1-3

#	Evaluation Item	Indicators and Target Values	Status of Achievement
1	GI Standards (Draft)	Standard document (1)	Achieved Reviewed ISO standards for "Metadata", "DPS", and "DQ". Other ISO standards for GI were also outlined.
2	Guideline (Draft)	Draft Guideline (1)	Achieved Guidelines of "Metadata", "DPS", and "DQ" were developed.
3	Consultation with the NSDI stakeholders	Report (2)	Achieved Metadata registration in the NSDI system was

#	Evaluation Item	Indicators and Target Values	Status of Achievement
			initiated in accordance with the metadata guidelines. Draft "DPS" for "Trek Route" in accordance with the "DPS" guideline was created
4	Educational program	Designed specification (1)	Achieved Explanatory material on GI Standards has been prepared.
5	Activities for rulemaking	Periodical discussion with BSB (1)	Achieved A subcommittee on Bhutan Standards for GI was established.

Source：JPT

(4) Evaluation of the achievement of the goals of Activity 1-4

The action plan was evaluated from the viewpoint of four indicators determined in the work plan. They include: (1) the number of action plans (equal to the number of agencies that prepared action plans), (2) presentation and sharing of action plans, (3) quality of contents of action plans, and (4) status of action plan implementation (start of action plans).

Especially with regard to (3), the action plan was evaluated in terms of "Appropriateness: Appropriateness for the current situation in Bhutan", "Completeness: Inclusion of all items required for action plan", "Feasibility for monitoring and evaluation: clear subdivision of items for monitoring and evaluation". As a result, it was determined that, overall, the action plan developed in this activity met the evaluation criteria.

The evaluation method and results of Activity 1-4 are shown below. Since the CGI Office took the lead in developing a single action plan for this activity, the "Action Plan" in this table should be read as "individual measures" implemented by each agency.

Table 4.1.5 Evaluation of the Achievement of Activity 1-4

#	Evaluation Item	Indicators and Target Values	Status of Achievement
1	Action plans in C/P and member agencies	The number of action plans (5) The number of agencies that prepared action plans (5)	Achieved A total of 6 individual measures were developed by a total of 6 agencies, including the CGI Office.
2	Presentation and sharing of action plans	The number of presented and shared action plans (5)	Achieved A total of 6 individual measures were presented at an online meeting by a total of 6 agencies, including the CGI Office.
3	Quality of action plans	The contents of action plans (1)	Achieved Met the criteria in terms of Appropriateness, Completeness, and Feasibility for monitoring and evaluation.
4	Implementation status of action plans	The number of implemented Action plans (3)	Achieved A total of 5 individual measures were implemented by a total of 5 agencies, including the CGI Office.

Source：JPT

(5) Evaluation of the achievement of the goals of Activity 1-5

The evaluation method and results of Activity 1-5 are shown below. In developing the system, the initial plan was to only add necessary functions to the system on that time (Geo-portal), but due to unrecoverable failures, a new system has been built using resources available within NLCS. It is thought that a system equivalent to WebGIS operated by other countries, international agencies, and large-scale local governments has been created.

Table 4.1.6 Evaluation of the Achievement of Activity 1-5

#	Evaluation Item	Indicators and Target Values	Status of Achievement
1	Designed specification of NSDI system required for NSDI	Designed specification (1)	Achieved Documented service design, requirements definition, and system configuration.
2	Contents of ICT designed specification of NSDI system	Development of a system (development)	Achieved NLCS will update the data and move it to the Data Center in the future.
3	Launching and utilization of NSDI system	Number of registered Web map layers (10)	Achieved NLCS developed the NSDI system and hosted within Government Data Center with GovTech Agency. In addition, more than 10 layers are registered.

Source：JPT

(6) Evaluation of the achievement of the goals of Activity 1-6

The evaluation method and results of Activity 1-6 are shown below. The procurement of this equipment has allowed the NLCS to continue to have a backup NSDI system within the NLCS and also to build an environment for additional development and testing (in coordination with GovTech Agency, NSDI service (software and contents) were moved to the government data center equipment).

Table 4.1.7 Evaluation of the Achievement of Activity 1-6

#	Evaluation Item	Indicators and Target Values	Status of Achievement
1	Specification of ICT equipment for NSDI preparation	Created specification (1)	Achieved Equipment specifications were prepared.
2	Contents of equipment specification	Procurement of equipment (Completion)	Achieved Server and accessories were procured.
3	Installation and operation of equipment	Status of NSDI system operation (24-hour operation)	Achieved Procured equipment was installed in the NLCS server room (for the actual service, the equipment provided by the government data center will be used, and the procured equipment in the project will be used as backup and for development and verification purposes).

Source：JPT

(7) Evaluation of the achievement of the goals of Activity 1-7

The evaluation method and results of Activity 1-7 are shown below.

Table 4.1.8 Evaluation of the Achievement of Activity 1-7

#	Evaluation Item	Indicators and Target Values	Status of Achievement
1	Impact of training in Japan	Organization of debriefing session (30 attendants / time)	Achieved Circulation of report and report at final seminar (60 attendants)
2	Awareness activities in the seminar	Number of presentation (5 presenters / time)	Achieved CGI member meeting (December 2021): 6 Interim seminar (October 2023) : 6 Final seminar (November 2024) : 8
3	Reporting of the third Country training	Organization of debriefing session (1)	Achieved In the final seminar
		Number of attendants (30)	Achieved In the final seminar (60 attendants)
4	Implementation of NSDI workshops	Number of NSDI workshops (3)	Achieved 10 conducted

Source : JPT

4.1.4 Achievement of Output 2

Regarding the Goal of Output 2: "Capacity development for making, updating, management and utilization of digital topographic maps", indicators and target values, as well as the status of achievement, are shown in the table below.

Table 4.1.9 Indicators and Target Values for Output 2

#	Indicator	Target Value	Related Activities	Status of Achievement
1	Pilot area described in R/D	Topographic maps creation (1:25,000 = 1,000 km^2, 1:5,000 = 50 km^2, Larger than 1:5,000 = 0.1 km^2)	2-1	Achieved 1:25,000 = more than 2,300 km^2 1:5,000 = 50 km^2 Larger than 1:5,000 = more than 3.2 km^2 Were completed
2	Number of qualified operators	Technical examination (3)	2-1	Achieved 3 technicians who have met both the quality assessment of pilot results and more than 75 points on the verification test.
3	Number of authorized procedures of Geospatial Information for management	Number of training sessions for the implementation of agreed procedure (3)	2-2, 2-3	Achieved A final draft version of the framework was completed. The number of training sessions conducted was more than 3.

Source : JPT

4.1.5 Evaluation of each activity in Output 2

(1) Evaluation of the achievement of the goals of Activity 2-1

The evaluation method and results of Activity 2-1 are shown below.

Table 4.1.10 Evaluation of the Achievement of Activity 2-1

#	Evaluation Item	Indicators and Target Values	Status of Achievement
1	Productivity and Quality	Maintenance within the timeframe envisioned in the plan	Achieved
		Level of quality meeting DPS (Evaluation by JICA Experts)	Achieved It was at a passable level
2	Established specifications	Number of established specifications (1)	Achieved The specifications have been updated
3	Established technology, ToT manuals	Number of established manuals (1)	Achieved 6 different manuals were maintained by NLCS technicians
4	New efficient technologies transferred by trainers	Number of new technologies for work efficiency transferred by trainers (4)	Achieved Trainers reached at a level where they can train other technicians on the 4 techniques (Drone, DEM, Digital Field Verification, Utilization of Existing materials)
5	Vector tile	Converted 1:25,000 and 1:5,000 and larger than 1:5,000 topographic maps (3 scales)	Achieved 3 scales converted.
6	Geospatial Information trainers	Number of cultivated trainer (2)	Achieved 3 trainers were cultivated
7	Geospatial Information technicians	Number of cultivated technicians (10)	Achieved 12 technicians were cultivated

Source：JPT

1) Scope, productivity, and quality of topographic map maintenance by NLCS

As shown in the figure below, NLCS has developed 1:25,000 digital topographic maps covering more than 2,300 km^2 using stereo pairs of SPOT satellite images provided by JICA or WWF for the period from 2021 to September 2024. The processes implemented included work planning and process-based accuracy control, and included GCP surveying, Aerial Triangulation, Stereo Mapping and Digital Editing, structurization, and symbolization, confirming that NLCS will be able to continue to maintain and update the 1:25,000 topographic maps in the future.

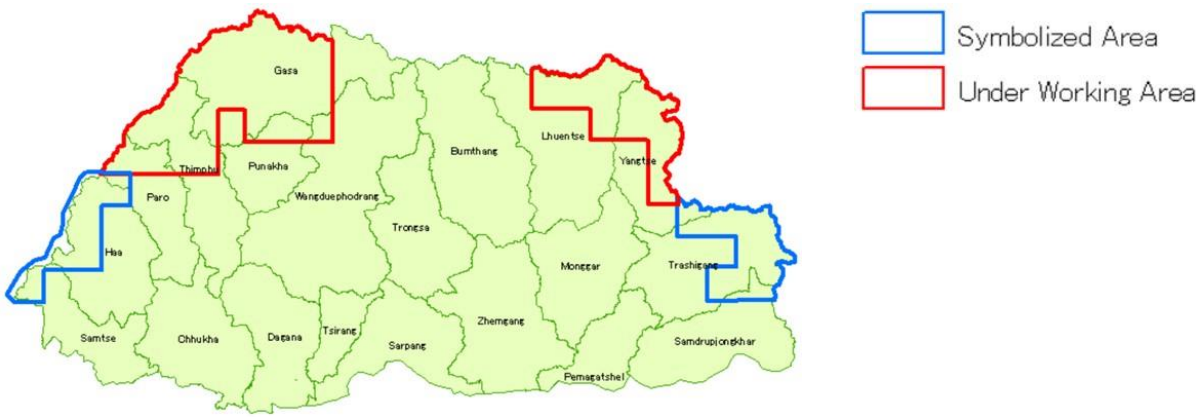


Figure 4.1.1 Capacity of NLCS to Establish 1:25,000 Digital Topographic Maps in the Project

The figure below shows the status of digital topographic maps at 1:5,000 or higher that have been established by the NLCS.

Results of training on maintenance and updating of digital topographic maps with a scale of 1:5,000 or more, comparing with 1:25,000 digital topographic maps in terms of specifications, required accuracy, work process, and examples of use, NLCS has maintained a pilot area of 50 km^2 for 1:5,000 and an area (Jigmeling Industrial Area) of approximately 1.6 km^2 for digital topographic maps over 1:5,000 using drones.

In addition to the pilot area, NLCS was commissioned by another agency to photograph and create topographic data for an area (Tashicholling) of approximately 1.6 km^2.

These confirm that the NLCS has not only improved its capacity to maintain and update digital topographic maps at 1:5,000 and above, but has also reached a level that will be sustainable after the project is completed.

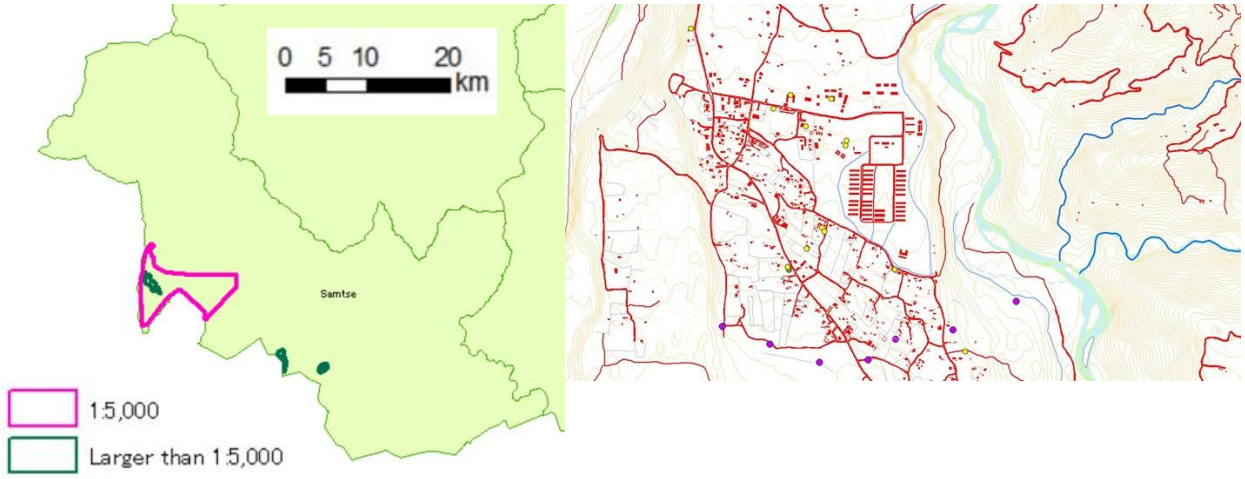


Figure 4.1.2 Capacity of NLCS to Establish Digital Topographic Maps at Scales of 1:5,000 and Larger (Left: Established area in the project, Right: 1:5,000 digital topographic maps)

2) Technologies for improving work efficiency and their effects

To support the sustainability of the maintenance and updating of digital topographic maps by the NLCS after the completion of the project, the JPT provided training on techniques to further reduce the burden of maintenance and updating. As a result, the following effects were observed.

Compared to conventional methods, many techniques have shown a reduction in the number of working days, indicating that the training is highly effective.

Table 4.1.11 Effectiveness of Newly Introduced Technologies and Manuals for GI Maintenance

#	Technology	Expected Effects (Examples)	Effectiveness / Improvement from Conventional Methods
1	Digital Field Survey	- Shorter preparation time by omitting the printing process - Improved accessibility to survey targets in the field with the tablet's built-in GPS - Digital input reduces text entry errors from handwritten methods - Digital input streamlines the summarization of survey results from the printed map method	Compared to the conventional method, the field work period was reduced by 1 to 2 days / sheet, and the time required to summarize the results after the field work was less than half the time required by the conventional method. Human errors also decreased.
2	Contour creation by DEM	Improving efficiency of contouring by DEM processing in the northern part of bare and mountainous areas (Comparison with Stereo Plotting)	In areas covered with forests, stereo mapping (conventional method) tended to be better in terms of quality and speed, on bare land, it was observed that if the Spot Heights, etc., on Summits could be properly complemented, the accuracy of the method would be equivalent to that of conventional methods, and a significant time reduction could be achieved.
3	Drone	Improved efficiency and lower cost of large-scale topographic mapping using Drone imagery and LiDAR sensors compared to digital mapping of stereo satellite imagery (limited to a narrow area of about 2 km^2 as a condition).	Photography cost: The smaller the area, the more cost-effective image acquisition is compared to satellite imagery, which has a minimum purchase area requirement. Compared to the time required to search for and purchase process of satellite imagery, a drone can be ready within a few days. In addition, the altitude of photography is lower than that of clouds, and there is less standby due to weather conditions. Mapping costs: Contour lines can be created from ground data acquired by LiDAR, and work can be expected to be reduced by more than 50% compared to conventional methods. The very high resolution allows for the creation of large-scale topographic maps.
4	Use of existing materials	Especially in the process of Aerial Triangulation, improving accuracy and shortening field work by utilizing secondary geodetic points, Cadastral data, existing stereo satellite images and topographic maps (archives).	By effectively using existing materials as checkpoints for horizontal position and height, the number of working days was reduced and accuracy was improved.

Source：JPT

3) Specifications, manuals, that have been developed

The JPT assisted the C/P in developing the following manuals. In addition, SNS and other services were used during the project to assist in real-time troubleshooting of the C/P's work.

It is expected that necessary manuals will continue to be developed from time to time and uploaded to the NSDI system, and that consideration will be given to services to support technicians in a format tailored to the technology, such as SNS and videos.

Table 4.1.12 Manual on GI Maintained by C/P

#	Documents / Manuals	Contents
1	Digital Field Survey	Preparation of necessary data, basic tablet operation, organizing and exporting results, etc.
2	Creation of contours from DEM	Set parameters by terrain and inspect results
3	Manual for quality control	Explanation of “DPS,” quality control processes and details
4	Symbolization	How to symbolize using ESRI's templates, how to create marginal information, etc.
5	Commercial satellite imagery and DEM search and procurement	Explanation of search tool operation and product-specific specifications
6	Vector Tile creation	Vector tile creation method using ESRI software (1:25,000 level to large-scale level)

Source：JPT

4) NLCS experts trained and their level

From June to October 2024, a confirmation test was conducted on basic knowledge of topographic mapping and on the knowledge and skills covered in the project training.

The results showed that the percentage of correct answers related to field work such as field surveying and field investigation was high, but with respect to photogrammetric work, many GIS technicians understood the operation of the software, but some did not understand the overall flow of the work.

Some GIS technicians did not fully understand the applications and uses of elevation data such as DEMs and contour lines, and digital topographic maps according to accuracy and scale, perhaps because they had not had many opportunities to create topographic maps at multiple scales before this project. In the future, it will be important to meet the needs of users while efficiently creating data that meets their accuracy requirements.

Qualitative testing by JICA experts for each process on quality and performance aspects.

On the theoretical side, a comprehension test was administered at the end of the project. Five of the 12 examinees met the passing score of 75. The average score was 68.3, indicating a good overall level of understanding. The fields with the lowest percentage of correct answers were “DEM” and “Orthophoto”. This was due to the fact that these tasks are not performed as frequently as “Field survey”, “Aerial Triangulation”, and “Mapping”, which had higher percentages of correct answers. The problem is expected to be solved as the opportunities for Orthophoto increase in drone operations and as the knowledge and experience of ortho-imaging increase.

Table 4.1.13 Comprehension Test Trends and Results

#	Field	Trends in Responses	Pass Rate
1	General (5 Qs)	Major incorrect answers were given for questions such as “Bhutan's old and new coordinate system” and “ellipsoids and geoids”.	75.3
2	Field survey / Field Identification (5 Qs)	Major incorrect answers are related to the “purpose of Field Identification”.	91.1
3	Aerial Triangulation (5 Qs)	Major incorrect answers are related to “photogrammetric process”.	86.7
4	DTM/DSM, Contour line (5 Qs)	Major incorrect answers are related to “DEM uses”.	71.1
5	Orthophoto (5 Qs)	Major incorrect answers are related to “orthophoto process”.	71.1
6	Digital Plotting (3D Mapping) (5 Qs)	Major incorrect answers are related to “Uses of topographic maps by scale”.	80.0
7	Digital Editing (5 Qs)	Major incorrect answers are related to “Dislocation”.	71.1
8	Structurization /Symbolization (5 Qs)	Major incorrect answers are related to “Vector Tiles”.	68.9

Source：JPT

(2) Evaluation of the achievement of the goals of Activity 2-2

The evaluation method and results of Activity 2-2 are shown below. The original plan was to develop Guidelines for all data management, sharing, and updating, but the team worked with Activity 1-5 to develop regulations for effective data management, sharing, and updating by separating the contents that pertain to universal concepts from the contents that depend on the system package software.

Table 4.1.14 Evaluation of the Achievement of Activity 2-2

#	Evaluation Item	Indicators and Target Values	Status of Achievement
1	Guideline for management, sharing, update include procedure (draft)	Document (1)	Achieved Procedures for managing, updating, and sharing data were discussed and guidelines were developed.
2	Minutes of meeting	Document (1)	Achieved A survey form that was initially filed by the C/P in coordination with the parties involved was used as a record of the discussions. (*Since the kickoff, the work was mainly done by phone, SNS, and in the form of asking for feedback at some of the workshops and internally at NLCS).
3	Presentations in seminars and workshops	Number of presentations (1 / meeting)	Achieved Presentations were made at seminars and workshops.
4	Implementation status of management, sharing, update based on procedure (draft)	Commencement of practice work with procedure (draft) (4 agencies)	Achieved At a workshop attended by more than 4 institutions in total, the data management procedures were explained and it was understood that the same procedures would be followed for post-operational operations.

Source：JPT

(3) Evaluation of the achievement of the goals of Activity 2-3

The evaluation method and results of Activity 2-3 are shown below. Initially, the plan was to proceed with training based on the Geo-portal on that time, but that system became unusable due to a failure. Consequently, training commenced while waiting for the new system to become operational. However, training on the concept of WebGIS and its general usage was provided using ArcGIS Online (which has the same functionality and operability as ArcGIS Enterprise, adopted as the basis for the NSDI system). In particular, awareness-raising within the C/P agencies by the ToT enabled the trainers, which led to the subsequent development of the system and the implementation of training led by trainers on the C/P side using the system. Furthermore, the C/P could organize procedures for creating and rolling out new training programs in the future.

Table 4.1.15 Evaluation of the Achievement of Activity 2-3

#	Evaluation Item	Indicators and Target Values	Status of Achievement
1	Number of trainers of GIS Tool	Trainers cultivated (3)	Achieved 4 within NLCS and 3 at other agencies.
2	Number of trainees (technicians) of GIS Tool	Trainees (technicians) cultivated (20)	Achieved More than 49 in total. *Training conducted by trainers from other agencies in their own agencies is **not** included.
3	Number of training sessions, workshops using GIS Tools	Number of implementation (6)	Achieved 8 sessions conducted. *Training conducted by trainers from other agencies in their own agencies is **not** included.
		Number of targeted sectors (Total 20)	Achieved A total of 35 sections. *Training conducted by trainers from other agencies in their own agencies is **not** included.

Source：JPT

(4) Evaluation of the achievement of the goals of Activity 2-4

The evaluation method and results of Activity 2-4 are shown below.

As described in Activity 2-4 of Chapter 3.3.6, about 10 workshops were held during the project period regarding the development of Geospatial Information. On average, more than 10 people from NLCS and CGI member agencies participated.

Workshops conducted by the C/P were also included, and it is expected that such workshops will continue on a regular basis after the completion of the project to share and disseminate issues, solutions, technologies, and knowledge related to NSDI promotion.

Table 4.1.16 Evaluation of the Achievement of Activity 2-4

#	Evaluation Item	Indicators and Target Values	Status of Achievement
1	Implementation of training and workshops	Number of implementation (1 / theme)	Achieved Conducted approximately 10 times
2	Number of participants	Number of participants for training and workshops (10/ time)	Achieved
3	Number of proposed ideas for utilization	Number of adopted ideas (5)	Achieved 10 applications of GI utilization have been discussed. All ideas are necessary for practical use, and all should be realized.

Source：JPT

4.2 Review results based on DAC evaluation criteria

4.2.1 Relevance

From the results of the evaluation of the project's "Relevance" from each of the perspectives in the table below, it was evaluated as “Satisfactory”.

Table 4.2.1 Perspectives and Evaluation of Project “Relevance”

Perspective	Evaluation	
Consistency with Bhutan's development policies and development needs	This is highly consistent with the Five-Year Plan of the NLCS based on the 12th FYP (2018 - 2023) and 13th FYP (2024 - 2029), which clearly states the promotion of NSDI for various purposes, including infrastructure development, environmental monitoring, risk management, Cadastral, and land use.	
Appropriateness as a means	Field	Reliable and accurate GI is fundamental to national operations and development, and sharing this information with relevant agencies through the NSDI established and operated by the Royal Government of Bhutan is appropriate for an area that meets the needs of Bhutan.
	Target group	The NLCS, the core C/P for this project, was appropriately selected because it is the agency that develops and manages the underlying GI in Bhutan and is also the agency to which the CGI Office, which has a coordinating role among the stakeholder agencies, belongs to the NLCS.
	Spillover effects beyond the target group	There are approximately 33 agencies involved in GI in Bhutan, and workshops, training, seminars, and regular meetings were held for them during the project, which is considered to have a high spillover effect.
Advantages of Japanese cooperation	Japan has been involved in the establishment of Geospatial Information in Bhutan for nearly 10 years and is familiar with Bhutan's policies, characteristics, and challenges, and has established a relationship of trust with NLCS and other related agencies.	

Source：JPT

4.2.2 Coherence

From the results of the evaluation of the project's “Coherence " from each of the perspectives in the table below, it was evaluated as Highly Satisfactory”.

Table 4.2.2 Perspectives and Evaluation of Project “Coherence”

Perspective	Evaluation
Coherence with Japan's Aid policy and MOFA's Country assistance policy	As a priority field in “Country Assistance Policy for Bhutan (January 2023)”, It is described as the following. Need to correct disparities between rural and urban areas for ”**1) Sustainable economic growth**” “Development of social services”, ”Climate Change and Disaster Prevention”, ”Addressing Urban Environmental Issues”, ”Support for Health Care Maintenance and Improvement”, “Biodiversity Conservation” for ”**2) Strengthening Resilience**” This project will contribute to the development of GI that will serve as the basis for the aforementioned national development plan and to the cross-functional GI utilization managed by related agencies
Coherence with JICA Country Analysis Paper (Bhutan)	Most of the “Development Issues and Areas of Cooperation” are marked with ”Efficient data management using digital technology”, Geospatial Information is one of the key digital technologies enabling efficient data management. In particular, in the field of “urban environment improvement,” it clearly states, “To promote urban planning and development, JICA will encourage the utilization of digital topographic maps and data sharing platforms that have been developed through technical cooperation and grant aid.
Cooperation with other JICA projects	For the “JICA Grant Aid Project”: The Project for the Development of Digital Topographic Maps”, technical assistance was provided for the remaining 1:25,000 area after the project, assuming that NLCS would develop the area by itself or outsource the work. In addition, for the 1:5,000 topographic maps, areas with high needs were selected as pilot areas while taking into consideration the areas to be developed in the "Grant Aid Project".
	In conjunction with the “Comprehensive National Development Plan 2030)”, the JPT assisted the NLCS with the creation of a 1:5,000 digital topographic map of the area required by the DHS, while also coordinating between the two agencies.
International framework	According to “JICA Country Analysis Paper (Bhutan)”, the area to which this project will directly contribute, “Urban Environmental Improvement,” is mentioned as ”Goal 3: Ensure healthy lives and promote well-being for all at all ages”, ”Goal 10: Reduce inequality within and among countries”, ”Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable” as a related SDG goal. In particular, Geospatial Information is essential for development planning and various policies related to a target of “Goal 11”, ”11.a: Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning”.

Source：JPT

4.2.3 Effectiveness

The project purpose “To share the reliable and precise Geospatial Information with related organizations including the private sector utilizing NSDI established and operated by the Royal Government of Bhutan.” will be achieved if the following outputs are produced.

The results of the evaluation of the project's “Effectiveness” from each of the perspectives in the table below, it was evaluated as “Satisfactory”.

Table 4.2.3 Perspectives and Evaluation of Project “Effectiveness”

Perspective	Evaluation			
Project purpose	Purpose	It is clearly described		
	Indicator	It is appropriate to check the “number of shared GI” to see the status of Geospatial Information managed by SSOT based on SOP that can be updated to the NSDI system and downloaded by users.		
	Means of Verification	The “number of layers available for download” and “number of institutions that have agreed to data sharing” can be quantitatively verified and require no cost.		
	Target Value	The “number of layers available for download” 50 is appropriate, as it represents a significant increase compared to the number of layers available for download via the Geo-portal at the beginning of the project, which was 1 digit (the number of public layers was approximately 30). The “number of agencies that approved data sharing” 10 is more than double and appropriate number compared to the number of agencies that had uploaded data to the Geo-portal at the start of the project, which was about 5.		
Outputs	Overall	It is clearly described and can be measured at no cost.		
	Output 1	The achievement level of the indicator: ”**Capacity development for the operation planning and implementation for the strategic utilization and promotion of NSDI**” can be evaluated by the achievement of the following 4 indicators. In addition, the means of verification for each indicator is quantitative and the cost is appropriate.		
		1	Number of stakeholders of NSDI	The target value of 36 agencies can be considered the maximum value, including several years into the future, and can be considered appropriate.
		2	Number of meetings and participants	The target value of “2 / year” is more than double that of “less than once a year” at the beginning of the project, and can be considered appropriate.
		3	Number of accesses to “Web Map Service”	Given that the number of layers that the NLCS assumes can be published in the NSDI system is approximately 20, with additional layers to be added by outside agencies, the target value of 10 is appropriate.
		4	Number of proposed action plans	As a result of discussions with the focal persons at the start of this activity, the target was set at a minimum of 5 agencies, since there are 6 agencies that have created or are using GI and would like to consider using it in the future. The value was appropriate in light of the issues involved in this activity and the content of the individual measures.
	Output 2	The achievement level of the indicator ”**Capacity development for making, updating, management and utilization of digital topographic map**” can be evaluated by the achievement of the following 3 indicators. In addition, the means of verification for each indicator is quantitative and the cost is appropriate.		
		1	Pilot area described in R/D	The 1:25,000 target of 1,000 km^2 is equivalent to about 6 map sheets, which is appropriate in terms of the balance between the number of trainees (3 trainers and a maximum of 12 trainees) and the duration of the work, as well as in the scope of complementing and strengthening the necessary technology by identifying trends in areas maintained by NLCS.
				The target value of 50 km^2 for 1:5,000 can be accurately considered to be equivalent to the average area of 1:5,000 target cities for "JICA Grant Aid Project".

Perspective	Evaluation			
				The target value of 0.1 km^2 for large-scale topographic maps produced by Drone can be appropriately considered to be equivalent to the area photographed per drone shot.
		2	Number of qualified operators	The target value of 3 is appropriate from the perspective of confirming further improvement in the capacity to create and update 1:25,000 topographic maps and topographic maps at 1:5,000 and above, as these were the 3 main participants in the technology transfer of the previous project.
		3	Number of training sessions conducted based on GI management guidelines	The target values are appropriate because the main process for improving GI management capacity involves 3 steps: “Basic understanding of NSDI and WebGIS”, “Improving data management capacity in NSDI”, and “Promoting the use of GIS tools provided by the NSDI".

Source：JPT

4.2.4 Efficiency

For the results of the evaluation of the project's “Efficiency” from the results of the analysis in terms of the planned and actual project cost and duration of the project and the causal relationship between the activities and inputs of the project and the achievement of its outputs, it was evaluated as ”Satisfactory”.

Table 4.2.4 Perspectives and Evaluation of Project “Efficiency”

Perspective	Evaluation
Causal relationship	The activities necessary to produce the outputs have been planned.
	To implement all activities, an adequate amount and quality of inputs were provided from both the Bhutanese and JICA sides.
Period / Timing	Due to the impact of COVID-19, the project period was extended by 1 year. As stated in the R/D, the JICA experts were able to conduct field activities in 38 months from the time they traveled to Bhutan, an appropriate time frame to achieve the project purpose.
	In terms of staffing and assignment, in response to the issue of insufficient C/P personnel and other resources for the activities, the JPT devised a way to increase the efficiency and effectiveness of in-person training by having JICA experts concurrent roles in several highly related activities and conduct training concurrently. As a result, flexible travel planning was possible, and overlapping of work between activities and exchanges of C/P between activities were eliminated, resulting in highly effective training with little burden on the C/P.
	The inputs and burden items on the Bhutanese side were implemented at the appropriate time without causing any delays in the activities.
Cost	With regard to the project's operating costs, the actual results were 99.5% of the plan.
	The main cost item that exceeded the planned value was airline tickets, but the JPT was able to change the airline to the least expensive airline or to the most expensive airline, Furthermore, when there were assignments in neighboring countries, the burden was reduced by moving directly from those countries to Bhutan.

Perspective	Evaluation
	About equipment, although there was an increase in costs due to the upgrade of drone specifications and the expansion of the satellite imagery procurement area at the request of the C/P, it was cost-effective because it led to a significant improvement in the efficiency of large-scale topographic map production in NLCS and the possibility of utilizing topographic maps.
	The entire activity was ultimately completed without exceeding the originally planned cost by reducing transportation costs by increasing the local procurement rate, switching to the latest and less expensive satellite imagery, and adjusting the amount of equipment and number of consumables to match the duration of the work in Bhutan.
	In the NSDI system, there was a change from planned expansion of the existing system, but the alternative system took into account the challenges of the Geo-portal on that time and Bhutanese technical staff, and effectively utilize resources on the Bhutanese side.

Source：JPT

4.2.5 Impact

(1) Impact related to Overall Goal

The Overall goal: ”To promote the strategic utilization of the reliable and precise Geospatial Information through NSDI for the formulation of infrastructure development planning for regional and industrial development” is expected to be achieved. Details are mentioned in “Chapter 5.1 Prospects for Achieving Overall goal”.

(2) Impact related to spillover effects

For “Spillover effects”, the following effects are considered.

Table 4.2.5 Perspectives and Evaluation of Project “Impact”

Spillover Effects	Evaluation
Economic impact	The establishment and operation of an NSDI will avoid redundancy of data and double investment in the cost of data maintenance. It is also expected that the NSDI will facilitate national development planning, thereby reducing the disparity between rural and urban areas.
People's happiness	In the GI policy, Geospatial Information is positioned as an important foundation for the realization of: “The pursuit of Gross National Happiness as the development philosophy and the aspiration of harmonious existence with nature require mastery over the information of one’s own surrounding”, NSDI development is expected to contribute to the realization of policies and resolution of social issues, as well as to the well-being of the Bhutanese people.

Source：JPT

4.2.6 Sustainability

The sustainability of the project effects was analyzed in terms of “Policies & Institutions”, “Organization and Structure”, ”Finances”, “Technology”, “Society, Culture and Environment” regarding the promotion of the NSDI.

For the results of the evaluation of the project's “Sustainability” from each of the perspectives in the table below, it was evaluated as ”Highly Satisfactory”.

Table 4.2.6 Perspectives and Evaluation of Project “Sustainability”

Perspective	Evaluation
Policies and Institutions	As noted in “Chapter 2.1.1 Plan , Institutional and legal framework about NSDI”. The current policy on NSDI, the GI Policy, will be in the review phase in the 13th Five-Year Plan, although it will still take some time for it to become a more enforceable rule. Since the GHLC is expected to be actively involved in the future, policy support for NSDI promotion will continue after the project.
	As noted in “Chapter 2.1.3 GI Standards”, it is important to establish common rules for the use of NSDI. The project was able to clarify the steps leading to the establishment of a Bhutan Standards for GI. The fact that the new work item proposal is actually expected to be considered by the Technical Committee is a first and hard-earned experience for the C/P, and is expected to be sustained in the future. After the completion of the project, it would be difficult for the C/P to implement, maintain, and develop the Bhutan standards for GI.
Organization and Structure	CGI member agencies were regularly active before the project and have become more active and habitual through each activity of the project. Future issues and initiatives related to NSDI promotion have also been identified. The GHLC's inability to operate as planned during the project will continue to challenge the decision-making process, but the organizational capacity to implement activities to sustain project effectiveness will continue.
	As noted in ”Chapter 2.1.2 NSDI Promotion Structure”, cooperation among the agencies involved is essential to the maintenance and management of NSDI. NLCS leadership is required for the interlocking roles of “CGI”, “GHLC”, “TWG” and “TF”. NLCS clearly states the promotion of NSDI in the 13th FYP and “SAZHI 2034 (10-year Plan)” and that “Sustainability” can be expected from this.
Finances	The budget for the operation of CGI meetings has been secured by NLCS as in the past.
	Regarding topographic map development, the NLCS 13th Five-Year Plan has budgeted for the development of the required 1:25,000 topographic maps and 1:5,000 topographic maps. Regarding the updating of topographic maps, partial updating by drones is envisaged for the time being, but at present the work can be carried out by the NLCS or the budgets of the agencies concerned.
	For NSDI services, the use of commercial software, which C/P has contracted with in the past, this time provides a more stable environment for continued operation, as well as vendor support for security and functionality improvements. The support of the data center in terms of "Hardware, basic software, network” of NSDI services greatly enhances the ability to spread the service in case of emergency, and this can be done without the burden on the C/P, making the system environment more sustainable. The NLCS proposed budget for 2024-2025 is approximately 174,879,000 BTN, while the IT-related budget is approximately 28,700,000 BTN. Of that amount, approximately 2,500,000 BTN is for the maintenance of the NSDI system, so there will be no problem in securing the budget.
Technology	Activities related to the technology introduced in the project were implemented through ToT on the Bhutanese side and training from the trainers to the technicians. This means that the implementing agencies are not only capable of implementing the technology, but also have the technical capacity and mechanisms to disseminate it within and outside of their institutions.

Perspective	Evaluation
	Regarding newly purchased or existing equipment used in the project, if the currently used equipment breaks down and the amount of stereo equipment used falls below the required amount, but it is possible to use existing sources and reduce the amount of stereo work by using LiDAR drones to reduce the amount of stereo work.
Society, Culture and Environment	Since the achievement of the project's effectiveness or the achievement of the overall goal tends to increase the consideration and resolution of issues related to women, the poor, the socially vulnerable, and the environment, lack of consideration for these issues will **not** be a factor that prevents the continuation of the project's effectiveness.

Source：JPT

4.2.7 Factors affecting the implementation of activities and achievement of outputs and risk management

(1) Promotive Factor and Obstructive Factor

The main “Promotive Factor” that contributed to the achievement of the outputs and the main “Obstructive Factor” that influenced the achievement of the outputs are shown in the table below.

The most significant “Promotive Factor” was voluntary activities on the Bhutanese side, which in some cases reduced delays associated with COVID-19 and in others increased the effectiveness of the training.

About the 3 “Obstructive Factors” that affected the achievement of the project's results, for 1) Delays in GHLC activities, The JPT supported the promotion of activities by assisting in the development of an operational manual and proposing the holding of the first GHLC meeting at the final seminar. For 2) Geo-portal (on that time) breakdown, the use of existing commercial GIS licenses and the assignment of JICA experts with experience in system development enabled the project to be handled without major changes to the originally planned timeframe or cost”, for 3) Travel restrictions and delay during COVID-19, efforts were made to enhance training effectiveness by extending the project period and by timing the implementation of theory and practice through multitasking by JICA experts and collaboration with related activities.

Table 4.2.7 Promotive Factor and Obstructive Factor to Outputs

Factor		Reason
Promotive Factor	Active activities with the Bhutanese initiative	Promote dissemination of technology to relevant organizations and improve the effectiveness of training by conducting voluntary workshops and study groups.
		Establishment of a subcommittee on national GI standardization with the participation of the Bhutan Standards Bureau (BSB) in the activities of the “GI Standards"
		The BSB has always been able to share the latest ISO international standards with NLCS (at no cost).
		The system is hosted in the data center operated by the GovTech Agency, the government's IT organization, enabling the system to prevent failures and recover more quickly in the event of system failure.
		Significant leadership, facilitation, and other support from NLCS in “Human Resources”, “Technical Resources”, “Stakeholder Coordination”, “Financial Support:”

Factor		Reason
Obstructive Factor	1) Delays in GHLC activities	The GHLC has been delayed due to the Government of Bhutan's major structural reforms, including the integration of the GNHC, which has made it difficult to coordinate the level of decision makers among the agencies involved.
	2) Geo-portal breakdown	Initially, the expansion and training of the NSDI system was planned on the premise of adding functionality to the Geo-portal (on that time), but the failure of the Geo-portal necessitated a change in policy.
	3) Travel restrictions & Delay during COVID-19	The full-scale start of the project was delayed by the need to wait for JICA experts to travel to Bhutan after the travel restrictions by the Bhutanese government in connection with COVID19 have settled down, as it was anticipated that the efficiency of online technology transfer of practical contents such as document preparation was limited compared to in-person technology transfer for activities such as “GI Standards,” in which Bhutanese engineers had no prior experience.

Source：JPT

(2) Notable voluntary activities on the C/P and their impact

The activities of this project were basically led by the C/P. The table below shows the factors that affected the achievement of the project purpose due to voluntary activities on the Bhutanese side that went beyond initial expectations.

Table 4.2.8 Achievements Made and Future Prospects for Implementation on the Bhutanese Side

#	Themes		Achievements and Effectiveness	Future Prospects
1	Partnership	Study groups and workshops	Study meetings and workshops were voluntarily held by the C/P to share, discuss, and learn information jointly with related organizations on Drones, SSOT, and GI Standards. Executive level meeting, project seminars and stakeholder consultation workshops were conducted by the C/P.	Raising the bar for CGI member agencies on NSDI promotion
2	GI Standards	BSB	The participation of the BSB in the activities of the “GI Standards” has enabled the establishment of a subcommittee on the national GI standardization and the consideration of draft standards, clarification and sustainability of the approval process for national standards ensured.	Completion and sustained implementation of standardization of 3 standards
3	GI Utilization Action plan	Identification of issues, planning, and dissemination of information	Based on an accurate understanding of the current situation in Bhutan, C/Ps identified issues to be addressed in the Action plan. They also formulated their own plans for necessary individual measures. In addition, each C/P took an initiative in explaining the importance of this activity and the NSDI to senior and higher-level officials. This led to the awareness raising among the senior and higher-level officials.	The member agencies (CGI Office, DoST, Thimphu Thromde, DoFPS, DoSAM / NLCS) are expected to continue their required work by incorporating activities into their respective IWPs.

#	Themes		Achievements and Effectiveness	Future Prospects
4	NSDI system	Operation by GovTech Agency	NLCS had concerns about hosting the NSDI system as a GI infrastructure in terms of the agency's IT infrastructure and human resources. However, by hosting the system in a data center operated by the GovTech Agency, the government's information arm, and by obtaining technical support for server operations, a system was established to prevent failures and to restore the system more quickly in the event of a failure. The following initiatives were carried out by C/P: - Deployment and development of NSDI system - Operation manual for the NSDI system - Service design of the NSDI system. - Requirement definition of the NSDI system - development of user training manual and conduct of training on NSDI system All of the activities were initiated and carried out by the C/P with the feedback and comments from the JPT	Full-scale operation
5	Geospatial Information	Digital topographic maps	- Drone training was conducted with sole budget from C/P's side. - The digital topographic map was created mainly by the C/P with advisory roles from the JPT, with fewer of working photogrammetry workstations and photogrammetrists. - The verifications for the topographic maps were also primarily initiated by the C/P.	Safe and planned operations
6		National geodetic points	- National geodetic points, including CORS, have been systematically expanded over the past decade, with support from international donors, and data provision services and technical support for organizations other than NLCS are in place. - Inspection surveys for benchmarks have been carried out under Bhutan's budget.	Enlargement of reference information provision services to improve the accuracy of on-site measurement and drone photography operations.
7		Management and Utilization	- C/P led, in collaboration with other organizations, to compile SOP in a feasible manner and conducted related workshops. - Framework for GI Management, Sharing and Update, SOP for GI categorization and SSOT and Operation Manual were developed by C/P instead of just compilation.	Continued constant operation and training in the same manner is possible in the future.

Source：JPT

4.3 Lessons Learned from the Project

4.3.1 Overall lessons learned

Bhutan also had a longer post-travel quarantine period associated with COVID-19 than other countries (about 4 weeks at the longest), which delayed the start of local travel and in-person training after the start of the project.

Until the JICA experts were able to travel to the site, kick-off meetings, regular meetings with C/Ps, individual training, etc., were conducted online in an attempt to ensure that activities would not be delayed, although this was considered to be somewhat effective as no problems with time difference or internet environment were observed. Regarding the technology transfer in the activity of "GI Standards" in which C/P had no experience, the efficiency of online technology transfer of practical contents such as document preparation was limited compared to in-person technology transfer. However, the online technology transfer was effective in the area of lectures on basic theory and case studies of other countries. In addition, JPT thinks that it was effective to start with a detailed explanation of the basics when JICA experts was able to discuss face-to-face.

There were 3 Japanese training sessions in this project, each targeting 16 trainees. The size of the group of 16 participants made it difficult to coordinate the itinerary on the part of the trainees and to arrange a venue (both training and lunch) in Japan, and it also placed a heavy burden on the staffs in charge of arranging and attending the training both in Bhutan and the Japan side.

4.3.2 Lessons learned on Output 1

(1) Lessons learned on planning for NSDI promotion

It was confirmed that due to the impact of COVID-19 and other factors, the measures described in the GI policy are not progressing as planned, and that the GI policy itself is not recognized as an issue to be addressed by the agencies concerned.

Therefore, this activity will start by monitoring the progress of the existing GI Policy and related measures in the GI Policy Action Plan and related activities of the project, and review the end date of the GI Policy Action Plan. The emphasis was on sharing this progress with relevant agencies to remind them of the importance of the GI policy and implementation of the measures.

(2) Lessons learned on partnership

At the beginning of this project, the GI policy included definitions and roles of CGI, GHLC, and TWG, but specific action procedures starting with the CGI Office were not documented. By clearly documenting the roles and scope of responsibility of each agency and understanding what the CGI Office staff should do (discussion and selection of agendas, and securing evidence by taking and referring to meeting minutes.), the C/P side was able to be aware of their own responsibilities. Recognizing the importance of documenting,

archiving, and sharing procedures and minutes, the C/P itself was able to achieve information sharing among CGI member agencies through Google Drive.

(3) Lessons learned on GI Standards

At the beginning of this project, the C/P had no knowledge of GI Standards, and the ISO documents were unique and difficult to read, so there was not much progress in understanding them. Through voluntary study sessions held by the C/P side, understanding gradually progressed, and at some point they were able to determine which parts of the ISO Standards were necessary for their operations and which parts were unnecessary. The fact that the C/Ps themselves had the opportunity to study in groups helped promote understanding and gave them a great deal of confidence, enabling them to engage in more active discussions.

(4) Lessons learned on GI Utilization Action Plan

Two main lessons were learned through Activity 1-4. First, to involve member agencies in the project and ensure smooth collaboration between the CGI Office and the member agencies, the CGI Office along with the JPT visited the member agencies and explained the importance of the project to decision-makers in each agency, including the director general and the supervisors of focal persons. As a result, the importance of the outcomes from this project was well understood by key persons, and the focal persons smoothly participated in this project. Second, the use of common forms for individual measures and monitoring enabled the CGI Office and the member agencies to smoothly share the progress status and issues. In addition, monitoring meetings were regularly conducted in collaboration with the CGI Office and the member agencies. This allowed the CGI Office and the member agencies to raise awareness of time limits and conduct activities in a time-bound manner as much as possible.

(5) Lessons learned on NSDI System

The C/P decided to use the ArcGIS Enterprise System as the primary infrastructure as the NSDI system for Bhutan. They were able to explore the use of available tools in the ArcGIS enterprise environment with feedback and suggestions from the JPT. However, the available tools did not meet their requirements for a robust user interface. This has led the C/P to explore, develop and customize user interfaces through coding.

JPT mainly assisted in defining the overall methodology for the development process. The actual development and input were conducted by the C/P.

4.3.3 Lessons learned on Output 2

(1) Lessons learned regarding the development and updating of Geospatial Information

In topographic mapping using stereo satellite imagery by NLCS, aerial triangulation work in areas where topography limited access to the site often took longer than planned. In many cases, such areas were affected

by an imbalance in the quantity and placement of auto-generated tie points and observed GCPs.

As a result of the JICA experts' advice to use manual observation of tie points and to minimize the number of tie points and GCPs, better aerial triangulation output can now be obtained more quickly than before.

Regarding the management of work progress in creating topographic maps, information was shared digitally on each operator's PC and verbally among operators; the JPT has informed NLCS trainers and trainees about the importance of sharing information in an analog manner by printing out assignments and progress.

From the above, it can be said that while it is important to increase the speed and efficiency of work, such as through digitization and automation, it is equally important to think in terms based on theory and analog technology.

(2) Lessons learned on GI Management

GIS and Data Management was common in Bhutanese offices; however, in the survey conducted for data management, sharing, and update framework, the standard procedures and infrastructures were not in place.

On the other hand, each single responsible agency registers data on the NSDI system. This was a matter of common understanding among the NSDI participating agencies in Bhutan, led by the NLCS, which is the C/P agency. This background fostered a consensus to adhere to those principles for managing, sharing, and updating geographic information, which was reflected in the framework (The former “Guidelines” has been renamed “Framework”).

(3) Lessons learned regarding GI Utilization Tools

The GI utilization depends on the diverse nature of the stakeholders involved in the NSDI project. The adoption of the ArcGIS platform used for the development and implementation is found to be successful as the C/P and all the stakeholders are already advanced in the field of GIS and the use of the software. The educational materials were already in use before the commencement of the project.

The training materials used to train workshop participants were developed without reference to the JPT project and are already in place.

Chapter5 Recommendations for Achieving the Overall Goal

5.1 Prospects for achieving Overall Goal

The Overall goal: ”To promote the strategic utilization of the reliable and precise Geospatial Information through NSDI for the formulation of infrastructure development planning for regional and industrial development” is considered highly likely to be achieved for the following reasons.

- The “Policies and Institutions” described in the “GI Policy” and the “Organization and Structure” described in the “NSDI promotion structure” discussed in the project will be maintained in the 13th FYP.
- The NSDI system, which will serve as the basis for future NSDI promotion in Bhutan, has been developed as a financially and technologically sustainable structure that is maintained and managed by C/P with the cooperation of participating agencies and the maintenance support of software vendors with whom C/P already has license agreements.
- Reliable and accurate Geospatial Information with clear SSOT ownership is uploaded to the NSDI system, and is downloadable by the general public based on data categorization SOP.
- NLCS, the primary agency for maintaining and updating Geospatial Information, has acquired the equipment, technology, and other capabilities to perform this work on a sustainable basis.
- During the project, there must be a track record of using digital topographic maps for “Infrastructure development” such as road management and airport development plans, or there must be plans to use digital topographic maps for planning projects related to “Urban environment improvement".

5.1.1 Indicator of the Overall goal: number of planned projects using Geospatial Information based on NSDI

During the project, GI managed by NLCS was used for analysis and other purposes in the planning and preparation of the “Gelephu Mindfulness City (GMC)” project, “Phuentsoling - Samtse Linked Urban Centre (LUC)”, a priority project in Bhutan's 13th Five-Year Plan and identified as a future development potential area in the “Comprehensive National Development Plan Project (CNDP 2023)” and it requested digital topographic maps.

Other requests were made by local governments to the NLCS to develop and share digital topographic maps for the “Lhamoizingkha” and “Tashicholling” areas.

The feasibility of developing 1:25,000 topographic maps of all of Bhutan and 1:5,000 topographic maps of major cities has increased, an environment has been established in which these maps are managed and shared via the NSDI system. In addition, the use of Geospatial Information created by the transferred technology for development planning has already begun.

5.2 Recommendations to the Government of Bhutan

For the results of this project to be effectively utilized and for NSDI to be promoted sustainably in Bhutan, the following are expected to be implemented.

Through Output 1, the rules for searching, accessing, and obtaining necessary geospatial information have been unified and streamlined through the development of geographic information standards and the NSDI system, and through Output 2, the number of organizations that have enhanced their ability to share and utilize geospatial information through GIS has increased. Furthermore, since the entire Bhutan will be generally covered by the base map by 2025.

It is desirable that meetings of CGI member agencies on the promotion of NSDI be held regularly in the future, and that dissemination activities be conducted for other agencies as well, and that a Task Forces be established to address any technical issues related to the management and utilization of Geospatial Information. These are expected to increase opportunities for Geospatial Information to be utilized in infrastructure development planning and other activities, as well as to increase the number of agencies that practice such activities.

5.2.1 Recommendations for Output 1

Recommendations for Output 1 are as follows.

Table 5.2.1 Recommendations for Output 1

Themes		Recommendation
Policies and Institutions	GI Policy 2018 update	The GI Policy was enacted in 2018, but currently there is a gap between the wording of the GI Policy and the perception of each agency, including the rules for establishing TWGs and the position of the Action Plan (Ex: in 6.1.4, the CGISC is to establish a TWG, but in 8.1.6.2, the GHLC is to establish a TWG. In addition, NLCS has renamed from CGISC to CGI). Although TS is not mentioned in the GI policy, “Rules & Regulations/Guidelines for GI Policy Action” states that the TWG will form a TF. It is recommended that the GI policy be revised from the perspective necessary to resolve these inconsistencies and ensure the sustainable maintenance and management of the NLCS (Ex: First, the GHLC will meet to resolve to start considering GI policy revision and establish a TF in charge of GI policy revision. The TF is in charge of identifying current issues and formulating a revision proposal, which is then reviewed by the TWG, consensus is reached at the CGI member meeting, and then approved by the GHLC).
Technology	Conduct data quality evaluation	It is advisable to start with what C/P can do such as automated checks using GIS software or visual checks through sampling and gradually gain experience.

Themes		Recommendation
Operation of NSDI system	Create "DPS" and "Metadata" and facilitate registration in the NSDI system	For the NSDI system to be effective, GI under the management of each agency must be registered in the NSDI system to facilitate data distribution. It is essential not only to register GI data, but also to register metadata for its retrieval and DPS with detailed contents in the NSDI system. It is desirable for the NLCS not only to promote its own data registration but also to encourage relevant agencies to do so. If the authority of the NLCS is weak, the GHLC may encourage relevant agencies to register their data top-down through a resolution of the GHLC.
	Documentation in NSDI system development	In developing NSDI system, JICA experts advised that it is important to fully design services and define requirements, and to be sure to document them, and that even when developing a system on their own, information related to the system design and configuration should be kept in writing so that the system can be recovered in case of any problems. It is recommended that the C/P continue to plan for system upgrades and data management on a sustainable basis, document even the smallest details, and be prepared to avoid repeating the mistakes of the Geo-portal (on that time) that have been rendered unrecoverable.
	Promote activities to expand the usefulness of NSDI	The NSDI system can store and share data, create applications that combine NSDI data with data from other agencies, and publish this information as dashboards and map applications. It is recommended to continue offering these services and promoting activities that increase the usefulness of the NSDI system.
Personnel aspects	Consideration of measures in line with fiscal year	In Bhutan, each government official formulates an individual action plan called “Individual Work Plan (IWP)” every year. It would be effective to consider measures in line with the fiscal year so that future activities to promote NSDI are approved as part of the IWP, which is a mandatory task for government officials, rather than an additional task.

Source：JPT

5.2.2 Recommendations for Output 2

Recommendations for Output 2 are as follows.

Table 5.2.2 Recommendations for Output 2

Issues	Recommendation
Development of digital topographic maps	It is expected that a maintenance plan will be developed in accordance with the NLCS's ”10-Year STRATEGIC PLAN FOR LAND SECTOR (2024 - 2034)” policy and that 1:25,000 digital topographic maps of the entire country and 1:5,000 digital topographic maps of major areas will be completed by 2029 in accordance with the plan. While there may be a shortage of stereo equipment during this period, it is desirable to establish an environment in which topographic maps can be created and updated with a minimum amount of stereo equipment, utilizing Drones and commercially available or existing data, while appropriately segregating the methods and equipment used to create the geographic features.
Vector Tile	Although the 1:25,000 digital topographic maps of the entire land area and 1:5,000 digital topographic maps of major areas will not be completed until after the completion of this project, it is hoped that all digital topographic maps will be vector tiled and used as background for the NSDI system, taking advantage of the results of training in the project.
Review framework for GI managing, sharing, and updating	Although a framework for GI managing, sharing, and updating has been compiled and documented, full-scale operation of the NSDI system will not begin until after the project is completed, and it is recommended that necessary review discussions be held periodically to ensure that the framework is established in accordance with the actual operational conditions. In particular, since it is important for this framework to be consistent with SSOT and SOP stipulated in other activities, it is also important to keep a close watch on the trends of related criteria and standards, and review them whenever there are any changes.
Efforts to improve NSDI services	The launch of the NSDI service will greatly improve access to GI data in Bhutan; however, for GI to disseminate and be effectively utilized in society, it is necessary to realize the following: Efforts to make the existence of NSDI known. Improving the quality and efficiency of operations through the use of NSDI. Improving skills of data users to use data. In Bhutan in particular, there is the impression that it is important to be taught by others, and actively developing training menus and providing learning opportunities will be significant in promoting future utilization.

Source：JPT

Appendix

1) Project Design Matrix and Plan of Operation (PDM and PO)
2) Documents regarding NSDI Partnership
3) Documents regarding GI Standards
4) Action Plan for the Advancement of Utilizing GI
5) NSDI System Operation Plan
6) Documents regarding GI Management

1) Project Design Matrix and Plan of Operation (PDM and PO)

Appendix 1-1: PROJECT DESIGN MATRIX (PDM)
Appendix 1-2: PLAN OF OPERATION (PO)

Project Monitoring Sheet I (Project Design Matrix)

Project Title: "The Project for Promotion of Utilization of Geospatial Information through Development of National Spatial Data Infrastructure"

Implementing Agency: NLCS

Period of Project: Nov 2020 ~ Jan 2025 (51 Months)

Version 5.0

Dated 2 December, 2024

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption	Achievement	Remarks
Overall Goal					
To promote the strategic utilization of the reliable and precise geospatial information through NSDI for the formulation of infrastructure development planning for regional and industrial development.	Numer of planned projects using geospatial information based on NSDI.	Report from each organization.			
Project Purpose					
To share the reliable and precise geospatial information with related organization including private sectors utilizing NSDI established and operated by Royal Government of Bhutan.	Number of shared geospatial information.	The number of geospatial layers available for download by the general public more than 50 Agreement from each organization more than 10 agencies		Base deployment of the system has been completed. Some base layer (vector tile data etc.) has been registered by the counter part.	
Output1			No dramatic change of the related policy in RGOB. No dramatic change of the key persons of the Project.		
Capacity development for the operation planning and implementation for the strategic utilization and promotion of NSDI.	Number of stakeholders of NSDI.	CGI Member List. 36 member agencies		Completed (33 agencies)	
	Number of Meetings and Participants.	Outcomes of Meeting. (Meeting among CGI member agencies: 2times/year)		1st CGI Meeting: 12 agencies, 22 people, 2nd CGI Meeting: 15 agencies, 24 people 3rd CGI Meeting: 24 agencies, 51 people CGI workshop: 9 agencies, 13 people	
	Number of Access to Web Map Service.	The number of geospatial layers registered to the NSDI system is more than 10		More than 10 map layers are resistered to the NSDI system, and viewable on the web map of NSDI suystem.	
	Number of proposed action plans.	Proposed action plans (more than 5).		Six action plans (also called "individual measures") for the fiscal year 2023/24 were prepared by CGI Office, DoST, Thimphu Thromde, DoFPS, DoSAM/NLCS, and SJ Thromde each.	
Output2					
Capacity development for making, updating, management and utilization of digital topographic map.	Pilot area described in R/D.	<Area of Satellite Image Acquisition> 240km2 for 1:5,000, 1,376 km2 for 1:25,000 and 0.1 km2 for larger than 1:5,000. <Area of Topographic Map Creation> 50km2 for 1/5,000, 1,000 km2 for 1:25,000 and 0.1 km2 for larger than 1:5,000.		<Area of Satellite Image Acquisition> 240km2 for 1:5,000, 2,635 km2 for 1:25,000 and 0.1 km2 for larger than 1:5,000 have been completed <Topographic Map Creation> 1:25,000: 2,300 km2 completed 1:5,000k: 50 km2 completed Larger than 1:5,000: 3.2 km2 completed	
	Number of qualified operators.	Technical examination (3 operators more than 75pnts).		3 operators has been qualified	
	Number of authorized procedures of geospatial information for management.	Number of training sessions for the implementation of authorised (agreed) procedure (more than 3 agencies)		Geospatial data management, sharing, and update framework, and operation plan were established. Then trainings for data administrators from more than 3 agencies were presented.	

Activities	Inputs		Important Assumption
	The Japanese Side	**The Bhutan Side**	
Activity1-1: To summarize legal framework, plans and policies related to NSDI and to create basic plan of NSDI in accordance with Geo-information policy. Activity1-2: To summarize related organizations and its role and responsibility for the establishment and operation of NSDI and to enhance the cooperation among the related organizations. Activity1-3: To establish draft of geographic information standard in Bhutan and to implement its promotion to related organizations. Activity1-4: To develop and implement action plans for utilization of geospatial information in related organizations. Activity1-5: To conduct conceptual design for ICT services including Bhutan Geospatial Portal for NSDI and to provide Web Map Service as a part of NSDI. Activity1-6: To identify the required equipment for the operation of NSDI and to decide the specification of the equipment. Activity1-7: To develop the strategy and policy for the promotion of NSDI and geographic information standard and to conduct awareness campaign such as seminar and training or workshop for the promotion of utilization. Activity2-1: To enhance the capacity of making and updating the digital topographic map on scale 1/25,000 and 1/5,000 or larger in pilot area. Activity2-2: To clarify the authorized organization for the management of geospatial information and to develop the efficient process of data management, sharing and updating of each geospatial information. Activity2-3: To enhance the capacity of utilization of digital topographic map in related organization. Activity2-4: To conduct awareness campaign such as seminar and training or workshop for the promotion of utilization of geospatial information including digital topographic map.	1. Experts 2. Equipment and Materials (PCs, Satellite Images for activities 2-1, ISO Document, Drone, Softwares, ICT related devices, etc.) 3. Training in Japan (Management Cources and Engineer Cources) related to NSDI and Utilization of related geospatial information, etc. 4. On-the-job Training 5. Third country training (e.g. Presentation in related International Conference)	1. Counterpart including their personnel expences 2. Engineers for NSDI and Digital Topographic Map 3. Field Surveys such as ground control point survey, field verification, field completion and related costs including transportation and daily allowances, etc. 4. Equipment and Materials (including softwares, etc.) related to make and update the digital topographic map. 5. Office space and facilities for experts of the Project. 6. Running expenses for other local costs such as electricity, water bill and internet access, etc. 7. Training space and facilities for the Project.	The Counterpart has an ownership for the activities of the Project. The Counterpart takes necessary permission for the activities of the Project from the related authorities in proper timing. **Pre-Conditions** The Counterpart bears the required costs for their personnel of RGOB to take necessary actions related to the Project in Bhutan such as transportation, daily allowance, etc. at its own expence. **<Issues and countermesures>**

Project Monitoring Sheet II (Revision of Plan of Operation)

Version 5.0
Dated 2 December, 2024

Project Title: "The Project for Promotion of Utilization of Geospatial Information through Development of National Spatial Data Infrastructure"

Duration: Thirty-eight (38) months from the arrival of the first expert (2021/11/29-2025/1/28)

Inputs	Year	2020	2021				2022				2023				2024				2025	Remarks	Monitoring: Issue	Monitoring: Solution
		11-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1			
Expert		(Remote work caused by COVID-19)																				
NSDI basic plan/ Digital Topo-map establishment plan / Project Leader Activity 1-1	Plan																			196 100%		
	Actual																			196		
Buildup of Coordination of agencies Activity 1-2	Plan																			72 100%		
	Actual																			72		
Geographic Information Standard Activity 1-3	Plan																			147 100%		
	Actual																			147		
Utilization Promotion and Action plan of Geospatial Information Activity 1-4	Plan																			153 100%		
	Actual																			153		
NSDI ICT services Activity 1-5, 1-6	Plan																			147 100%		
	Actual																			147		
Digital topo-map creation / Human Resource Development Activity 2-1	Plan																			122 100%		
	Actual																			122		
GI Management / GIS Tools Activity 2-2, 2-3	Plan																			145 100%		
	Actual																			145		
Training plan / Coordinator Activity 1-7, 2-4	Plan																			114 100%		
	Actual																			114		
Equipment																						
Satellite Images(Images, DEM)	Plan																			100%		
	Actual																					
For Office work	Plan																			100%		
	Actual																					
For Field Work	Plan																			100%		
	Actual																					
For GI Standard	Plan																			100%		
	Actual																					
For ICT Service	Plan																			100%		
	Actual																					
Drones	Plan																			100%		
	Actual																					
Training in Japan																						
Technical Training in Japan (NSDI, Utilization of Geospatial Information, etc.)	Plan																			100%		
	Actual																					
In-country/Third country Training							Seminar								Seminar			3rd Country	Seminar			
Seminar, 3rd Country training	Plan																			100%		
	Actual																					

Activities / Sub-Activities		Year	2020	2021				2022				2023				2024				2025	Responsible Organization: Japan	Responsible Organization: Bhutan	Achievements	Issue & Countermeasures
			11-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1				
Output 1: Capacity development for the operation planning and implementation for the strategic utilization and promotion of NSDI.																								
Activity1-1: To summarize legal framework, plans and policies related to NSDI and to create basic plan of NSDI in accordance with Geo-information policy.	○	Plan																			Experts	NLCS Related Organizations	GI Policy action Plan was monitored by CGI Office	
		Actual																						
Activity1-2: To summarize related organizations and its role and responsibility for the establishment and operation of NSDI and to enhance the cooperation among the related organizations.	○	Plan																			Experts	NLCS Related Organizations	More than 7 CGI Meetings have been held. The data inventory of the CGI member agencies was prepared and shared.	Exective meeting has been held. GHLC should also be plannned.
		Actual																						
Activity1-3: To establish draft of geographic information standard in Bhutan and to implement its promotion to related organizations.	○	Plan																			Experts	NLCS BSB	The New Work Item Proposal (NWIP) for Metadata BTS has been submitted with the Guidelines on Metadata at the Subcommittee on Geographic Information Standard. The draft Guidelines for Data Product Specifications (DPS) and Data Quality (DQ) have been prepared and reviewed internally within NLCS.	
		Actual																						
Activity1-4: To develop and implement action plans for utilization of geospatial information in related organizations.	○	Plan																			Experts	CGI Office, DoSAM/NLCS, DoST, DoFPS, SJ Thromde, Thimphu Thromde	Six action plans (also called "individual measures") for the fiscal year 2023/24 were prepared by CGI Office, DoST, Thimphu Thromde, DoFPS, DoSAM/NLCS, and SJ Thromde each. Five of them implemented their activities as originally planned, and progress of these activities were monitored and evaluated periodically.	
		Actual																						
Activity1-5: To conduct conceptual design for ICT services including Bhutan Geospatial Portal for NSDI and to provide Web Map Service as a part of NSDI.	○	Plan																			Experts	NLCS, DITT, Related Organizations	The system was developed update will be continued as needed base.	
		Actual																						
Activity1-6: To identify the required equipment for the operation of NSDI and to decide the specification of the equipment.	○	Plan																			Experts	NLCS, DITT Related Organizations	Procuremenrt was completed.	
		Actual																						
Activity1-7: To develop the strategy and policy for the promotion of NSDI and geographic information standard and to conduct awareness campaign such as seminar and training or workshop for the promotion of utilization.	○	Plan																			Experts	NLCS Related Organizations	・The Final Seminar was held in November 2024 ・2nd and 3rd Training in Japan have been carried out in 2024 ・Training in the 3rd country(Thailand) has been carried out ・Some of workshops have been carried out	
		Actual																						
Output 2: Capacity development for making, updating, management and utilization of digital topographic map.																								
Activity2-1: To enhance the capacity of making and updating the digital topographic map on scale 1/25,000 and 1/5,000 or larger in pilot area.	Spec. Planning	Plan																			Experts	NLCS	Explanation of Specification for 1:25,000 and 1:5,000 map was carried out	
		Actual																						
	1/25,000	Plan																					More than 2,300km2 of 1:25,000 Topographic map has been created include QC.	
		Actual																						
	1/5,000	Plan																					More than 50km2 of 1:5,000 Topographic map has been created include QC.	
		Actual																						
	Larger Scale	Plan																					More than 3.2km2 of 1:1,500 level topographic map have been created by NLCS with procured Drones.	
		Actual																						
Activity2-2: To clarify the authorized organization for the management of geospatial information and to develop the efficient process of data management, sharing and updating of each geospatial information.	○	Plan																			Experts	NLCS, DHPS, DHS, NEC, DoFPS	Draft of data management, sharing, and update was created.	
		Actual																						
Activity2-3: To enhance the capacity of utilization of digital topographic map in related organization.	○	Plan																			Experts	NLCS, DHPS, DHS, NEC, DoFPS	Trainings of WebGIS basic, data administration, and GIS tools were carried out.	
		Actual																						
Activity2-4: To conduct awareness campaign such as seminar and training or workshop for the promotion of utilization of geospatial information including digital topographic map.	○ ○	Plan																			Experts	NLCS Related Organizations	Some of workshops have been carried out	
		Actual																						
Duration / Phasing		Plan																						
		Actual	(Remote work caused by COVID-19)																					

Monitoring Plan	Year	2020	2021				2022				2023				2024				2025	Remarks	Monitoring: Issue	Monitoring: Solution
		11-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1			
Monitoring																						
Joint Coordinating Committee	Plan																					
	Actual																					
Submission of Monitoring Sheet	Plan																					
	Actual																					
Reports/Documents																						
Work Plan, ProgressReport	Plan																					
	Actual																	(Draft)	(Final)			
Project Completion Report	Plan																					
	Actual																					

2) Documents regarding NSDI Partnership

Appendix 2-1: GHLC_ToR
Appendix 2-2: Procedures for Conducting CGI Meeting
Appendix 2-3: Draft ToR for TWG
Appendix 2-4: Operational manual for Task Force

Geo-Information High Level Committee (GHLC) Terms of Reference

(A Committee for National Geospatial Information Management, NGIM)

Mission

To foster innovation, provide leadership and coordination, and promote standards necessary to strengthen National Geospatial Information Management (NGIM) to achieve sustainable development through effective use of geospatial information for evidence based decision making.

Principles

Members agree to abide by the underlying principles:

1. Take whole of government approach to foster and strengthen cooperation and collaboration among member agencies and with the community, including the private sector
2. Continuously improve the geospatial data acquisition and management assuring data quality, coverage and completeness.
3. Facilitate access to spatial information without compromising security, confidentiality or privacy and in compliance with policies and guidelines.

Committee Responsibilities

1. Provide strategic direction for NGIM and Center for Geo-Information (CGI) to deliver its functions and whole of government outcome.
2. Provide policy recommendations to address significant issues related to Geospatial Information.
3. Identify potential threats to the implementation of the GI policy and NSDI and recommend risk management strategies.
4. Promote the use of spatial information for decision-making as an enabler to sustainable development.
5. Promote optimum utilisation of limited resources through sharing of expertise and resources within GI communities to reduce duplication of effort and develop synergies.
6. Facilitate the professional development of the GI community.
7. Review and approve GI Rules and Regulations and pricing model of geo-information proposed by CGI.
8. Endorse and approve strategic plans, and promote national GI standards for sharing geospatial information.

Role of a GHLC Member

GHLC members should:

1. understand the strategic implications and outcomes of any GI initiative.
2. appreciate the significance of the NGIM to all the major stakeholders and represent their interests;
3. be genuinely interested in the initiative and be an advocate for broad support for any GI activities being pursued.
4. have a broad understanding of GI policy and management issues and approach being adopted.

Code of conduct

Committee members are required to:

- avoid any improper use of information or GHLC position;
- avoid misuse information obtained in the course of GHLC meetings either to:
    - obtain a direct or indirect gain for themselves or others
    - do harm to other people
    - maintain confidentiality; not to divulge information which is confidential or sensitive;

- declare conflict of interests and disclose any personal interests
    - in a written notice given to the Chair before the meeting; or
    - at the meeting immediately before the matter is discussed
- If a member discloses an interest, the Chair of the group may:
    - allow the member to be present during any discussion or decision making procedure relating to the matter; or
    - request that the member refrain from discussion and/ or leave the meeting prior to the decision making procedure.

In the event of any member committing a breach of this code of conduct, the Chair may report the details of such breach with the organisation the member represents.

Procedure for GHLC Meetings

The following rules of procedure shall apply for the conduct of GHLC meetings:

- The meeting shall be held biannually or as and when required. Presence of two thirds of the members shall constitute a quorum.
- If the Chair is absent from a meeting, the Co-Chair shall preside and the Co-Chair acting as Chair shall have the same powers and duties as the Chair.
- New proposals for discussion and amendments to previous decisions or resolutions taken by the Committee shall normally be introduced in writing and submitted to the Member Secretary of the Committee, who shall circulate copies to the representatives.
- Each member organization participating in the Committee shall have one vote. Decisions of the Committee shall be taken by a majority vote.
- The Committee shall normally vote by a show of hands.

Endorsement

By signing the Charter, members of GHLC agree to actively contribute and support the principles and policies and, where relevant, incorporate them within the culture and day-to-day operations of their organisation.

Designation

.....

Organisation

.....

Signature

.....

Date

.....

(DRAFT) Procedures for Conducting CGI Meeting

27 July 2022

CGI Office, NLCS

(Conduct of Meeting)
Article 1

(1) In pursuance of sections 6.1.2, 6.1.3 and 9.2 of GI Policy 2018, the Center for Geo-Information (hereinafter referred to as "CGI") shall convene the member agencies to hold the meeting(s) (hereinafter referred to as "CGI meeting(s)") on periodic basis.

(2) CGI Office shall prepare agenda and schedule date, time and venue for CGI meetings. CGI Office shall inform the participants timely on venue, time and agenda of the meeting.

(3) CGI meetings may be open to all CGI members or specific groups depending on the topic of discussion and they shall attend on the invitation.

(4) CGI Office shall send the formal invitation letter to the respective agency heads with a copy to Focal Person.

(Meeting Participation)
Article 2

A quorum of two-third of total participants including the virtual attendants is required to convene a CGI meeting.

(Minutes of Meeting/Reports)
Article 3

(1) CGI Office shall maintain clear records of all minutes of meetings/record of discussion.

(2) Minutes of Meeting/Report shall contain date, place of meeting, names of participants, issues discussed and decisions/resolutions of meetings.

(3) CGI Office shall circulate the draft minutes or reports to all the participants electronically for edition before finalization within a reasonable period of time from the date of convening the meeting or producing the draft report.

(4) The members and any other participants should provide any comment or feedback they have on the Minutes or Report within a stipulated date after the circulation of the draft Minutes or Report.

(5) All final minutes of meetings and Reports should be circulated to the member agencies and participants.

(Miscellaneous Provisions)
Article 4

In addition to the provisions of these procedures, the Chairperson shall determine matters necessary for the meetings.

Draft Terms of Reference for Technical Working Group

25 August 2022

CGI Office, NLCS

Procedures for Formation of Technical Working Group

1. In pursuant to section 6.1.4 and 8.1.6.2 of GI Policy 2018, Technical Working Group (TWG) shall be formed by CGI and approved by the Geo-information High Level Committee (GHLC).
2. The CGI Office shall select the candidate members of TWG from the member agencies and get the consents from them in advance.
3. The CGI Office shall submit the proposal of the TWG candidate members to CGI members.
4. The establishment of TWG shall be approved by GHLC.
5. The Technical Working Group may establish a project based Task Force to work on a specific task.

Roles and Responsibility of TWG

1. TWG shall comprise technical people with professional experience in geospatial science and geo-information.
2. TWG shall be responsible to implement the decision of GHLC.
3. TWG members shall meet quarterly to carry out the designated tasks and report to GHLC through the member secretary of CGI. However, TWG shall attend any ad-hoc meeting that may be convened to discuss important and urgent issues as they may arise.
4. If any members are transferred or feel that they cannot further serve as the TWG member, he/she should inform the CGI Member Secretary immediately and make a recommendation for replacement.
5. TWG shall form Task Force as and when necessary to resolve any issues that may arise.
6. TWG shall provide technical services to the member agencies, as and when required.
7. TWG shall validate the data conformity as per the national data standards defined in NSDI.
8. A specific task assigned to a Task Force shall be reviewed and validated by TWG.
9. TWG shall formulate relevant guidelines in the context of geospatial data in line with the GI policy.

Procedure for TWG meetings

The following rules of procedure shall apply for the conduct of TWG meetings:

- CGI Office shall coordinate and facilitate TWG meetings.
- The meeting shall be held quarterly or as and when required. Presence of two thirds of the members shall constitute a quorum.
- CGI Office shall maintain clear records of all minutes of meetings/record of discussion.
- CGI Office shall inform the members of the working group on venue, time and agenda of the meetings.

Operational Manual for Task force

This operational manual is being put in place in compliance with clause 6 section 1.3.1 of GI Rules and Regulation which states that 'Project based Task Force team shall be formed from TWG members as and when necessary'.

Purpose

Task forces are time-bound and outcome-focused groups that are convened to support mission, strategic objectives or program activities related to Geospatial information.

Member

1. The task force shall be chaired by the Member Secretary of CGI office.

2. Upon the approval from the Member Secretary of CGI office, the Technical Working Group (TWG) shall identify the candidate of the task force based on the nature of project or issue.

3. Any focal person of the CGI member agencies may attend the task force meeting at the invitation and approval from the Chair of the task force.

4. The task force shall be dissolved once the objectives of the particular project are fulfilled or when the key issues are resolved.

Meeting

1. The CGI Office shall prepare the agenda for the task force meetings in close coordination with the members of the task force.

2. CGI office shall inform the members of the task force on venue, time and agenda of the meetings.

3. Meetings of the Committee may be called by the CGI office at any time to consider any matters falling within these Terms of Reference.

4. CGI Office shall draw up minutes of the meetings and shall be circulated to all the task force members and attendees.

5. The draft minutes of the meeting shall be circulated within the 5 working days from the convening of the meeting to seek any feedback or additional comments from the participants.

Roles and Responsibilities

1. The Task Force shall not be an implementing entity but rather submit its findings and recommendations to the Technical working group for further deliberations.

2. The target issues to be addressed with the formation of the task force shall be identified during the general CGI meeting.

3. Task force formed shall identify and analyze the source of the issue and propose the most suitable method to solve the issue.

4. The work of the task force shall be conceptualized into two phases.

5. The first phase is the fact-finding phase in which the candidate will present the perspective on the issue. These presentations may include research summaries and statistics and a description of a particular program.

6. The second phase is the recommendation phase. At this point, the task force shall develop consensus around a set of solutions based on the findings of the first phase.

3) Documents regarding GI Standards

Guideline for Metadata

(Ref: ISO 9115-1: 2014)

(DRAFT_V0)

NOVEMBER 2023

National Land Commission Secretariat (NLCS)

Royal Government of Bhutan

Table of Contents

1. Introduction 1
2. Objective 1
3. Conformance 2
4. General rules for Metadata Creation 2
    4.1 Obligation/Condition 2
    4.2 Element Domain 2
    4.3 Metadata Template 3
5. Metadata creation process 5
6. Metadata validation 5
7. Metadata sharing and distribution 6
8. Maintenance of metadata 6
9. Acronyms 6
Annexure I: Definition of Metadata elements 7
Annexure II: Code List and Enumerations 9
Annexure III: Standard Operating Procedure (SOP) for metadata creation. 17
Annexure IV: Metadata example 19
References 22

1. Introduction

The development of geographic metadata standards began with the evolution of Geographic Information System (GIS) and digital mapping technologies. Initially, metadata were compiled as reports for managing dataset production and inventory. Gradually, with the advancement of geospatial technologies, Geographic Information (GI) metadata has become an underpinning resource for data discovery and accessibility.

Metadata is a set of information that captures and describes the basic characteristics of a dataset or an information resource. It describes who, what, when, where, why and how of the associated data, enabling users to find the information and assist its optimal utilization.
Metadata plays an important role in data management, facilitating data sharing, interoperability, consistency and a collaboration among the geospatial data creators and users. It improves search and discovery of the dataset, facilitates the organisation of the data content, enables us to understand data lineage, helps in data longevity and importantly ensures the data integrity and compliance of the metadata standards.

Metadata must be reviewed periodically to ensure that it remains up to date and aligned with Bhutan Standards (BTS) for metadata. The revision of the guideline shall be carried out by the Centre of Geo-Information (CGI), NLCS in collaboration with CGI member agencies. This guideline clearly defines the metadata standards and formats for creating consistent and comprehensive metadata ensuring both geographic producers and users to understand and capture the information adhering to the Bhutan Standards (BTS) for metadata.

2. Objective

The main objective of this guideline is to provide a clear understanding and reference for creation of the metadata so that it ensures consistent adoption of the metadata standards. It shall be applicable to all the geospatial data creators and producers within Bhutan for metadata creation and management.
The guideline aims to achieve the following objectives;

1. To adopt standardized formats and structures for describing various types of geographic information to ensure uniformity in metadata representation.
2. To enable seamless integration of metadata across various applications.
3. To enhance data searchability, discovery and access.

4. To enable users to analyse and assess the suitability of the datasets.

3. Conformance

This guideline is in line with BTS for geographic information. It is designed to ensure BTS for metadata is consistent, comprehensive, and adheres to the ISO 19115-1:2014 metadata standard. The definitions for the elements were rephrased for more clarity and easy reference.

4. General rules for Metadata Creation

4.1 Obligation/Condition

Based on the ISO 19115-1:2014 metadata standards, each metadata element has the property of the obligation/condition which describes whether a metadata item shall always be documented or sometimes be documented.

The BTS for metadata defines the following three values:
Mandatory (M): The metadata elements that must be included in every metadata record to comply with the ISO 19115-1:2014 standard. Failure to include mandatory elements will result in rejection in the metadata publication.

Conditional (C): The elements that depend on specific conditions or situations for adoption under which at least one metadata is mandatory.

Optional (O): The optional elements are not mandatory to include in the metadata record but they can be included based on the specific needs and requirements of the data creator or users. Optional elements can have mandatory contents and those contents become mandatory if the optional elements are used.

4.2 Element Domain

In adherence to the ISO 19115-1:2014 metadata standard, each metadata element is defined by its allowable values, known as its domain. These values shall either adhere to a specific range, such as positive or negative integers, or they shall be derived from a set of code values established within a predefined code list as specified in the ISO standard for metadata. For certain metadata elements like 'abstract,' 'purpose,' etc., the acceptable values shall be in free text format. However, this free text should align with the definitions provided for each respective element. Defining these domains is vital for the creation of metadata and helps in ensuring the quality of metadata.

4.3 Metadata Template

Metadata template provides a schema and establishes a common set of metadata terminology, definitions, and extension procedures in line with BTS for geographic information. It provides information about the identification, the extent, the quality, the spatial and temporal schema, spatial reference, and distribution of digital geographic data. Table 1 shows the metadata template for creation of the metadata. The detailed elements and lists with its definition and domain can be referred to annexure I and II respectively.

Table 1: Metadata template showing the general elements

Category	Class	Elements	Sub elements	Obligation/ Condition	Domain
Overview	Item Description	Title		M	free text
		Abstract		M	free text
		Purpose		O	free text
		Use limitation		O	free text
	Topic and Key Word	Topic Category		M	list
	Citation	Title		M	free text
		Date	Created	M	date
			Published	M	date
			Revised	O	date
Metadata	Details	File identifier		O	
		Date Stamp		M	date
		Language		M	list
	Contact	Contacts	Name	M	free text
			Organisation	M	free text
			Position	M	free text

			Role	M	list
		Contact Information	Email	O	free text
			Phone	O	free text
	Maintenance	Update Frequency		M	list
		Next Update		O	date
Resource (Geographic Datasets)	Details	Status		M	list
		Language		M	list
		Character Set		O	list
		Spatial Representation Type		O	list
		Scale Resolution		O	free text
		Distance Resolution		O	free text
	Extents	Extent	Bounding box	M	free text
	Points of Contact	Contacts	Name	M	free text
			Organization	M	free text
			Position	M	free text
			Role	M	list
		Contact Information	Email	O	free text
			Phone	O	free text
	Maintenance	Update Frequency		M	list
		Next Update		O	date
	Constraints	General Constraints	Use Limitation	O	Open/Common/Restricted

	Spatial Reference	Reference Systems	Code	O	free text (Ex. code- EPSG 5266)
	Spatial Data Representation	Vector Representation	Geometric Object	O	code
	Content	Image Description	Attribute Description	M	free text
			Content Type	M	list
			Imaging Condition	O	list
			Cloud Cover Percentage	O	free text
	Lineage	Data Source	Source Description	M	free text
		Process Step	Process Description	M	free text
	Distribution	Distribution Format	Format Name	M	free text
			Format Version	M	free text
		New Distribution Transfer options	Units of distribution	O	free text
			Transfer size	O	free text

5. Metadata creation process

Metadata can be created using any proprietary or open-source GIS software, as long as it adheres to the ISO 19115-1:2014 metadata standard. However, it is recommended to create a metadata in ArcGIS software since it has an inbuilt metadata style selection based on the ISO standards implementation specification.

Metadata creators may adopt the following generic process for creation of metadata.

- Select the dataset for creation of the metadata

- Select “ISO 19139 Implementation Specification” as metadata styles (ISO/TS 19139-1:2019 is the XML implementation of ISO 19115-1:2014 for machine readability as most of the GIS softwares support this encoding)
- Create metadata records
- Capture all mandatory metadata elements specified in this guideline
- Adhere to the specific domain rule (free text/code list and Enumerations table)
- Review and validate metadata in conformance to this guideline
- Save the metadata
- Use XML format for sharing the metadata

6. Metadata validation

Metadata validation is an important process to ensure the complete capture of the mandatory elements and formats described in the guideline. Validation of metadata shall be carried out through the system as well as manual inspection. The system identifies the errors, missing elements, or inconsistencies in the metadata. Manual validation should be carried out to review the metadata records in detail and ensure that all required elements are captured accurately. Moreover, it is necessary to carry out the consistency check to match the required information and align with the content of the dataset.

Metadata validation shall be done by both the creator and the publisher. However, it should be also validated by the system administrator if the metadata is to be published in a system. The following checks need to be considered for metadata validation:

- BTS Standard Check: Compliance with this guideline.
- Completeness Check: Verify the completeness of all mandatory metadata elements.
- Content Quality Check: Assess the quality and coherence of the metadata content, ensuring it aligns with this guideline.

7. Metadata sharing and distribution

To make geospatial information more accessible and discoverable to a wider audience, the sharing and distribution of standardized metadata files is critical. Therefore, every geospatial dataset should encompass the metadata information in conformance with this guideline. Additionally, explicit sharing of metadata can also be done through xml format separately.

8. Maintenance of metadata

Metadata maintenance is not only a good practice but also a requirement for the metadata standard. Updating metadata ensures accurate, consistent, and reliable data that can be used to

track history, quality, and lineage. It also helps to avoid duplication, errors, and confusion when sharing or publishing data.

Metadata shall be:

- Updated when the particular geospatial dataset is modified.
- Updated by the agency that produced the geospatial data.
- Maintained up-to-date, complete, and consistent over time.
- Reviewed and validated after Updation.

9. Acronyms

BTS: Bhutan Standards
XML: Extensible Markup Language
CGI: Centre for Geo-Information
ISO: International Standard Organization
GIS: Geographic Information system
GI: Geographic Information
NLCS: National Land Commission Secretariat

Annexure I: Definition of Metadata elements

SI no	Elements	Definition
1	Title	Name of the dataset
2	Abstract	Clear and concise summary about the dataset's content, and significance.
3	Purpose	The intended purpose of the geographic dataset
4	Use limitation	Restrictions or constraints placed on the utilisation of a particular dataset or geographic information.
5	Topic Category	A high-level classification scheme to assist in the grouping and topic-based search of available spatial data resources.
6	Date	Date when the dataset was created, published, and revised.
7	File identifier	Unique identifier for the metadata
8	Date Stamp	The date of creation of metadata
9	Language	Language used in the metadata or dataset
10	Contacts	Organisation or individual responsible for the metadata /data

11	Contact Information	The contact details of the parties responsible for creating, maintaining, and providing access to the metadata/dataset.
12	Update Frequency	Frequency of metadata and data update
13	Next Update	Date for the next update of metadata and data
14	Status	Progress status of the dataset
15	Character Set	Name of the character set used in metadata/dataset for representing characters in a computer system (e.g., utf-8)
16	Spatial Representation Type	Geometry used to represent spatial feature in the dataset
17	Scale Resolution	The scale at which the spatial data is represented in the map. Scale resolution is the denominator value (e.g., scale 1/50,000, resolution is 50,000)
18	Distance Resolution	Detail or precision with which distances can be represented and measured in a geospatial dataset.
19	Extent	Geographic extent of the dataset using the minimum and maximum latitude and longitude coordinates
20	General Constraints	It refers to the access restrictions and usage limitations associated with the dataset.
21	Reference Systems	The coordinate reference system used in the dataset.
22	Vector Representation	Information on whether the geographic feature is a point, line, or polygon feature.
23	Image Description	Description of the image information
24	Data Source	Information about the source data used in creating the data
25	Process Step	General description of how the data was created
26	Distribution Format	Data format such as shp/kml/dwg/CSV/etc.
27	Distribution Transfer options	Size of the dataset

Annexure II: Code List and Enumerations

Table 1: Topic Category

ISO Topic Category and code	Definition	Examples
farming	Rearing of animals or cultivation of plants	Agriculture, irrigation, aquaculture, plantations, herding, pests and diseases affecting crops and livestock
biota	Flora or fauna in natural environment	wildlife, vegetation, biological sciences, ecology, wilderness, sea life, wetlands, habitat, biological resources
boundaries	Legal land descriptions	political and administrative boundaries, governmental units, marine boundaries, voting districts, school districts, international boundaries
climatologyMeteorologyAtmosphere	Processes and phenomena of the atmosphere	cloud cover, weather, climate, atmospheric conditions, climate change, precipitation
economy	Economic activities, conditions, and employment	Production, labour, revenue, business, commerce, industry, tourism and ecotourism, forestry, fisheries, commercial or subsistence hunting, exploration and exploitation of resources such as minerals, oil and gas
elevation	Height above sea level	altitude, bathymetry, digital elevation models, slope, derived products, DEMs, TINs
environment	Environmental resources, protection and conservation	environmental pollution, waste storage and treatment, environmental impact assessment, monitoring environmental risk, nature reserves, landscape, water quality, air quality, environmental modelling

geoscientificInformation	Information pertaining to earth sciences,	geophysical features and processes, geology, minerals, sciences dealing with the composition, structure and origin of the earth's rocks, risks of earthquakes, volcanic activity, landslides, gravity information, soils, permafrost, hydrogeology, groundwater, erosion
health	Health, health services, human ecology, and safety	disease and illness, factors affecting health, hygiene, substance abuse, mental and physical health, health services, health care providers, public health
imageryBaseMapsEarthCover	Base maps	land/earth cover, topographic maps, imagery, unclassified images, annotations, digital ortho imagery
intelligenceMilitary	Military bases structures, activities	barracks, training grounds, military transportation, information collection
inlandWaters	Inland water features, drainage systems and characteristics	rivers and glaciers, salt lakes, water utilisation plans, dams, currents, floods and flood hazards, water quality, hydrographic charts, watersheds, wetlands, hydrography
location	Positional information and services	addresses, geodetic networks, geodetic control points, postal zones and services, place names, geographic names
oceans	Features and characteristics of salt water bodies (excluding inland waters)	for example, tides, tidal waves, coastal information, reefs, maritime, outer continental shelf submerged lands, shoreline
planningCadastre	Information used for appropriate actions for future use of the land	land use maps, zoning maps, cadastral surveys, land ownership, parcels, easements, tax maps, federal land ownership status, public land conveyance records

society	Characteristics of society and culture	settlements, housing, anthropology, archaeology, education, traditional beliefs, manners and customs, demographic data, tourism, recreational areas and activities, parks, recreational trails, historical sites, cultural resources, social impact assessments, crime and justice, law enforcement, census information, immigration, ethnicity
structure	Man-made construction	buildings, museums, churches, factories, housing, monuments, shops, towers, building footprints, architectural and structural plans
transportation	Means and aids for conveying persons or goods	roads, airports/airstrips, shipping routes, tunnels nautical charts, vehicle or vessel location, aeronautical charts, railways
utilitiesCommunication	Energy, water and waste systems and communications infrastructure and services	hydroelectricity, geothermal, solar and nuclear sources of energy, water purification and distribution, sewage collection and disposal, electricity and gas distribution, data communication, telecommunication, radio, communication networks
extraTerrestrial	Region more than 100 km above the surface of the Earth	
disaster	information related to disasters	Site of the disaster, evacuation zone, disaster-prevention facility, disaster relief activities.

Table 2: Role codelist

Sl. no	**Name (code)**	**Definition**
	CI_RoleCode	**function performed by the responsible party**

1	Resource Provider	party that supplies the resource
2	custodian	party that accepts accountability and responsibility for the resource and ensures appropriate care and maintenance of the resource
3	owner	party that owns the resource
4	user	party who uses the resource
5	distributor	party who distributes the resource
6	originator	party who created the resource
7	pointOfContact	party who can be contacted for acquiring knowledge about or acquisition of the resource
8	principalInvestigator	key party responsible for gathering information and conducting research
9	processor	party who has processed the data in a manner such that the resource has been modified
10	publisher	party who published the resource
11	author	party who authored the resource

Table 3: Update frequency codelist

Sl. no	**Name (code)**	**Definition**
	MD_MaintenanceFre-quencyCode	**frequency with which modifications and deletions are made to the data after it is first produced**
1	continual	resource is repeatedly and frequently updated
2	daily	resource is updated each day
3	weekly	resource is updated on a weekly basis
4	fortnightly	resource is updated every two weeks

5	monthly	resource is updated each month
6	quarterly	resource is updated every three months
7	biannually	resource is updated twice each year
8	annually	resource is updated every year
9	asNeeded	resource is updated as deemed necessary
10	irregular	resource is updated in intervals that are uneven in duration
11	notPlanned	there are no plans to update the data
12	unknown	frequency of maintenance for the data is not known

Table 4: Use Limitation codelist

Sl. no	**Name (code)**	**Definition**
	Data access	
1	open	open data shall be openly and freely accessible
2	restricted	restricted data shall be used only by the authorized government agencies

Table 5: Progress codelist

Sl. no	**Name (code)**	**Definition**
	MD_ProgressCode	**status of the resource**
1	completed	has been completed
2	historicalArchive	stored in an offline storage facility
3	obsolete	no longer relevant

4	onGoing	continually being updated
5	planned	fixed date has been established upon or by which the resource will be created or updated
6	required	needs to be generated or updated
7	underDevelopment	currently in the process of being created

Table 6: Spatial Representation Type codelist

Sl. no	**Name (code)**	**Definition**
	MD_SpatialRepresenta-tionType Code	**method used to represent geographic information in the resource**
1	vector	vector data are used to represent geographic data
2	grid	grid data are used to represent geographic data
3	textTable	textual or tabular data are used to represent geographic data
4	tin	triangulated irregular network
5	stereoModel	three-dimensional view formed by the intersecting homologous rays of an overlapping pair of images
6	video	scene from a video recording

Table 7: Geometric Object Type Codelist

Sl. no	**Name (code)**	**Definition**
	MD_GeometricObject-TypeCode	**name of point or vector objects used to locate zero-, one-, two-, or three-dimensional spatial locations in the dataset**

1	complex	set of geometric primitives such that their boundaries can be represented as a union of other primitives
2	composite	connected set of curves, solids or surfaces
3	curve	bounded, 1-dimensional geometric primitive, representing the continuous image of a line
4	point	zero-dimensional geometric primitive, representing a position but not having an extent
5	solid	bounded, connected 3-dimensional geometric primitive, representing the continuous image of a region of space
6	surface	bounded, connected 2-dimensional geometric primitive, representing the continuous image of a region of a plane

Table 8: Coverage Content Type Codelist

	Name (Code)		**Definition**
	MD_CoverageContent- TypeCode		**specific type of information represented in the cell**
1.	image	image	meaningful numerical representation of a physical parameter that is not the actual value of the physical parameter
2.	thematicClassification	thematicClassification	code value with no quantitative meaning, used to represent a physical quantity
3.	physicalMeasurement	physicalMeasurment	value in physical units of the quantity being measured

Table 9: Imaging Condition Code Codelist

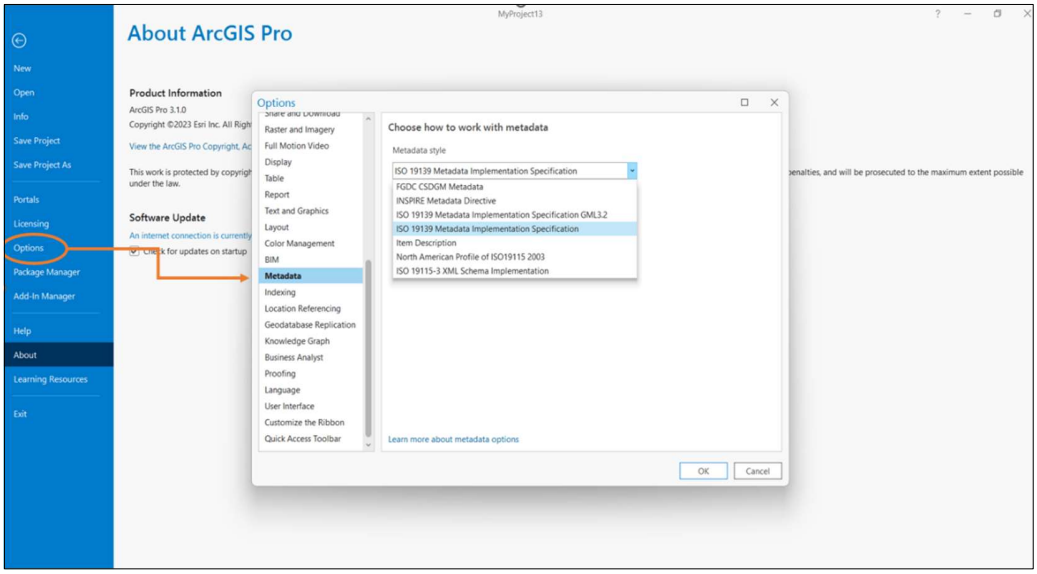
	Name (Code)	Definition
	MD_ImagingCondition-Code	**code which indicates conditions which may affect the image**
1.	blurredImage	portion of the image is blurred
2.	cloud	portion of the image is partially obscured by cloud cover
3.	degradingObliquity	acute angle between the plane of the ecliptic (the plane of the Earth's orbit) and the plane of the celestial equator
4.	fog	portion of the image is partially obscured by fog
5.	heavySmokeOrDust	portion of the image is partially obscured by heavy smoke or dust
6.	night	image was taken at night
7.	rain	image was taken during rainfall
8.	semiDarkness	image was taken during semi-dark conditions – twilight conditions
9.	shadow	portion of the image is obscured by shadow
10.	snow	portion of the image is obscured by snow
11.	terrainMasking	the absence of collection data of a given point or area caused by the relative location of topographic features which obstruct the collection path between the collector(s) and the subject(s) of interest

Annexure III: Standard Operating Procedure (SOP) for metadata creation.

1. *Select metadata styles*

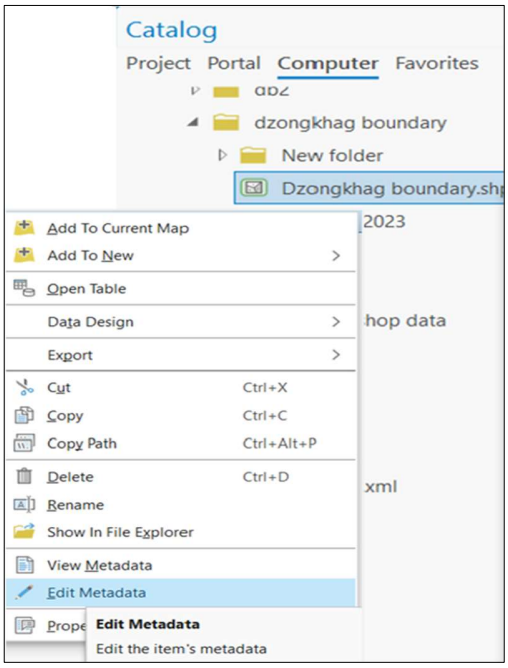
A metadata style provides access to a set of metadata elements, and a stylesheet for displaying their content.

1. Go to: Project (Tab) >> Options >> Metadata
2. Select: **ISO 19139 Implementation Specification** from metadata style list



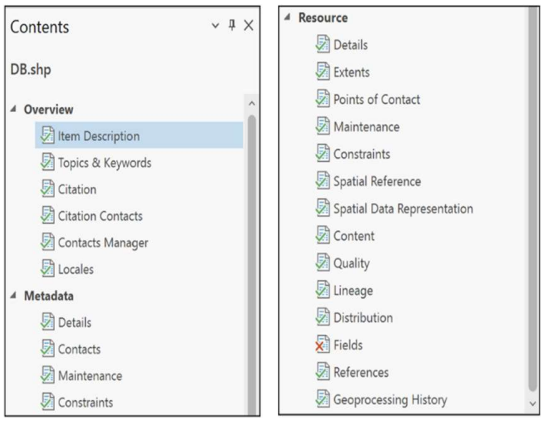
2. Create metadata

1. View tab>> Catalog Pane>> Folder (*Navigate to the data*)
2. Right click >> Edit Metadata



3. Fill up the metadata elements

>>Add **info** in metadata elements based on the contents

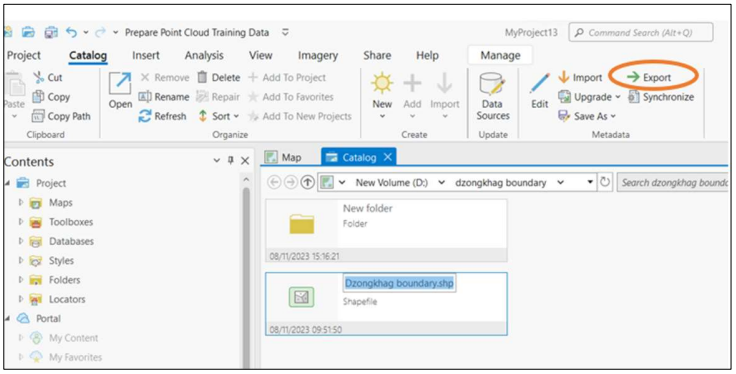


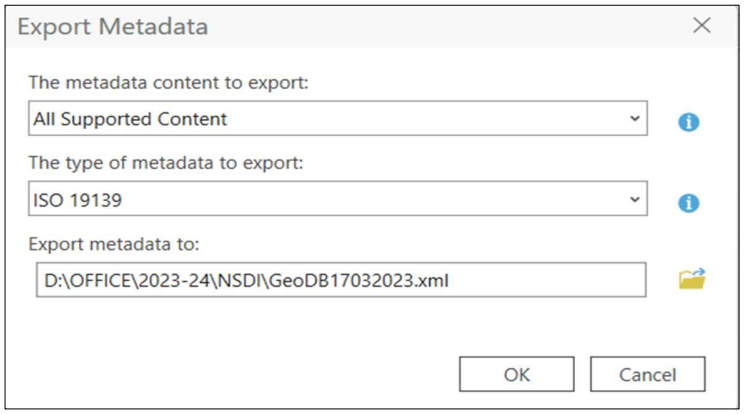
4. Export the metadata

>>Close the metadata window and navigate to the catalog pane.

>>Right click >>View metadata

>>Export metadata





** While exporting the metadata in the metadata content to export tab, select all supported content and select **ISO 19139** option in the type of metadata to export.

Annexure IV: Metadata example

Dzongkhag Boundary

ISO-19139 Metadata
Metadata Information:
Metadata language:
Metadata character set: utf8

Last update: 2023-11-08
Maintenance:
Update frequency: asNeeded

Metadata contact publisher:
Individual's name: Pema Wangda
Organization's name: NLCS
Contact's position: GISO

Scope of the data described by the metadata: dataset
Scope name: dataset

Name of the metadata standard used: ISO 19139 Geographic Information – Metadata Implementation Specification
Version of the metadata standard: 2007

Metadata identifier: CD38C09E-9876-4B30-860B-E7FC54246D56
Resource Identification Information:
Citation:
Title: Dzongkhag Boundary
Reference date - **creation:** 2023-11-07

Party responsible for the resource - publisher:
Individual's name: Pema Wangda
Organization's name: NLCS
Contact's position: GISO

Contact information:
Phone:
Voice:
Address:
e-mail address: @gmail.com

Themes or categories of the resource: boundaries

Abstract:
The dataset shows the clear boundary delineation of 20 Dzongkhags with names of each Dzongkhag. It has the attribute information showing the total geographical area against each Dzongkhag. The boundary has been mapped from the 1:50000 scale topographic map.

Dataset language: eng
Dataset character set: utf8

Maintenance:
Update frequency: asNeeded
Resource constraints:
Constraints:
Limitations of use: Open

Spatial representation type: vector

Spatial resolution:

Dataset's scale:

Scale denominator: 50000

Extent:

Geographic extent:

Bounding rectangle:

West longitude: 27

East longitude: 29

North latitude: 89

South latitude: 87

Point of contact - originator:

Individual's name: Prakash Rai

Organization's name: NLCS

Contact's position: SE

Contact information:

Phone:

Voice:

Address:

e-mail address: @nlcs.gov.bt

Reference System Information:

Reference system identifier:

Value: EPSG 5266

Data Quality Information:

Scope of quality information:

Level of the data: series

Lineage:

Process step:

Description: This data has been created from a small-scale map of 50000 scale topographic maps. However, minor changes and corrections have been carried out in the later phases by the NLCS upon the request from the local government due to some boundary discrepancies between the two Dzongkhags.

Source data:

Level of the source data: Generated from 50000 scale topographic base map

Distribution Information:

Format:

Format name: Shape file

Format version: Not application

Transfer options:

Transfer size: 10

Units of distribution (e.g., tiles): mb

Note: The above metadata was created using ArcGIS Pro software.

METADATA WORKING GROUP

1. Samdrup Dorji, Chief, GID
2. Sherub Tenzin, Specialist, CID
3. Lobzang Tobgye, DCSE, TOPO
4. Prakash Rai, SSE, GID
5. Pema Wangda, SGISO, CGI
6. Sangay Nidup, GIS, CGI
7. Gonpo Tenzin, Chief, PPD

References

ISO 19115-1 Geographic information Metadata-Part 1: Fundamentals. (2014).

ISO/TC 211 GEOGRAPHIC INFORMATION/GEOMATICS. (2009).

Metadata Standards for Digital Geospatial data, National Spatial Data Infrastructure (NSDI). (2009).

INSPIRE Metadata Implementing Rules: Technical Guidelines based on EN ISO 19115 and EN ISO 19119. (2010).

A Guide to the Role of Standards in Geospatial Information Management. (2015).

Standard for Maps and GIS Data Submission_Final_2016. (2016).

North Carolina Department of Transportation (NCDOT), Metadata Content Standard for Geospatial Data. (2017).

ICSM ISO 19115-1 Metadata Good Practice Guide. (2019).

4) Action Plan for the Advancement of Utilizing GI

Action Plan
For the Advancement of Utilizing Geospatial Information
2023

March, 2023

Center for Geo-Information (CGI),
National Land Commission Secretariat (NLCS)

Table of Content

Chapter 1. Introduction 2
1.1 Background 2
1.2 Purpose 2
1.3 Current Situation and Issues 3
1.4 Future Vision 3
1.5 Key Outputs 3
Output 1: Categorize Geospatial Information 3
Output 2: Identify SSOT of geospatial data 4
Output 3: Foster collaborations among different stakeholders 4
Output 4: Develop NSDI ICT service 4
Output 5: Develop common GI data standards and formats 4
Chapter 2. Action Plan for the Advancement of Utilizing Geospatial Information for Each Measure 5
2.1 Outline of Each Measure 5
2.2 Action Plan of Each Measure 5
2.2.1 Categorization of Geospatial Information 6
2.2.2 Identify SSOT of geospatial data 11
2.2.3 Foster collaborations among stakeholders 16
2.2.4 Development of NSDI/ICT Services 17
2.2.5 Develop common GI data standards and formats 18

Chapter 1. Introduction

1.1 Background

Geospatial data plays a crucial role in socio-economic and infrastructure development of any country. The use of Geospatial data serves as a backbone for evidence based decision making for various applications such as Land Administration and Management, Urban Planning, Disaster Management, Agriculture, Hydrography, etc. With an advancement of technology in collection of Geospatial data, Government agencies in Bhutan produce and possess large volumes of Geospatial data. However, data remains scattered and stored in individual agencies without the knowledge of other user agencies which leads to data duplication and redundancy. To address such issues and also to save resources and time, the Royal Government of Bhutan (RGoB) enacted the GI Policy and its Action Plan in 2018, which is first of its kind and serves as an overarching policy concerning Geographic Information.

For the initial phase, six pilot member agencies, such as the Department of Forest and Park Service (DoFPS), the Department of Local Governance and Disaster Management (DLGDM), the Department of Surface Transport (DoST), Thimphu Thromde, the National Land Commission (NLC), and Samdrup Jongkhar Thromde, have been selected for the preparation of an action plan. On the later stage of the project, DLGDM could not prepare an action plan as all the outputs identified were irrelevant. At the same time, for Samdrup Jongkhar Thromde, the action plan could not be materialized due to constant changes in the focal person to the activity. Therefore, a total of five agencies prepared the plan (CGI and NLC considered as separate entity due to difference in nature of individual measures). The action plan prepared through this project[1] will provide detailed steps that will contribute towards achieving the short and long-term strategic goals of the GI Policy. Section 6.3 of the GI policy states, "Data discovery, accessibility, and sharing mechanisms without duplication or silos in operation," which reflects the importance of data sharing as a key element of the policy. Therefore, in line with the GI Policy and the sharing of Geospatial data being a national concern, the Centre for Geo-Information (CGI) and its member agencies of this activity will prepare an action plan focusing on enhancing data sharing, which will indeed enhance data utilization in the future.

The action plan developed as part of this project will comply with the GI Policy and the 13th National Five Year Plan of Bhutan. It will provide a comprehensive list of actions and steps that need to be taken by each member agency. For it to be implemented effectively, it will be included in the Annual Performance Target/Agreement (APT/APA) of the respective agencies and its associated measures will be featured in the Individual Work Plan (IWP) of focal person of this activity.

1.2 Purpose

The creation of an action plan by the CGI and its member agencies to address the issues of Geospatial information sharing will be of utmost importance. Following are some of the purpose of creating the action plan:

1. To achieve the vision and goals of GI Policy.

[1] The project on National Spatial Data Infrastructure with an assistance from JICA

2. To have collaborative efforts to address the issues concerning data sharing among member agencies.
3. To improve the coordination among organizations to avoid data duplication.
4. To address the legislative and institutional barriers with regard to data sharing.

1.3 Current Situation and Issues

Currently, Bhutan produces a large pool of geospatial data which is scattered across various government organizations, private sectors, and academic institutions. This data is stored and maintained on individual laptops and computers due to a lack of proper guidelines for data management, storage, and infrastructure. Thus, the existence and use of this data are confined within the boundary and scope of its own agency. Usually, the collection of this Geospatial data is carried out by individual agencies without consulting other agencies, leading to data duplication and redundancy. Moreover, there is no standard operating procedure for the management or collection of this data. The data produced by one agency does not cater to the needs of other agencies. Therefore, the following are some of the issues that impede the utilization of GI in Bhutan:

1. Lack of coordination among different sectors
2. Absence of spatial data sharing and access policy
3. Lack of data standards which contributes to data interoperability issues
4. Absence of mandate to update data
5. Absence of data sharing platform
6. Cost of data acquisition

1.4 Future Vision

The action plan created will focus on achieving the goals and mandates of the GI Policy. The Office of Centre for Geo-Information (the CGI Office) cannot implement the GI policy and its action plan alone, and requires collaboration and efforts from other CGI member agencies. Initially, the action plan will be implemented in the seven pilot agencies. If the implementation of this action plan is successful and makes a positive impact in data sharing and utilization, CGI will extend it to all CGI member agencies, making it an annual task. In the future, through action plans, it is possible to envision data sharing without issues of data standards and interoperability, and improved utilization in evidence-based decision making.

Moreover, the preparation and implementation of such action plan annually can also help gradually achieve mandates laid down in the GI Policy and GI Policy Action Plan.

1.5 Key Outputs

Output 1: Categorize Geospatial Information

In order to ensure a smooth data sharing process, the GI Policy requires the Centre for Geo-Information to classify geospatial information into Open, Common, and Restricted categories. Upon consultation with the member agencies of this activity, it was found that it is of utmost importance to have an inventory of all the geospatial data available in respective agencies before categorizing it. This can be achieved by conducting a workshop involving all the data-producing agencies, whereby the participating agencies can list down all the data available in their respective agencies. After that, the CGI Office, along with its member agencies, will develop a set of criteria to categorize data. Based on

the criteria, respective agencies will categorize data produced in their agencies and get approval from the management. CGI Office will compile the list of all the categorized datasets submitted by member agencies.

Output 2: Identify SSOT of geospatial data

The Royal Government of Bhutan included the concept of Single Source of Truth (SSOT) in its GI policy, which states that the 'The CGISC shall ensure single source of truth identifying responsible agencies in producing fundamental as well as thematic GI data'. To adhere to this policy, the CGI office and its member agencies will work together to identify and assign the ownership of all geospatial data to the respective agencies. This will be done through consultation with all GI producing agencies of the country involving the CGI focal from each agency. After the consultation, if necessary, the respective focal person will report the discussed SSOT with their respective agency head. Finally, the Geo-Information High Level Committee (GHLC) will endorse the identified SSOT for all the geospatial data.

Output 3: Foster collaborations among different stakeholders

Section 6.5.3. of the GI policy states that 'sustained effort shall be made to mainstream the use of geo-information and GIS for national planning, decision making for dispensing citizen services effectively'. To achieve this, the CGI office and designated pilot agencies are committed to promoting the use of geo-information not only among government and private organizations but also to citizens. This will be achieved by conducting seminars, expos and regular CGI meetings/workshops where the CGI Office and member agencies can exhibit works/projects related to creation and use of geo-information carried out in their respective agencies. Such events can not only provide opportunities for them to share their works and experience but also receive feedback/comments from participants which can help them learn and improve their works. The ultimate goal of these efforts is to promote the utilization of geo-information and stay informed about any on-going geospatial related activities in various agencies. Additionally, social media will be used extensively to raise awareness among the general public.

Output 4: Develop NSDI ICT service

According to Policy statement 6.3.2 of the GI policy, all agencies, including the private sector, must submit metadata and data for integration through a common data portal managed by the CGI. In line with the policy, the CGI office and JICA experts are working on developing an NSDI ICT service. The objective is to share all government geospatial data and products through a common platform. The service will include tools for data visualization, analysis, and download, allowing users to extract relevant information and insights from the geospatial data available in the system. The CGI office will work closely with government agencies, the private sector, and other stakeholders to ensure the service's smooth operation and continuous improvement.

Output 5: Develop common GI data standards and formats

To facilitate efficient communication and collaboration among various organizations, individuals, and computer systems, it is crucial to establish common data standards and formats. This is because when data is stored, processed, and transmitted in varying formats and standards, it can lead to confusion and inefficiencies, hindering accurate

sharing and analysis of information. Therefore, recognizing the significance of standardized data, the CGI office and NLCS, along with other CGI member agencies, will collaborate to create and adopt GI standards that align with the ISO standard.

Chapter 2. Action Plan for the Advancement of Utilizing Geospatial Information for Each Measure

2.1 Outline of Each Measure

The CGI office, in collaboration with pilot agencies, has identified five major measures/outputs to be implemented in the upcoming financial year (i.e.2023-24). These measures/outputs are interdependent, and their implementation will ultimately contribute towards achieving the overall goal of the action plan, which is to enhance the sharing of existing geospatial information between member agencies. By enhancing stakeholder collaboration, the objectives of the other outputs can also be accomplished. Developing shared data standards and formats, categorizing geographic information, and identifying single sources of truth will contribute to the development of NSDI ICT services. The provided figure illustrates the relationship between each individual output/measure.

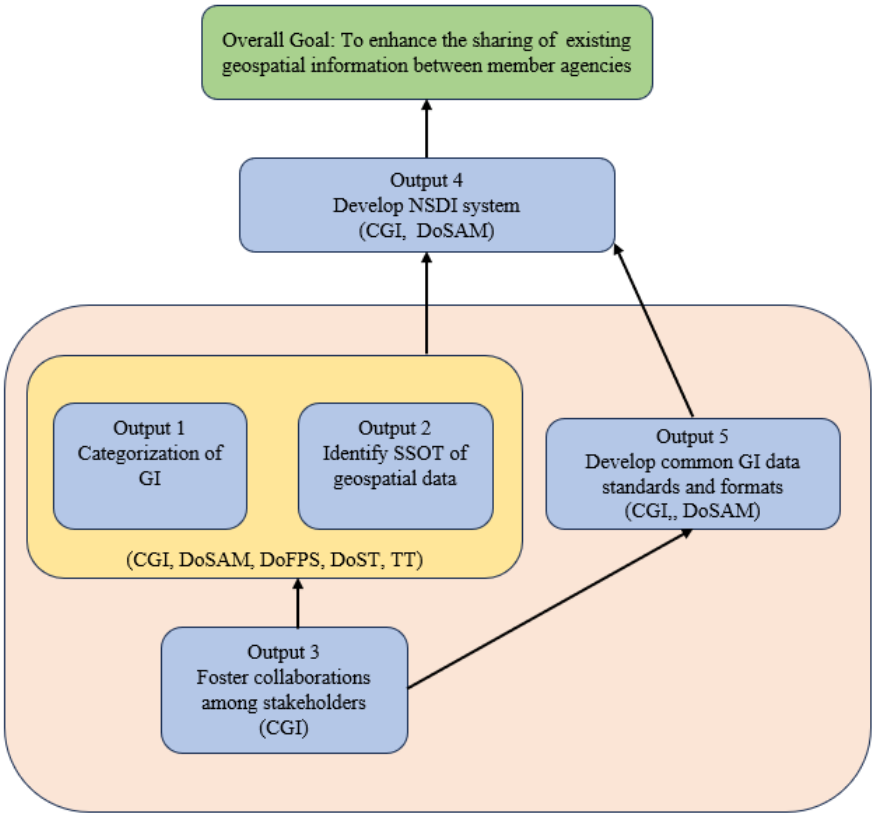


Figure 1 Relation between each measure

2.2 Action Plan of Each Measure

This section shows the overviews of individual measures prepared by each member agency in March 2023. Throughout the financial year 2023-2024, monitoring meetings

were conducted once every quarter to share the work progress and issues. The results of these meetings were summarized in the 3rd monitoring sheet shown in the following Annexure.

2.2.1 Categorization of Geospatial Information

(1) CGI Office

<table>
<tr><td>Measure name</td><td colspan="3">Categorization of geospatial Information</td></tr>
<tr><td>Relevant NKRA</td><td colspan="3">NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved.</td></tr>
<tr><td>Relevant AKRA</td><td colspan="3">Sustainable land resources for human settlement managed.</td></tr>
<tr><td>Relevance in the GI Policy Action Plan</td><td colspan="3">Clause 6.3.1: Development of guidelines to categorize geo-information into restricted, common and open categories.</td></tr>
<tr><td>Outline of measure</td><td colspan="3">Categorizing Data into Open, Common and Restricted can help individual agencies to manage access and use of data appropriately. The purpose of categorizing data into open, common, and restricted categories is to manage data according to its sensitivity level. Categorizing the geospatial data help organizations to make informed decisions about data access and sharing, which reduces the risk of unauthorized access and breaches and also ensure that data sharing and use is in compliance with the legal framework.</td></tr>
<tr><td>Schedule</td><td colspan="3">
<table>
<tr><th>FY</th><th>Quarter</th><th>Task</th></tr>
<tr><td rowspan="4">2023-24</td><td>1st</td><td>● Conduct consultation meetings with pilot agencies to explain types of data category and develop a checklist to categorize data.
● Assign tasks to focal persons (FPs) to categorize their respective GI data into open, common and restricted.</td></tr>
<tr><td>2nd</td><td>● Monitor and update progress of categorization tasks carried out by each member agency.</td></tr>
<tr><td>3rd</td><td>● Collect and document the categorized spatial data in a formal agreement.</td></tr>
<tr><td>4th</td><td>● Communicate the categorized data to all stakeholders through meetings or seminars to ensure that everyone is aware of types of data category and list of categorized datasets.</td></tr>
<tr><td>2024-25</td><td></td><td>● Integrate the categorized data in the NSDI ICT Service</td></tr>
</table>
</td></tr>
<tr><td>KPI</td><td>The particular set of geospatial data that has been categorized with the approval from the head of the respective agency.</td><td>Means of Verification</td><td>Timeline by which a particular set of geospatial data has been categorized and officially approved with sign from the head of the respective agency.</td></tr>
<tr><td>Baseline</td><td>Data listing and tentative data categorization is completed in consultation with FPs of pilot agencies.</td><td>Target</td><td>Compilation of list of approved data categories of datasets produced in various agencies.</td></tr>
<tr><td>Key interventions</td><td colspan="3">• Conduct consultation meetings with pilot agencies to explain types of data category, checklist to categorize data.
• Quarterly meeting to update on the progress of the activity.</td></tr>
<tr><td>Risk mitigation plan</td><td colspan="3">● Immediate replacement of focal person from the pilot agencies in case the focal person leaves their agency.
● Extend technical assistance to the new focal person assigned in case the previous person in charge leaves their agency.</td></tr>
<tr><td>Budget amount</td><td colspan="3">Nu. 0.05 million</td></tr>
<tr><td>Responsible agency</td><td colspan="3">Center for Geo-Information</td></tr>
</table>

(2) Department of Surface Transport (DoST)

<table>
<tr><td>Measure name</td><td colspan="3">Categorization of geospatial Information</td></tr>
<tr><td>Relevant NKRA</td><td colspan="3">Infrastructure, Communication and public services.</td></tr>
<tr><td>Relevant AKRA</td><td colspan="3">Climate proof road accessible through-out the year in all types of weather</td></tr>
<tr><td>Relevance in the GI Policy Action Plan</td><td colspan="3">Clause 6.3.1: Development of guidelines to categorize geo-information into restricted, common and open categories.</td></tr>
<tr><td>Outline of measure</td><td colspan="3">Categorizing Data into Open, Common and Restricted can help individual agencies to manage access and use of data appropriately. The purpose of categorizing data into open, common, and restricted categories is to manage data according to its sensitivity level. Categorizing the geospatial data help organizations to make informed decisions about data access and sharing, which reduces the risk of unauthorized access and breaches and ensure that data sharing and use complies with the legal framework.</td></tr>
<tr><td>Schedule</td><td colspan="3">
<table>
<tr><th>FY</th><th>Quarter</th><th>Task</th></tr>
<tr><td rowspan="4">2023-24</td><td>1st</td><td>● Discuss within the department about the objective of the project and the importance of the activity 1-4 under this project.
● Conduct meetings and discussion internally with other divisions explain types of data category and develop a checklist to categorize data.
● Assign point of contact for each division dealing with the use of geo spatial data set.
● Participate in a meeting for categorization of geospatial information conducted by the CGI office.</td></tr>
<tr><td>2nd</td><td>● Monitor and update progress of categorization tasks carried out by each focal officials.</td></tr>
<tr><td>3rd</td><td>● Collect and document the categorized spatial data in a formal agreement.</td></tr>
<tr><td>4th</td><td>● Get it endorsed by the head of the agency, submit, and present in a meeting or seminars to other relevant agencies to ensure that everyone is aware of types of data category and list of categorized datasets.</td></tr>
<tr><td>2024-25</td><td></td><td>● Integrate the categorized data in the NSDI ICT Service</td></tr>
</table>
</td></tr>
<tr><td>KPI</td><td>The particular set of geospatial data that has been categorized with the approval from the head of the agency.</td><td>Means of Verification</td><td>Timeline by which a particular set of geospatial data has been categorized and officially approved with sign from the head of the agency.</td></tr>
<tr><td>Baseline</td><td>Data listing and tentative data categorization is completed in consultation with each division.</td><td>Target</td><td>Compile the list of categorized geospatial dataset of department and submit it to CGI office.</td></tr>
<tr><td>Key interventions</td><td colspan="3">● Conduct consultation meetings with each divisions to explain types of data category, checklist to categorize data.
● Conduct timely meeting and follow up to update on the progress of the activity.</td></tr>
<tr><td>Risk mitigation plan</td><td colspan="3">● Immediate replacement of focal if in case the focal person leaves their agency.
● Extend technical assistance to the new focal person assigned in case the previous person in charge leaves the office.</td></tr>
<tr><td>Budget amount</td><td colspan="3">N/a</td></tr>
<tr><td>Responsible agency</td><td colspan="3">DoST, MoIT</td></tr>
</table>

(3) Thimphu Thromde

Measure name	**Categorization of geospatial Information**
Relevant NKRA	NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved.

<table>
<tr><td>Relevant AKRA</td><td colspan="3">Public service delivery enhanced
Initiatives taken to improve mobility</td></tr>
<tr><td>Relevance in the GI Policy Action Plan</td><td colspan="3">Clause 6.3.1: Development of guidelines to categorize geo-information into restricted, common and open categories.</td></tr>
<tr><td>Outline of measure</td><td colspan="3">Categorizing Data into Open, Common and Restricted as per GI policy will help Thimphu Thromde to manage data properly. The purpose of categorizing geospatial data ensures sensitivity of data which will help Thromde about data access and sharing, which reduces the risk of unauthorized access and duplication.</td></tr>
<tr><td>Schedule (efforts in each year</td><td colspan="3"><table>
<tr><th>FY</th><th>Quarter</th><th>Task</th></tr>
<tr><td rowspan="4">2023-24</td><td>1st</td><td>Collect all the geospatial data produced by Thimphu Thromde and participate in a meeting for categorization of geospatial information conducted by the CGI office.</td></tr>
<tr><td>2nd</td><td>Conduct meetings with heads of division (Infra, CoED, and UPD) that produce and use geospatial data and discuss the importance of geospatial data categorization.</td></tr>
<tr><td>3rd</td><td>Categorize the data as per Clause 6.3.1</td></tr>
<tr><td>4th</td><td>Present in a meeting or seminars to other relevant agencies to ensure that everyone is aware of types of data category and list of categorized datasets and submit the categorized GI data through endorsement of the head of the respective divisions.</td></tr>
<tr><td>2024-25</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>KPI</td><td>The particular set of geospatial data that has been categorized with the approval from the head of the respective division.</td><td>Means of Verification</td><td>Timeline by which a particular set of geospatial data has been categorized and officially approved from the head of respective divisions.</td></tr>
<tr><td>Baseline</td><td>Data listing and tentative data categorization is completed.</td><td>Target</td><td>Compilation of list of approved data categories of dataset produced by Thimphu Thromde and its submission to CGI office.</td></tr>
<tr><td>Key interventions</td><td colspan="3">● Conduct meetings with divisions that produce geospatial data and explain types of data category, checklist to categorize data.</td></tr>
<tr><td>Risk mitigation plan</td><td colspan="3">● Meeting with the head of division timely</td></tr>
<tr><td>Budget amount</td><td colspan="3">N/a</td></tr>
<tr><td>Responsible agency</td><td colspan="3">Thimphu Thromde</td></tr>
</table>

(4) Department of Forests and Park Services (DoFPS)

Measure name	**Categorization of Geospatial Information**
Relevant NKRA	1. Healthy ecosystem services maintained 3. Carbon neutral, climate and disaster resilient development enhanced
Relevant AKRA	1. Management of Natural Resources for Sustainable Utilization of Ecosystem Goods and Services Enhanced 2. Climate Smart and Disaster Resilient Development Enhanced
Relevance in the GI Policy Action Plan	6.2. Availability of reliable geo-information 6.3.1. Development of guidelines to categorize geo-information into restricted, common and open categories
Outline of measure	Categorizing Data into Open, Common and Restricted can help individual agencies to manage access and use of data appropriately. The purpose of categorizing data into open, common, and restricted categories is to manage data according to its sensitivity level. Categorizing the geospatial data help organizations to make informed decisions about data access and sharing, which reduces the risk of unauthorized access and

<table>
<tr><td></td><td colspan="4">breaches and ensure that data sharing and use complies with the legal framework.</td></tr>
<tr><td>Schedule</td><td colspan="4"><table>
<tr><th>FY</th><th>Quarter</th><th>Task</th></tr>
<tr><td rowspan="4">2023-24</td><td>1st</td><td>i) Participate in a meeting for categorization of geospatial information conducted by the CGI office
ii) Concept and importance of GI data categorization presented to the Division/Department</td></tr>
<tr><td>2nd</td><td>Based on the guidelines the available GI data compiled for categorization into open, common and restricted</td></tr>
<tr><td>3rd</td><td>The compiled GI data reviewed and categorized as per the guidelines</td></tr>
<tr><td>4th</td><td>i. The submission of categorized GI data through endorsement of the head of the agency completed
ii. Present in a meeting or seminars to other relevant agencies to ensure that everyone is aware of types of data category and list of categorized datasets</td></tr>
<tr><td>2024-25</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>KPI</td><td>GI data that been categorized with the approval from the head of the agency: Protected Area, PA (National Parks, Wildlife Sanctuary, Strict Nature Reserve, Royal Botanical Park), Forest management Units (FMUs) and Community Forests (CFs)</td><td>Means of Verification</td><td colspan="2">Timeline by which a particular set of geospatial data has been categorized and officially approved by the head of the agency.</td></tr>
<tr><td>Baseline</td><td>GI data that have been developed and already categorized: PA (5 NPs, 3 WS, 1 SNR, 1 RBP and 8 Biological Corridors), 21 FMUs, 856 CFs</td><td>Target</td><td colspan="2">GI data listing and categorization completed and summited to CGI</td></tr>
<tr><td>Key interventions</td><td colspan="4">• Discuss within the department on GI data categorization
• Sensitization of GI data categorization to the field offices
• Carry out existing GI data inventory that needs to be categorized</td></tr>
<tr><td>Risk mitigation plan</td><td colspan="4">• Whenever there is change in the GI data as result of change in the boundary or function layers, the updating of the GI data shall be carried out on time.
• Ensure the GI data created or updated is topologically correct and up to the standards</td></tr>
<tr><td>Budget amount</td><td colspan="4">regular</td></tr>
<tr><td>Responsible agency</td><td colspan="4">Department of Forests and Park Services (DoFPS), Ministry of Energy and Natural Resources (MoNER)</td></tr>
</table>

(5) Department of Survey and Mapping (DoSAM)

<table>
<tr><td>Measure name</td><td>Categorization of geospatial Information</td></tr>
<tr><td>Relevant NKRA</td><td>NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved</td></tr>
<tr><td>Relevant AKRA</td><td>Sustainable land resources for human settlement managed.</td></tr>
<tr><td>Relevance in the GI Policy Action Plan</td><td>Clause 6.3.1: Development of guidelines to categorize geo-information into restricted, common and open categories.</td></tr>
<tr><td>Outline of measure</td><td>Categorizing Data into Open, Common and Restricted can help individual agencies to manage access and use of data appropriately. The purpose of categorizing data into open, common, and restricted categories is to manage data according to its sensitivity level. Categorizing the geospatial data helps organizations to make informed decisions about data access and sharing, which reduces the risk of unauthorized access and breaches and also ensures that data sharing and use is in compliance with the legal framework.</td></tr>
<tr><td>Schedule</td><td><table>
<tr><th>FY</th><th>Quarter</th><th>Task</th></tr>
</table></td></tr>
</table>

	2023-24	1st	
		2nd	● Compile the list of all available spatial datasets, including their layer and attribute names. ● Conduct an assessment to understand the nature, purpose, and user needs of the data, including legal and regulatory considerations and sensitivity. ● Attend workshop conducted by CGI for data categorization. ● Prepare draft categorization.
		3rd	● Finalize and endorse the categorization with the management. ● Submission of data to CGI
		4th	● Present the categorized data of DoSAM to all stakeholders through meeting/seminar conducted by CGI
	2024-25		● Integrate the categorized data in the NSDI ICT Service
KPI	Percentage of spatial data categorized.	**Means of Verification**	Completeness of data categorization in percentage.
Baseline	List of tentative data categorized	**Target**	Categorize 100 percent of dataset mandated to DoSAM
Key interventions	● Contact all the division chiefs and section heads for their feedback. ● Conduct meetings with management for finalization and endorsement of the categorization.		
Risk mitigation plan	Consult all the data producers within the department for ensuring completeness of data.		
Budget amount	Nil		
Responsible agency	GID, DoSAM, NLCS		

(6) Samdrup Jongkhar Thromde

Measure name	**Categorization of Geospatial Information**		
Relevant NKRA	NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved.		
Relevant AKRA	Thromde's public services are citizen centric and delivered seamlessly in an efficient and effective manner		
Relevance in the GI Policy Action Plan	**Clause 6.3.1**: Development of guidelines to categorize geo-information into restricted, common and open categories.		
Outline of measure	Categorization of Geospatial information into open, common and restricted will help manage data sharing efficiently. Data categorization will reduce unauthorized data access and help in proper data management.		
Schedule	**FY**	**Quarter**	**Task**
	2023-24	1st	Conduct meeting with Thromde division heads (IDD, UPD, DRD, and LSD) and explain the importance of data categorization. Data compilation within individual divisions. Participate in a meeting for categorization of geospatial information conducted by the CGI office.
		2nd	Compilation of all geospatial data produced by various divisions and submit to focal person. Encourage and help divisions to create and maintain geospatial data in uniform format to help during compilation.
		3rd	Create committee comprising of division heads and Categorize data according to Clause 6.3.1 of GI Policy.

		4th	Present data categorization to Thromde Tshogde for endorsement and finalize to submit to CGI office.	
	2024-25			
KPI	Data categorization by different division is approved by Thromde Tshogde members.		**Means of Verification**	Timeline by which geospatial data categorized is officially approved from the head of respective divisions and Thromde Tshogde.
Baseline	No data have been compiled. No data have been categorized.		**Target**	Data compilation from divisions and data categorization is completed and presented to Thromde Tshogde. Present final data categorization to Thromde Tshogde for endorsement.
Key interventions	▪ Conduct meeting with division heads and sensitize on importance of data categorization.			
Risk mitigation plan	▪ Ensure timely intervention to divisions for data compilation.			
Budget amount	N/A			
Responsible agency	Samdrup Jongkhar Thromde			

2.2.2 Identify SSOT of geospatial data

(1) CGI Office

Measure name	**Identify SSOT of geospatial data**			
Relevant NKRA	NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved.			
Relevant AKRA	Sustainable land resources for human settlement managed.			
Relevance in the GI Policy Action Plan	**Clause 6.2.3**: The CGI shall identify a single source of truth (single agency) as owner to produce fundamental and thematic data.			
Outline of measure	The concept of a single source of truth (SSOT) in the geospatial domain entails appointing a particular agency or organization as the custodian of specified geospatial data. The objective of this strategy is to ensure coherence and precision across all datasets, decrease redundancies arising from multiple data sources, and allocate accountability for overseeing specific geospatial data. The agency selected as the single source of truth for a particular set of geospatial data is accountable for maintaining its currency and possesses the authority to upload/revise the data in the common portal administered by the Center for Geo-Information.			
Schedule	**FY**	**Quarter**	**Task**	
	2023-24	1st	● Conduct consultation meetings with pilot agencies, to discuss the concept of SSOT. ● Assign tasks to FPs to identify data produced in their respective agency and assign SSOT.	
		2nd	● Monitor and update progress of SSOT tasks carried out by each member agency.	
		3rd	● Collect and document the ownership of the spatial data in a formal agreement.	
		4th	● Communicate the data ownership to all stakeholders through meetings or seminars to ensure that everyone is aware of who is responsible for the given set of spatial data.	
	2024-25		● Integrate the SSOT assigned GI data in the NSDI ICT Service.	
KPI	The particular set of geospatial		**Means of**	Timeline by which a particular

	data that has been officially approved by the head of the respective agency and assigned the status of Single Source of Truth (SSOT).	**Verification**	set of geospatial data has been designated with SSOT and officially approved from the head of the respective agency.
Baseline	Data listing and tentative SSOT is assigned in consultation with FPs.	**Target**	Compilation of list of approved SSOT of datasets produced in various agencies.
Key interventions	● Make presentation on the importance of SSOT (Single Source of Truth) and the benefits it provides to each pilot agency before conducting consultation meetings. ● Quarterly meeting to update on the progress of the activity.		
Risk mitigation plan	● Immediate replacement of focal person from the pilot agencies in case the focal person leaves their agency. ● Extend technical assistance to the new focal person assigned in case the previous person in charge leaves their agency.		
Budget amount	Nu. 0.02 million		
Responsible agency	Center for Geo-Information		

(2) Department of Surface Transport (DoST)

Measure name	**Identify SSOT of geospatial data**		
Relevant NKRA	Infrastructure, Communication and public services.		
Relevant AKRA	Climate proof road accessible through-out the year in all types of weather		
Relevance in the GI Policy Action Plan	**Clause 6.2.3**: The CGI shall identify a single source of truth (single agency) as owner to produce fundamental and thematic data.		
Outline of measure	The concept of a single source of truth (SSOT) in the geospatial domain entails appointing individual officials from each division as the custodian of specified geospatial data. The objective of this strategy is to ensure coherence and precision across all datasets, decrease redundancies arising from multiple data sources, and allocate accountability for overseeing specific geospatial data. The official selected as the single source of truth for a particular set of geospatial data is accountable for maintaining, updating and submission to the portal or the person in charge of the project for necessary action.		
Schedule	**FY** / **Quarter** / **Task** 2023-24 / 1st / ● Conduct consultation meetings with divisions, to discuss the concept of SSOT. ● Participate in meetings conducted by CGIs to identify SSOT for the geospatial data. 2nd / ● Monitor and update progress of SSOT tasks carried out by each identified focal official. 3rd / ● Collect and document the ownership of the spatial data in a formal agreement. 4th / ● Get it endorsed by the head of the agency, submit, and present in a meeting or seminars to other relevant agencies in the project to ensure that everyone is aware of who is responsible for the given set of spatial data. 2024-25 / ● Integrate the categorized data in the NSDI ICT Service		
KPI	A particular set of geospatial data has been designated with SSOT and officially approved	**Means of Verification**	Timeline by which a particular set of geospatial data has been designated with SSOT and officially approved from the head

	by the head of the agency		of the agency.
Baseline	Data listing and tentative SSOT is assigned.	**Target**	Compilation of list of approved SSOT of datasets produced under the Department.
Key interventions	● Make a presentation on the importance of SSOT (Single Source of Truth) and the benefits it provides to each divisions before conducting consultation meetings. ● Timely meeting and follow to update on the progress of the activity.		
Risk mitigation plan	● Immediate replacement of focal if in case the focal person leaves their agency. • Extend technical assistance to the new focal person assigned in case the previous person in charge leaves the office.		
Budget amount	N/a		
Responsible agency	DoST, MoIT		

(3) Thimphu Thromde

Measure name	**Identify SSOT of geospatial data**		
Relevant NKRA	NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved.		
Relevant AKRA	Initiatives taken to reduce traffic congestion Public service delivery enhanced		
Relevance in the GI Policy Action Plan	**Clause 6.2.3**: The CGI shall identify a single source of truth (single agency) as owner to produce fundamental and thematic data.		
Outline of measure	The single source of truth (SSOT) in the geospatial domain entails appointing a particular agency or organization as the custodian of specified geospatial data. The objective of this strategy is to ensure coherence and precision across all datasets, decrease redundancies arising from multiple data sources, and allocate accountability for overseeing specific geospatial data. The agency selected as the single source of truth for a particular set of geospatial data is accountable for maintaining its currency and possesses the authority to upload/revise the data in the common portal administered by the Center for Geo-Information.		
Schedule	**FY** / **Quarter** / **Task** 2023-24 / 1st / Collect all the geospatial data produced by Thimphu Thromde and participate in a meeting for categorization of geospatial information conducted by the CGI office. 2nd / Conduct a meeting with the head of the division that produces geospatial data to discuss the concept of SSOT and to identify list of GI data for assignment of SSOT. 3rd / Present and obtain endorsement from the head of the division. 4th / Finalized the SSOT of each geospatial data produced by TT and submit it to the CGI office. Present in a meeting or seminars to other relevant agencies to ensure that everyone is aware of who is responsible for the given set of spatial data. 2024-25		
KPI	The particular set of geospatial data that has been categorized with the approval from the head of the respective division.	**Means of Verification**	Timeline by which a particular set of geospatial data has been categorized and officially approved by the head of the respective divisions.
Baseline	Data listing and tentative	**Target**	Compilation of list of approved

	SSOT is assigned in consultation with the head of division.		SSOT of datasets produced in different divisions.
Key interventions	● Conduct meetings with divisions that produce geospatial data and explain types of data category, checklist to categorize data.		
Risk mitigation plan	● Meeting with the head of division timely		
Budget amount	N/a		
Responsible agency	Thimphu Thromde		

(4) Department of Forests and Park Services (DoFPS)

Measure name	**Identify SSOT of geospatial data**		
Relevant NKRA	1. Healthy ecosystem services maintained 3. Carbon neutral, climate and disaster resilient development enhanced		
Relevant AKRA	1. Management of Natural Resources for Sustainable Utilization of Ecosystem Goods and Services Enhanced 2. Climate Smart and Disaster Resilient Development Enhanced		
Relevance in the GI Policy Action Plan	**Clause 6.2.3**: The CGI shall identify a single source of truth (single agency) as owner to produce fundamental and thematic data.		
Outline of measure	The concept of single source of truth (SSOT) in geospatial domain refers to assigning ownership of geospatial data to the agency which produces it. This entails appointing individual official in the Department, who will be responsible for identifying and getting ownership of the specified geospatial data through due procedures. This process ensures coherence and precision across all datasets, decrease redundancies arising from multiple data sources, and allocate accountability for overseeing specific geospatial data. The official processing the SSOT for a particular set of geospatial data is accountable for maintaining, updating and submission to the portal or the person in charge of the project for necessary action.		
Schedule	**FY** / **Quarter** / **Task** 2023-24 / 1st / i) Participate in a meeting to identify SSOT of geospatial data conducted by the CGI office. ii) The concept of single source of truth (SSOT) for GI data being produced presented to the Division/Department 2nd / List of GI data for assignment of SSOT identified 3rd / The GI data identified for assigning SSOT collected and compiled 4th / i. Present in a meeting or seminars to other relevant agencies to ensure that everyone is aware of types of data category and list of categorized datasets ii. SSOT assignment for the GI data through endorsement from the head of the agency and CGI completed 2024-25		
KPI	GI data that has been designated with SOTT and officially approved by the head of the agency: Protected Area (Parks, Wildlife, Strict nature reserve), Forest management Units (FMUs) and Community Forests (CFs)	**Means of Verification**	Timeline by which a particular set of geospatial data has been assigned with SSOT and officially approved from the head of the agency.
Baseline	GI data that have already been designated with SSOT: PA (5 NPs, 3 WS, 1 SNR, 1 RBP and 8 Biological	**Target**	Assigning SSOT to GI data of Department completed and submitted

	Corridors), 21 FMUs, 856 CFs.		to CGI
Key interventions	• Discuss within the department on SSOT of geospatial data • Carry out existing geospatial data inventory that needs assignment of SSOT		
Risk mitigation plan	• Whenever there is change in the GI data as result of change in the boundary or function layers, the updating of the GI data shall be carried out on time. • Ensure the GI data created or updated is topologically correct and up to the standards		
Budget amount	regular		
Responsible agency	Department of Forests and Park Services (DoFPS), Ministry of Energy and Natural Resources (MoNER)		

(5) Department of Survey and Mapping (DoSAM)

Measure name	**Identify SSOT of geospatial data**		
Relevant NKRA	NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved.		
Relevant AKRA	Sustainable land resources for human settlement managed.		
Relevance in the GI Policy Action Plan	**Clause 6.2.3**: The CGI shall identify a single source of truth (single agency) as owner to produce fundamental and thematic data.		
Outline of measure	Identifying SSOT of geospatial data will help in managing data ownership and reduce silos data production by various agencies. Currently identifying the SSOT of data is very difficult since single data is being produced by various agencies and accurate sources can't be traced. Even within division there are lots of data duplications. Therefore, identifying SSOT is very important to reduce data redundancy and allot accountability for specific data produced.		
Schedule	**FY** / **Quarter** / **Task** 2023-24 / 1st / 2nd / Compilation of all geospatial data produced by divisions. 3rd / Attend workshops conducted by CGI for SSOT. Identify SSOT of each geospatial data produced. 4th / Present to division heads and the Management and finally present for endorsement. 2024-25 / /		
KPI	Percentage of identification of SSOT.	**Means of Verification**	Completeness of identification of SSOT in percentage.
Baseline	List of tentative data currently produced by NLCS	**Target**	Identify SSOT to 100 percent of dataset mandated to NLCS
Key interventions	▪ Conduct meetings with division heads and sensitize the importance of identification of SSOT.		
Risk mitigation plan	▪ Consult every division regarding their mandate and the data produced by them. ▪ Consult with responsible agencies for those data that are currently produced by NLCS.		
Budget amount	Nil		
Responsible agency	National Land Commission Secretariat		

(6) Samdrup Jongkhar Thromde

Measure name	**Identify SSOT of geospatial data**
Relevant NKRA	NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved.
Relevant AKRA	Thromde's public services are citizen centric and delivered seamlessly in an efficient and effective manner
Relevance in the GI	**Clause 6.2.3**: The CGI shall identify a single source of truth (single agency) as

<table>
<tr><td>Policy Action Plan</td><td colspan="4">owner to produce fundamental and thematic data.</td></tr>
<tr><td>Outline of measure</td><td colspan="4">Identifying SSOT of geospatial data will help in managing data ownership and reduce silos data production by various agencies. Currently identifying the SSOT of data is very difficult since single data is being produced by various agencies and accurate source can’t be traced. Even within division there are lots of data duplication. Therefore, identifying SSOT is very important to reduce data redundancy and allot accountability for specific data produced.</td></tr>
<tr><td>Schedule</td><td colspan="4"><table>
<tr><th>FY</th><th>Quarter</th><th>Task</th></tr>
<tr><td rowspan="4">2023-24</td><td>1st</td><td>Conduct meeting with Thromde division heads (IDD, UPD, DRD and LSD) and explain the importance of identifying SSOT of geospatial data.
Participate in a meeting to identify SSOT of geospatial data conducted by the CGI office.</td></tr>
<tr><td>2nd</td><td>Compilation of all geospatial data produced by divisions.</td></tr>
<tr><td>3rd</td><td>Identify SSOT of each geospatial data produced.</td></tr>
<tr><td>4th</td><td>Present to division heads for final approval.
Present for Thromde Tshogde endorsement and finally submit to CGI office.</td></tr>
<tr><td>2024-25</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>KPI</td><td>Geospatial data being identified its SSOT is approved by Thomde Tshogde members.</td><td>Means of Verification</td><td colspan="2">Timeline by which identifying of SSOT of geospatial data is officially approved from the head of respective divisions and Thromde Tshogde.</td></tr>
<tr><td>Baseline</td><td>No data have been compiled. No SSOT has been assigned.</td><td>Target</td><td colspan="2">Data compilation from divisions and SSOT identification is completed and presented to Thromde Tshogde.
Present final approved SSOT of datasets in Thromde Tshogde for endorsement.</td></tr>
<tr><td>Key interventions</td><td colspan="4">▪ Conduct meeting with division heads and sensitize on importance of data categorization.</td></tr>
<tr><td>Risk mitigation plan</td><td colspan="4">▪ Ensure timely intervention to divisions for data compilation.</td></tr>
<tr><td>Budget amount</td><td colspan="4">N/A</td></tr>
<tr><td>Responsible agency</td><td colspan="4">Samdrup Jongkhar Thromde</td></tr>
</table>

2.2.3 Foster collaborations among stakeholders

(1) CGI Office

<table>
<tr><td>Measure name</td><td>Foster collaborations among stakeholders</td></tr>
<tr><td>Relevant NKRA</td><td>NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved.</td></tr>
<tr><td>Relevant AKRA</td><td>Sustainable land resources for human settlement managed.</td></tr>
<tr><td>Relevance in the GI Policy Action Plan</td><td>Section 6.5.3: Sustained effort shall be made to mainstream the use of geo-information and GIS for national planning, decision making for dispensing citizen services effectively</td></tr>
<tr><td>Outline of measure</td><td>Fostering collaboration in the geospatial domain is essential for effective decision-making and problem-solving. Collaboration between different organizations, individuals, and stakeholders involved in the geospatial domain can help to enhance the quality of geospatial data, facilitate data sharing, and ultimately reduce data redundancy and duplication.</td></tr>
<tr><td>Schedule</td><td><table>
<tr><th>FY</th><th>Quarter</th><th>Task</th></tr>
</table></td></tr>
</table>

	2023-24	1st and 2nd	● Create a social media platform with the exclusive purpose of sharing information and works pertaining to Geographic Information.
		3rd and 4th	● Conduct seminars to make presentations by CGI and its member agencies about projects/work related to geospatial information. ● Conduct seminar/meeting to share the progress of NSDI project
	2024-25		● Organize seminars and meetings to promote the adoption of GI standards and NSDI ICT services on a broader scale.

KPI	Number of seminars/meetings conducted to share the progress of NSDI project.	**Means of Verification**	Attendance records from the seminar/meeting. Minutes of the seminar/meeting to document the progress shared.
Baseline	One seminar conducted	**Target**	Two additional seminars to be conducted
Key interventions	● Developing a clear agenda and timeline for the seminar/meeting, including specific topics to be covered and speakers/presenters to be included. ● Inviting a diverse range of stakeholders to participate, including representatives from government agencies, academia, industry, and the community. ● Using appropriate communication tools and technologies to ensure that the seminar/meeting is accessible to all stakeholders, regardless of location or physical ability.		
Risk mitigation plan	● Ensure that the invitation is sent to the right audience. Have a follow-up plan in place to ensure maximum attendance. ● Ensure that the meeting stays on schedule, and there is enough time for questions and discussion.		
Budget amount	Nu 0.05 million		
Responsible agency	Center for Geo-Information		

2.2.4 Development of NSDI/ICT Services

(1) CGI Office

Measure name	**Development of NSDI/ICT Services**
Relevant NKRA	NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved.
Relevant AKRA	Sustainable land resources for human settlement managed.
Relevance in the GI Policy Action Plan	**6.3.2.** Through a common data portal managed by the CGI, it shall be mandatory to submit metadata and data for integration by all agencies including the private sector. These data must conform to the national and international standards.
Outline of measure	NSDI ICT service is developed with the objective to enhance data management and collaboration. It will provide necessary tools and infrastructure for data management and as well as enable sharing of data and information among stakeholders.
Schedule	

FY	**Quarter**	**Task**
2023-24	1st	● Conduct External Design in consultation with JICA expert. ● Determine HW specifications in consultation with JICA expert.

		2nd	● Develop prototype of ICT system in consultation with JICA expert. ● Formulate maintenance and operation plan in consultation with JICA expert. ● Involve key personals from GovTech while formulating maintenance and operation plan.
		3rd	● Release 1st version of ICT system in consultation with JICA expert.
		4th	● Release 2nd version of ICT system in consultation with JICA expert.
	2024-25		● Training on NSDI ICT service to the external stakeholders in consultation with JICA expert. ● Integrate the geospatial data that has been categorized and assigned with SSOT in the NSDI ICT service
KPI	● NSDI ICT service fully functional. ● Percentage of geospatial data available in the system/service.	**Means of Verification**	● Track the progress of development of NSDI ICT service and measure the percentage completed against the timeline. ● By counting and deriving the percentage of data available in the system/service.
Baseline	0 percent of NSDI ICT service developed	**Target**	100 percent of NSDI ICT service developed
Key interventions	● Involve key personals from GovTech while formulating maintenance and operation plan. ● Develop a repository of geospatial data that is accessible to test the NSDI ICT service that has been created.		
Risk mitigation plan	● Defining and including the roles and responsibilities for each team member involved in the activity will assist in gaining full commitment from each team members. ● Providing comprehensive user documentation and training to the external users thereby promoting the extensive use of the developed system.		
Budget amount	Nil		
Responsible agency	Center for Geo-Information		

2.2.5 Develop common GI data standards and formats

Measure name	**Develop common GI data standards and formats**
Relevant NKRA	NKRA 15- Livability, Safety and Sustainability of Human Settlements Improved.
Relevant AKRA	Sustainable land resources for human settlement managed.
Relevance in the GI Policy Action Plan	**6.1.2:** The CGI shall be responsible for coordinating in developing, promulgating and enforcing bylaws, regulations and standards covering all aspects of geo-information, including important roles of private sectors.
Outline of measure	Developing common GI (Geographic Information) data standards is a critical aspect of creating effective and efficient systems for managing and sharing geospatial information. The need for common GI data standards arose from the growing demand for interoperability and data sharing across different platforms and organizations. Without common standards and formats, it can be difficult to exchange data between systems, which can lead to data inconsistencies and errors.

<table>
<tr><td>Schedule</td><td colspan="3"><table>
<tr><th>FY</th><th>Quarter</th><th>Task</th></tr>
<tr><td rowspan="2">2023-24</td><td>1st and 2nd</td><td>● Reviewing the existing basic ISO GI standard with the JICA expert.
● Selection of relevant ISO GI standard for the Draft Bhutan National Standard (BTS).
● Develop a Draft BTS for Geo-Information.
● Consultation with stakeholders from various sectors on the draft BTS for Geo-Information.
● Submit a proposal of the Draft BTS for GI to BSB from NLCS.
● Include diverse groups of stakeholders from government agencies, private sector, academic institutions, and civil society while forming a sub-committee under BSB.</td></tr>
<tr><td>3rd and 4th</td><td>● Development of the draft Profile of GI Standards (practical essence).
● Development of the draft Guidelines for adopting the Profile.</td></tr>
<tr><td>2024-25</td><td></td><td>● Trial and validation for the draft Guidelines and the Profile to existing GI products.
● Promotion, Education and Training of BTS for GI / the Profile / the Guidelines to the external stakeholders.</td></tr>
</table></td></tr>
<tr><td>KPI</td><td>The percentage of the draft BTS for Geo-Information that has been completed.</td><td>Means of Verification</td><td>Track the progress of drafting the BTS for Geo-Information and measure the percentage of tasks completed against the timeline.</td></tr>
<tr><td>Baseline</td><td>0 percent of Draft GI standard</td><td>Target</td><td>100 percent of Draft completed</td></tr>
<tr><td>Key interventions</td><td colspan="3">● Including diverse groups of stakeholders from government agencies, private sector, academic institutions, and civil society while forming a sub-committee under BSB.</td></tr>
<tr><td>Risk mitigation plan</td><td colspan="3">● Conducting consultation meetings and workshops, to keep the external stakeholders and subcommittee members on board while drafting the GI standard.</td></tr>
<tr><td>Budget amount</td><td colspan="3">Nu. 0.05 million</td></tr>
<tr><td>Responsible agency</td><td colspan="3">Center for Geo-Information</td></tr>
</table>

5) NSDI System Operation Plan

Operation Plan for National Spatial Data Infrastructure System

CENTER FOR GEO-INFORMATION

Table of content

1. Introduction 4
2. System Overview..... 4
3. Legal and policy frameworks 5
4. User Roles and Data Management..... 6
4.1 System Admin 6
4.2 Portal Admin 7
4.3 Data Admin 7
5.Standard operating procedures for NSDI ICT Service 8
5.1 Portal Admin 8
5.1.1 Installation and configuration of ArcGIS Enterprise 8
5.1.1.1 Configure home page and footer 8
5.1.2 Group Creation and Configuration 10
5.1.3 Transfering group ownership to CGI Portal user, adding description and tags..... 11
5.1.4 Inviting Users to the Group. 11
5.1.5 Adding Items to the Group. 11
5.1.6 Content Management 11
5.1.6.1 Transfer all content owned by specific members 11
5.1.6.2 Change the ownership of specific items 12
5.1.7 Delete items owned by others 12
5.1.8 Manage items for a specific member 13
5.2 Data Admin 14
5.2.1 Data uploading, configuring and sharing. 14
5.2.2 Configuring the data setting. 15
5.2.3 Adding default visualization to the data. 16
5.2.4 Adding a view layer for public viewing and sharing. 16
5.2.5 Data editing and updating 17
5.2.6 Metadata creation and updation procedure 18

1. Introduction

The National Spatial Data Infrastructure (NSDI) is a pivotal initiative driven by the Royal Government of Bhutan to facilitate the growing need for accurate and reliable geospatial data in Bhutan, particularly for supporting informed decisions in the developmental activities such as natural resource management, urban planning, and disaster management.

NSDI encompasses various aspects of geographic information, such as legal frameworks, institutional arrangements, and technology to facilitate the management and sharing of geospatial data. The NSDI tries to achieve the facilitation and management of sharing of geospatial data through the development of NSDI ICT services.

This Operation Manual functions as a comprehensive guide, offering guidance into understanding the NSDI ICT system's functions, roles and responsibilities of different users, aiming to equip users and administrators with the knowledge necessary for proper system navigation, effective data management, and adherence to established legal and policy guidelines.

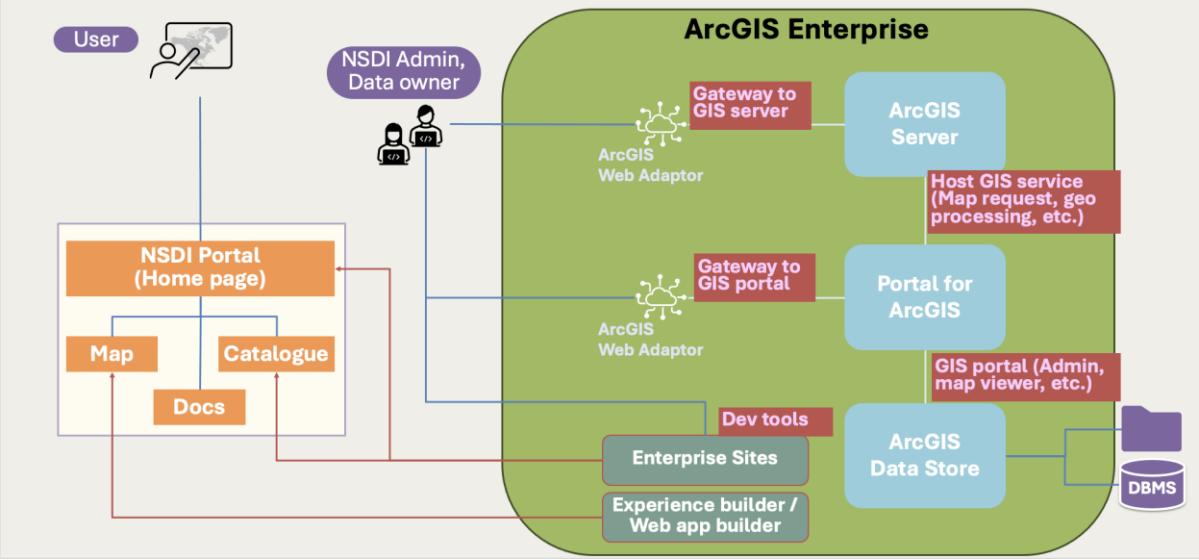
2. System Overview

The NSDI ICT system utilizes the ArcGIS Enterprise.The ArcGIS Enterprise comprises ArcGIS Server, Arcgis Portal and Data Store. ArcGIS Server enables the centralized sharing and distribution of geospatial services, ArcGIS Portal serves as a collaborative platform for organizing and sharing geographic content, and ArcGIS Data Store provides scalable data storage and management within the ArcGIS platform.

The Portal Admin and Data Admin (data owner) have direct access to the ArcGIS Enterprise through the Portal for Arcgis. The respective data producing agencies will have access to the portal as a data creator. The data created by each data producing agency will not be visible by default to the other data creator except the data is shared explicitly.The Portal Admin shall be responsible for content management such as data

cataloging, transferring ownership and sharing the data to the public portal. All the data in the system shall be visible and accessible to the portal admin.

Additionally a portal is set up for general public access. It is developed using a site and experience builder in ArcGIS Enterprise. Using this portal, the general public can explore data, metadata, view and download data that are directly published by the agency responsible for creation and maintenance of the data. The data is cataloged based on ISO themes for easy navigation and discovery. Also all the metadata is based on Bhutan Standard for Metadata and Metadata guidelines.



3. Legal and policy frameworks

In Bhutan, the NSDI will be governed by laws, policies, regulations, and guidelines as follows:

Geographic Information (GI) Policy 2018: GI Policy will facilitate sharing of geospatial data and prevent geospatial data from being confined within individual agencies/organizations and make data easily accessible and available to users. It is one of the many ways of promoting the use of geospatial information.

ICM Act of Bhutan 2018: The relevant chapters under this ACT regulates and enforces the data collection, usage, and sharing of personal information

The eGovernance Policy 2019: The eGovernance Policy 2019 provides a framework for the development and management of NSDI in a more efficient and effective manner, leading to better utilization of spatial data for the benefit of citizens and society as follows:

- Shared ICT Assets: The statement focuses optimal utilization of government data/infrastructure which can be reused/reshared. It also emphasizes the need to standardize e-governance services, including spatial data services.

- Single Source of Truth: The statement promotes correct and data currency in collaboration and partnership among government agencies and stakeholders. This can lead to the development of a more comprehensive NSDI, with better integration of spatial data from different sources. It can also help in the development of standardized data formats and metadata for NSDI, making it easier for users to access and use spatial data.

- Information Security and Privacy: The Policy also prioritizes data security and privacy. This can help to protect sensitive spatial data, such as those related to national security, from unauthorized access or misuse.

- Need-Driven Initiatives and Sustainability: The ICT initiatives should be need-based and citizen-centric with a long-term view, with provisions for maintenance, upgrades, and scalability.

Data Management Guidelines: This guideline ensures that the data collected and maintained by organizations are of high quality, and reliable and that it can be shared among different stakeholders. It also guides NSDI on how to collect, store, and archive data.

4. User roles and responsibility

4.1 System Maintainer

The system admins are focal ICT personnel from NLCS and GovTech. Their roles and responsibilities are as follows.

1. Server Maintenance
2. Network Maintenance
3. Operation system and Software Management
4. Maintaining safety and security of the system

4.2 Portal Admin

The officials from the Centre for Geo-Information will serve as the Portal Admin. The Portal admin shall be responsible for the content management of the system. Their roles and responsibilities are as follows.

1. **Installation and configuration of ArcGIS Enterprise:** This involves installing four software components of ArcGIS Enterprise on the server and configuring each component to connect with each other. Then creating and binding a domain certificate in IIS.
2. **Setup and development of public portal:** The public portal shall enable sharing of open data to the general public. The portal shall be developed using site and experience builder in ArcGIS Enterprise.
3. **Creation of data admin and group:** The portal admin shall create a Group for each member agency. At least one Data Admin with the privilege to publish data shall be created from each member agency and shall be the focal data admin. The user name for the focal data admin shall be the name of the Member agency itself and shall own all the agency's data. If required additional data admin can be created with the data editing rights. Optional users with viewing rights can be created for viewing of common data owned by different agencies.
4. **Ensuring Data Configuration:** All the data published shall be configured as follows
    - View is created and configured for public viewing for open data or viewing within agencies for common data and appropriately shared.
    - Data protection is enabled for all the data.

- Data export is disabled for common data and enabled for open data.
- Review and assign appropriate tags and categories for all data.
- Edit tracking is enabled.

5. **Ensuring data registration**: All the data uploaded in the portal need to be registered with CGI. The registration process involves carrying out SSOT and Data Categorization and submitting the endorsed form to the CGI office. If any unregistered data is uploaded to the system, the respective data owner shall be contacted for registration of the data.

6. **Review Metadata:** The portal admin should review and ensure that the respective data admin has entered metadata as per the Metadata guideline.

7. **Maintaining data Inventory :** Portal admins shall maintain a data inventory against each member agency for all the registered data to the NSDI system.

4.3 Data Admin

All the NSDI stakeholder agencies(data producers) shall have at least one data admin for updating and maintaining their respective data to the NSDI portal. The Data Admins shall be responsible for registering the data admin to the NSDI system.

1. **Register data:** Before uploading the data to the NSDI ICT system the data shall be classified and assigned with SSOT as per the standard operating procedure for GI categorization and SSOT. After assigning SSOT and data category, the data has to be registered in the GI Inventory list prepared by the CGI.

2. **Upload, configure and maintain data:** After the data registration, the data admin shall be responsible for uploading, configuring and updating the data into the NSDI ICT system. The data shall be organized in the system in the following named folder. Data owner shall only upload the registered data only.

    - NSDI data: All the source data and hosted feature layer.
    - NSDI view: All the views owned by the data admin.
    - NSDI app: All the app and dashboards are created using the NSDI data.
    - NSDI map: All the map creating using NSDI data

The data shall be configured as follows.

- View is created and configured for public viewing for open data or viewing within agencies for common data and appropriately shared.
- Data protection is enabled for all the data.
- Data export is disabled for common data and enabled for open data.
- Appropriated tags and categories are assigned.
- Edit tracking is enabled.

3. **Upload and maintain Metadata:** The meta data can be prepared prior to the upload using ArcGIS pro or ArcGIS Desktop or can be prepared after the upload in the ArcGIS Enterprise. The metadata shall be updated every time a new data has been entered or updated in line with the Bhutan Standard for Metadata and Metadata Guideline.

5. Standard operating procedures for NSDI ICT Service

The SoP for NSDI ICT Service will guide the Portal admin and the data admin for the basic operation of the ICT Service.

5.1 Portal Admin

5.1.1 Installation and configuration of ArcGIS Enterprise

Configure home page and footer

In ArcGIS Enterprise,the default administrator account or any custom account having privileges to edit the portal can edit the organization home page and modify it at any time.

In NSDI ICT services the Portal Admin will be given the privilege to edit and manage the Organization Home Page. This includes adding a name, logo for the organization and choosing a banner for the homepage.

1. Sign in with the portal admin account. The organization page is displayed. Initially after the installation of ArcGIS Enterprise the homepage displays a list of current members and membership status with expiration dates.
2. On the **Organization** page, click **Settings**.
3. Click **Home page >> Launch editor**. After launching the editor for the home page, the homepage editor section has the following elements that can be configured.

    - **Header**—Title, logo, and cover image
    - **Body**—Item galleries, text, and links
    - **Footer**—Contact information, custom footer text and links, and footer styling

4. After launching the editor for home pager Under **Contents**, click **Header**.
5. Toggle on the **Show organization title** and enter the **Organization title** in the text box.
6. Enable the **Show logo** toggle button and choose image file (logo) on the desktop. Pan and zoom to what you want to appear in your logo and click **Save**. Acceptable image formats are PNG, GIF, and JPEG. The recommended logo size is 65 x 65 pixels.
7. Next toggle on the **Show cover image**. You can use ready to use stock cover images from the drop down menu or upload from the desktop. To avoid distortion, a standard banner image should be 960 pixels wide by 180 pixels high.
8. Click the Layout **option** and configure any of the following settings.

    - Select a height for the cover image.

- Adjust the focal point of the cover image by clicking in the image preview window. The focal point you specify determines the center of the image on all screen sizes.
- Adjust the opacity of the cover image using the Overlay opacity slider.
- Adjust the vertical alignment of the title and logo and their horizontal position in relation to the cover image.

9. Navigate back to the **Contents** pane and click **Footer** in the **Contents** pane in order to configure a custom contact link for the organization in the Footer.
10. Turn on the **Display contact us link** toggle button and enter your email address, for example, support@nlcs.gov.bt.

5.1.2 Group Creation and Configuration

1. Sign in arcgis enterprise as a Portal Admin.
2. Click **Groups >> Create group** on the My Groups tab at the top of the site.
3. Upload a logo of the agencies as the thumbnail image to represent the group. The recommended image size is 400 by 400 pixels or larger with an aspect ratio of 1:1 in a web file format such as PNG, JPEG, or GIF. Pan and zoom to what you want to appear in the thumbnail.
4. Provide a group name and tags. Also add a short description about the agencies.
5. For **Who can view this group?,** select **Everyone (public)**.
6. For, **How can people join this group?**, select **By invitation**.
7. For, **Who can contribute content?**, select **All group members**.
8. For, **Who can see the full list of members on the group's Members tab?**, select **Anyone who can view the group**.

9. Enable **Shared Update**. This allows items that are shared to the group to be editable by all group members.

10. Enable **Administrative**. This allows only the portal admin to remove members.

11. Click **save**. The group is created and your will be taken to properties of the group. You can also navigate to the group by clicking **Group** >> **Name of Group** from the list of groups displayed.

5.1.3 Transfering group ownership to CGI Portal user and adding description.

12. clicking **Change owner** (under Owner at at the right hand side) >> click **CGI Portal** (from the list of users). If the user does not exist you need to create one.

13. Click Ad**d an in-depth description** of the group under Description to add the description of the group.

14. Add appropriate tags for easy filtering of the groups. To add tags click **edit** (under Edit tags section at the left side of the page). Select appropriate tags from the list or type new tags followed by enter keys.

5.1.4 Inviting Users to the Group.

15. If you're not in the property page of the group, click **Group** >> **Name of the Group** from the list of groups displayed go to group property page.

16. Click **Invite members** >> select list of users >> click **Add members to group**.

5.1.5 Adding Items to the Group.

17. Click **Add Items to the group** >> select appropriate items from the list >> click **Add Items**.

As a group owner, you can edit group properties on the Overview tab and group settings on the Setting tabs. Invite members button on the Members tab to invite members to the group.

5.1.6 Content Management

5.1.6.1 Transfer all content owned by specific members

1. Sign in as a portal admin.
2. Click **Organization** >> **Members** tab.
3. Search for members by name or username and apply filters to narrow the members list. Optionally, sort the list, such as by name or last login date.
4. Check the box next to each of the members whose content items you want to transfer.
5. Above the list of members, click **More** >> **Transfer content**.
6. In the Transfer content window, click to select a new owner for the content.
7. If you are transferring content from a single member, select or create a folder as needed.
8. Before clicking Transfer, you can review the list of items being transferred by clicking the View all items button View all items under Content to transfer.
9. Click Transfer.
10. The items are transferred to the new owner you specified.

5.1.6.2 Change the ownership of specific items

1. Sign in as a Portal Admin.
2. At the top of the site, click **Content** >> **My Organization** tab.
3. Use the filters, sort options, and search as needed to find the items to reassign.
4. Select the items from the list and click **Change Owner**.

5. In the Change owner window, search for and select a new item owner, and select or create a folder as needed.
6. Click **Save**. The items are reassigned to the new owner you specified.

5.1.7 Delete items owned by others

1. Sign in as a Portal Admin.
2. At the top of the site click **Content** >> **My Organization** tab.
3. Use the filters, sort options, and search as needed to find the items you want to delete.
4. Click the data to go to the item description page and un-tick the **Prevent this time from being accidentally deleted** and click **Delete Item**.
5. The items are deleted from your organization.

5.1.8 Manage items for a specific member

1. Login as a portal Admin.
2. At the top of the site, click **Organization** >> **Members** tab.
3. Search for members by name or username and apply filters to narrow the members list. Optionally, sort the list, such as by name or last login date.
4. Click the **More options** button >> **Manage** items. The member's content page appears.
5. Use the filters, sort options, and search as needed to find the items you want to manage.

6. To edit the **properties** and **settings** of a specific item, such as modifying its **description** or **enabling Delete Protection**, click the title of the item and make changes on the **Overview** and **Settings** tabs on the **item page**.

7. To **manage multiple items** owned by the member from the member's content page, check the box to the left of each item you want to manage and do any of the following:

    - To organize items into categories, click **Categorize** and follow the steps to categorize the member's items.
    - To move items to a different folder, click **Move** >> select an existing folder or create one >> **Save**.
    - To reassign items to a different owner, click **Change Owner** >> search for and select a new owner >> select a new folder as needed >> click **Save**.
    - To change the **sharing properties** of items, click **Share**. Update with whom the items are shared: the organization, everyone (public), or groups to which the member belongs.
    - To delete items from your organization, first disable Delete Protection from **Settings** tabs and click **Delete**.

Notes

1. Changing **layer ownership** changes ownership of the file from which the layer was created. When you change the owner of a hosted feature layer, ownership changes for its dependent hosted feature layer views.

2. Changing **layer ownership** does not change the ownership of the maps and scenes in which the layer is used. Similarly, changing the owner of maps and scenes does not change the ownership of the layers inside them, nor does it change the owner of the apps in which the maps and scenes are used.

3. Dependencies exist between some items, such as between a hosted tile layer and the tile package from which it was published or between the hosted feature layer view and the hosted feature layer from which it was created. You must delete the dependent item before you can delete the item from which it was created.

4. Other than deleting the items, none of the options above change the location on disk or ID of the items.

5.2 Data Admin

5.2.1 Data uploading, configuring and sharing.

Add data files as items

1. Sign in as Data Admin

2. Click **My Content** tab >> **New item** >> **Your device**.

3. Browse to the location of the file on your device and click open.

   Alternatively, you can drag and drop the file into the drop zone at the top of the **New item** window. (The folder that contains the data should be compressed to the zip folder prior to the upload.

4. In the New item window select appropriate file type such as shapefile, file geodatabase or csv collection.

5. For **How would you like to add this file?** Select the option to create a hosted feature layer and click next. This option will create a hosted feature layer together with the source data. If you select **Add Data only**, then you need to explicitly publish the data in order to create a hosted feature layer.

6. Add a unique title for the data.

7. Choose a folder named "*NSDI Data*" to save the data.

8. Assign categories and tags as per the guidelines in this manual.
9. Provide a summary that describes the data.
10. Click **Save**.
11. Arcgis Enterprise will create two files, one for data and another hosted feature layer with the same name. These two files must be kept in the NSDI data folder by the respective data owner.

5.2.2 Configuring the data setting.

12. Click **Content** >> **My Content** >> NSDI data (folder)>> data (hosted feature layer from the list) >> **Overview**.
13. Add **Description** and **Term of Use**.
14. Click the **Settings** tab.
15. In the **Delete Protection** section tick mark the **Prevent this item from being accidentally deleted**.
16. In Feature layer (hosted) section, tick mark the **Keep track of changes to the data (add, update, delete features)**. Though this layer is not enabled for editing, the data owner and Portal Admin can still change the data. Enabling this feature can keep track of those edits.
17. Tick mark the **Allow others to export to different formats** and click **Save**.

    The data sharing level shall be at owner level and the layer should not be enabled for editing for hosted all the feature layers.

5.2.3 Adding default visualization to the data.

18. Click **Content** >> **My Content** >> **NSDI data** (folder)>> data (hosted feature layer from the list) >> **Visualisation**.

19. Click **Change style** (icon) >> **Options** >> **Symbols**.
20. Select appropriate colors and style for Fill and Outline.
21. Adjust appropriate Transparency and Visibility Range settings.
22. Click **Save Layer**.

5.2.4 Adding a view layer for public viewing and sharing.

23. Click **Overview** tab >> **Create View Layer** (button).
24. Selecting layer to be included in the view and click next.
25. Click the layer to access the layer's definition options to filter the data. You can create a filtered view of the layer using attributes or by selecting area of interest. You can also hide the attribute field by toggling on and off.
26. When you finish setting definition options for all layers in the view, click **Next**.
27. Type a unique title for the hosted feature layer view.
28. Choose the NSDI view folder to store the hosted feature layer view.
29. Assign appropriate categories and tags as per the guidelines.
30. Type a summary that describes the use and content of the view.
31. Click **Create** to create the view.
32. After creation of the view layer, you will be taken to the item description page.
33. Click **Setting** >> **Prevent this item from being accidentally deleted** and save the change.
34. In the item description page click **Overview** >> **Edit** (under Share Section)
35. Set sharing lever to Everyone (public) and to make available to the portal by adding Bhutan Geospatial Portal site to Group Sharing setting.

This layer is for sharing the data to the public portal and to other agencies with read only access. Therefore the layer shall **not be enabled for editing**.

5.2.5 Data editing and updating

If there are any changes in the data that has been already uploaded in the ArcGIS Enterprise and there is a need to edit the data, it is advisable that data admin first download the data from the Enterprise Portal. The data can be then edited using any Desktop GIS Software. After the necessary changes have been made the data admin needs to update the data in the ArcGIS Enterprise Portal. When some changes are made to the data, make sure to update the metadata as well. The following are the procedures to be followed while updating the data in the ArcGIS Enterprise Portal using the desktop software ArcGIS Pro.

i) Open ArcGIS Pro

ii) Project tab>>Portals>>Add Portals

iii) Enter the URL for the enterprise Portal (i.e https://cgi.nlcs.gov.bt/portal/)

iv) Click on the Not signed in button available on the upper right hand corner

v) Sign In using the ArcGIS Enterprise Portal account

vi) Load the data into the ArcGIS Pro, that needs to be updated (make necessary changes in the metadata as well)

vi) Right click on the data>>sharing>>overwrite web layer>>My groups>>content

vii) Click on the data that needs to be replaced and the click ok.

viii) An overwritten web layer dialog box will appear.

ix) choose the Use the item description from the web layer>> click on the publish button

Alternatively the data can be updated using the ArcGIS Enterprise Portal. The following are the procedures to update the data using the ArcGIS Enterprise;

i) Sign in to the ArcGIS Enterprise Portal>>Content>>My Groups>>Select the hosted feature layer on which data needs to be updated.

ii)Setting>> Turn off the keep track changes to the data option.

iiI) Update Data>>Overwrite Entire Layer>>choose the file which will overwrite the existing hosted feature layer>>Then click overwrite.

5.2.6 Metadata creation and updation procedure

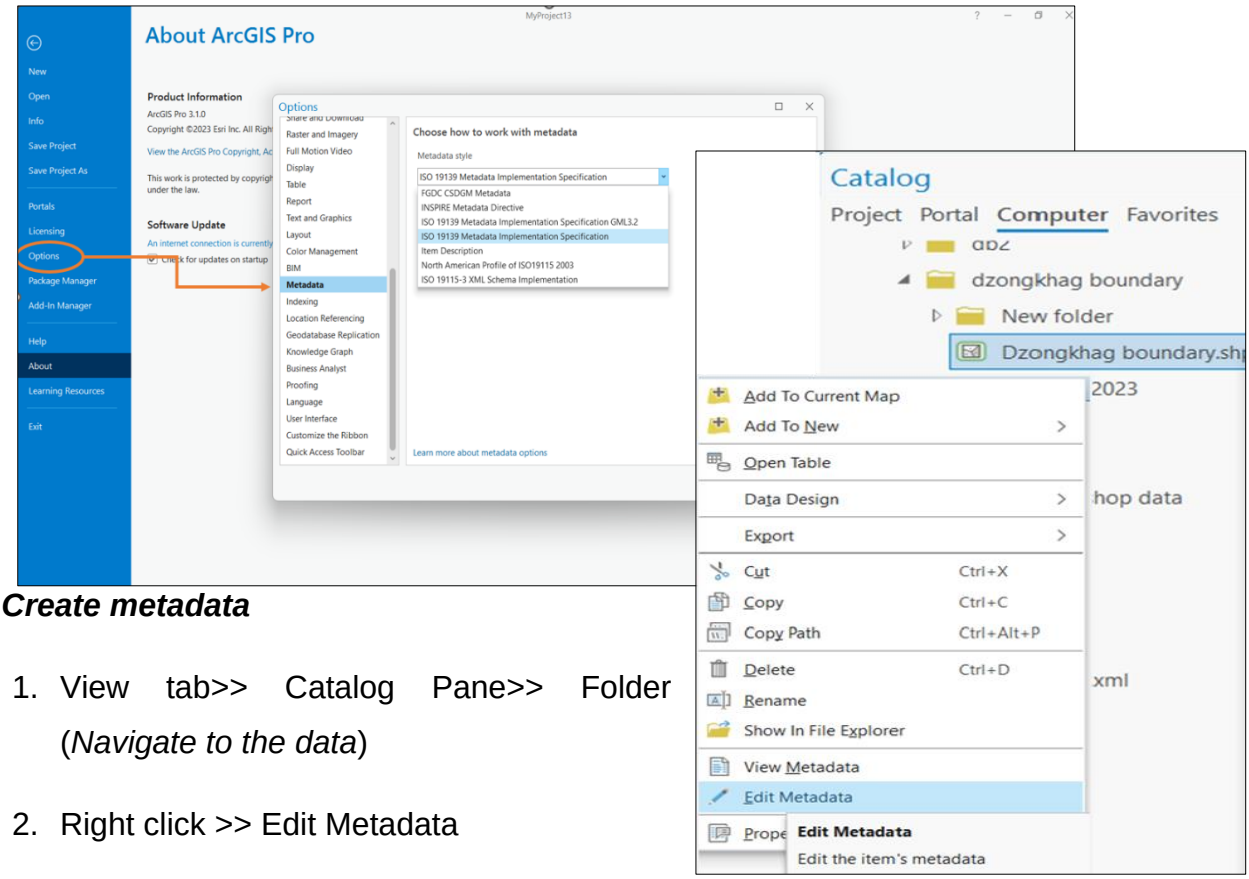
The metadata shall be created using a desktop software such as ArcGIS Pro, in accordance with the guideline for metadata. The following are the procedures for creating and publishing the metadata in the NSDI ICT system;

i) Select metadata styles

A metadata style provides access to a set of metadata elements, and a stylesheet for displaying their content.

Go to: Project (Tab) >> Options >> Metadata

1. Select: **ISO 19139 Implementation Specification** from metadata style list



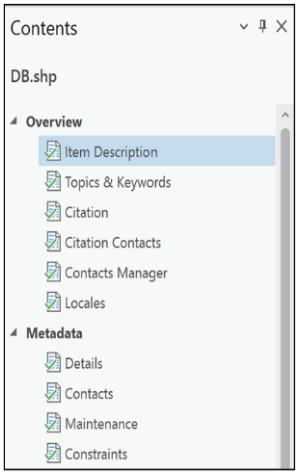
II) Create metadata

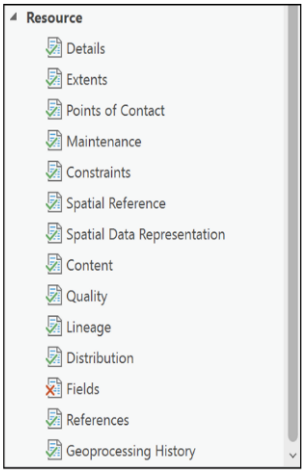
1. View tab>> Catalog Pane>> Folder (*Navigate to the data*)
2. Right click >> Edit Metadata

iii) Fill up the metadata elements

>>Add **info** in metadata elements based on the contents

>>Click on the save button>> a new file **.shp.xml** will be created in the data folder.





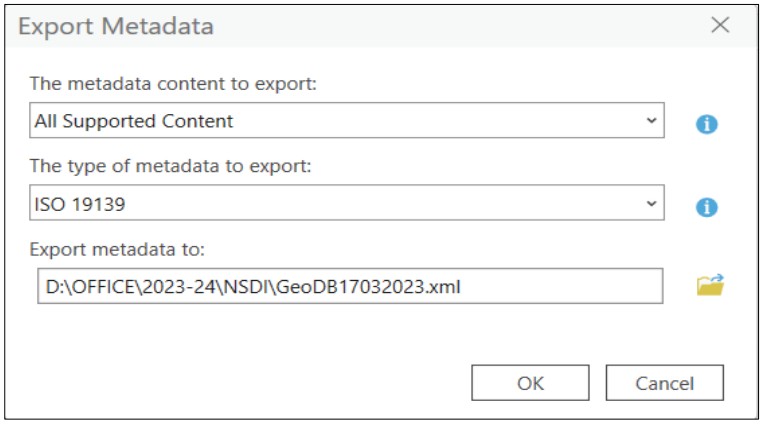
If metadata is to be exported in the xml format proceed with the step 4. For uploading the metadata to the NSDI ICT system, skip step 4 and proceed with step 5.

iv. Export the metadata

>>Close the metadata window and navigate to the catalog pane.

>>Right click >>View metadata

>>Export metadata



v. Upload the metadata in NSDI ICT Service

Sign in to the ArcGIS Enterprise Portal>>Content>>My Groups>>Select the **shape file and the data view** on which the metadata is to be uploaded. (The metadata should be updated on both the uploaded shape file and data view hosted feature layer)

Overview>>Metadata>>Overwrite>>Choose file>>Navigate and select the folder that contains the .shp.xml file in the data folder>>Save>>View

Metadata update

The metadata can be updated the ArcGIS Enterprise or either through ArcGIS desktop softwares. For updating the metadata in the desktop software, first download the data (Shape file) from the ArcGIS Enterprise. Then follow the same procedures of metadata creation.

Alternatively, the metadata can be updated using ArcGIS Enterprise. Following are the procedures for updating the metadata through ArcGIS Enterprise;

Sign in to the ArcGIS Enterprise Portal>>Content>>My Groups>>Select the **shape file and the data view** on which the metadata is to be updated.

Overview>>Metadata>>Input the metadata items as per the metadata guidelines>>click on the save button.

What	Who

Reporting bugs and system failure

Version	Date	Update

Bold or Gothic

NSDI Portal (ArcGIS Enterprise)

1. Using Enterprise Geodatabase

1. Installing Postgres

2. Basic SQL language guide
3. Creating/Enabling Enterprise Geodatabase
4. Connecting to ArcGIS Enterprise
5. Connecting of ArcGIS to Enterprise Geodatabase and ArcGIS Server (creating and working with datastore)
6. Connecting ArcGIS Pro/Desktop to Enterprise Geodatabase
7. Data Archival
8. Enable Edit Tracking
9. Versioning
10. Data Design (Creating subtype, domain, constraint, topology and relationship)
11. Working with data (create, overwrite, append, edit attribute and geometry)
12. Setting and Working with privileges and role-based access
13. Data Reviewer

** how to creating feature layer without having direct access to the database

1. **Documentation:**
    - Maintain documentation for server configurations, procedures, and best practices.
    - Keep an inventory of hardware and software assets.
    - Maintain logs for server activities and security events.

- Monitor logs for unusual or suspicious activities and respond as needed.

The Portal Admin gets the information about the data uploaded.

Remove the organization tab.

Data update procedure (Overwrite from the desktop or edit directly from the portal)

Data backup and Recovery procedure (In March or April)

January 10 or 11 online meeting to finalize the data management procedure

The system management shall be done as per the GDC requirements.

The registration of new data shall not be allowed until the subsequent GI inventory workshop has been conducted. Only the existing data can be updated.

V. Standard Operating procedures

1. **ICT System Management (System Admin)**

2. **Server Maintenance:**
    - Identify how to monitor server health and performance.
    - Identify routine maintenance tasks and procedures to perform for server maintenance.
    - Troubleshoot and resolve server-related issues.
    - Upgradation of server components such as RAM, storage, or processors.
3. **Network Maintenance:**
    - How to monitor network infrastructure for performance and security.
    - Configuration and maintenance of network devices (routers, switches, firewalls).
    - Optimization of network performance.
    - Security measures to protect the network.
4. **Operating System and Software Management:**
    - Guide to Install, configure, and maintain the operating systems (e.g., Windows Server) on servers.
    - Guide to Install, configure, and maintain the database.
    - Installation and licensing of antivirus software.
    - Deployment of ArcGIS Enterprise

- Updating of system and software
- Guide for proper system resource allocation.

5. **Security Management:**
    - Identify security measures to protect the server infrastructure.
    - Configuration of firewalls and intrusion detection/prevention systems.
    - Manage user access and permissions at the server level and database level.
    - How to conduct security audits and vulnerability assessments.
6. **Data Backup and Recovery:**
    - Understand the data backup procedure of the Gov- tech system.
    - Disaster recovery plans in case of data loss or system failure.
    - Identify additional backup requirements.

7. **System Auditing:**
    - Review the requirement to update the **Standard Operation Procedure.**
    - Analyze the system logs to identify the need for improvement and future updates.
    - Examine server and network capacity to accommodate growing needs.
    - Audit human capacity requirement and development.

V) Data Management (Portal/Data Admin)

a. Data Backup/recovery procedure (Chart to show who will conduct this activity)

b. Data upload procedure

c. Data Cataloging

d. Data ownership transfer procedure

e. Data download procedure

f. Metadata creation and updation procedure

1. Add members to the Portal and create groups for every member agency (Portal admin)
2. Working with data (create, overwrite, append, edit attribute and geometry) through a web portal and arcgis pro/ desktop (Data admin)
3. Creating and working with views for data sharing and editing (Data admin)
4. Share the contents to the portal for Public access (Portal admin)
5. Working with Site (Portal admin)
6. Working with Experience Builder (Portal Admin)

1. Viewing Data list that has been shared public, different member agencies or not shared (Portal Admin)
2. Viewing and managing activity logs such as new data added/removed modified/updated (Portal Admin)
3. Viewing and managing feedback and suggestions. (Portal Admin)

4. Viewing/updating and managing wrong or missing reports of data. (Portal Admin)
5. Data Cataloging (Data Admin)
6. Data ownership transfer (Data Admin/Portal Admin)
7. Metadata creation and update (Data Admin)

Guidelines for tags and categories

Create/edit/delete custom roles

Update catalogue (Enterprise sites)

Data Administrator

Add/Update data (ArcGIS pro / Portal)

Create/Update metadata

User

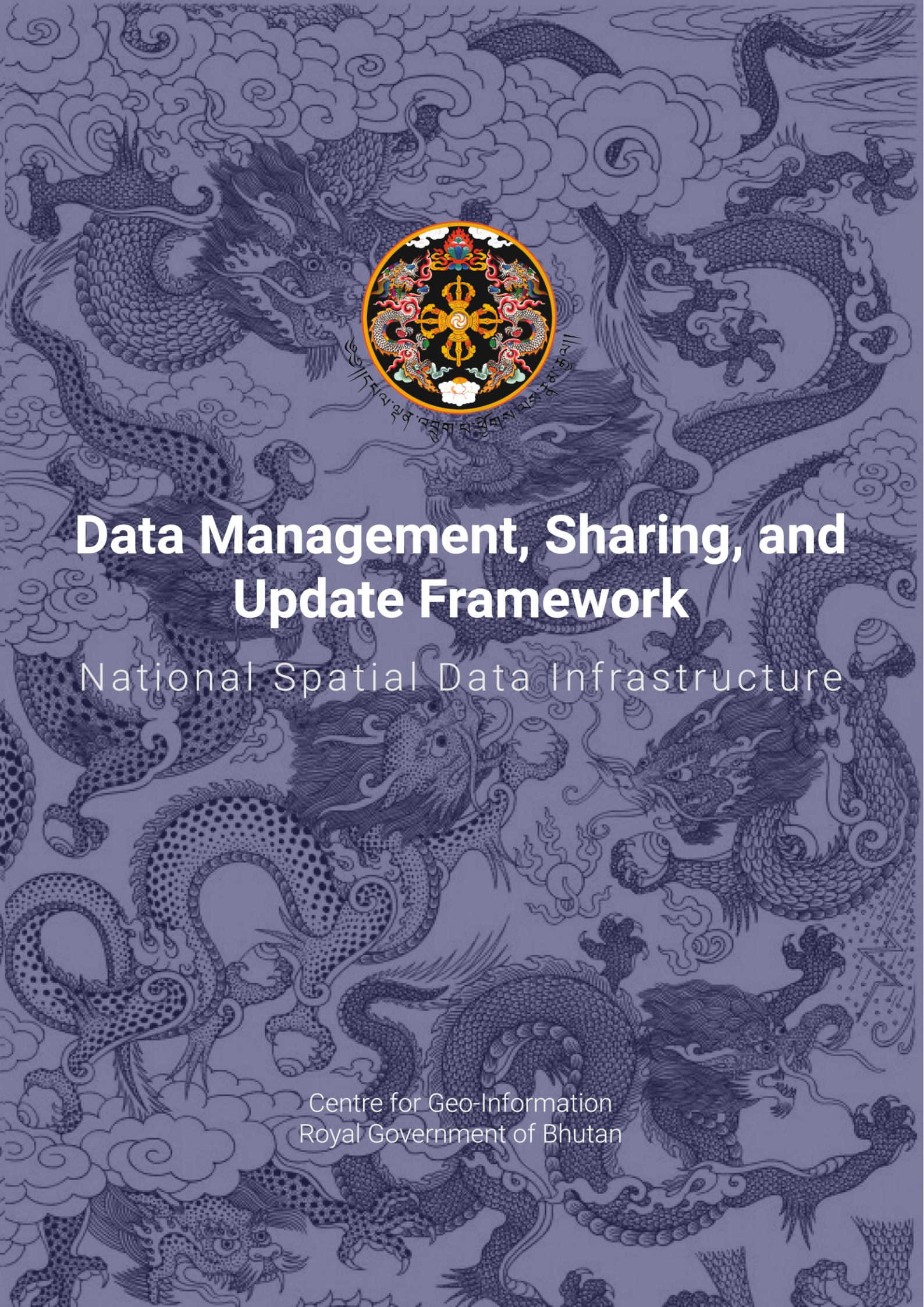
Navigate data (incl. metadata)

Download data

Reporting and feedbacks

6) Documents regarding GI Management

Appendix 6-1: Data management, sharing, and update framework
Appendix 6-2: ToT WebGIS Outline
Appendix 6-3: ToT WebGIS Basic Training Material



Data Management, Sharing, and Update Framework

National Spatial Data Infrastructure

Centre for Geo-Information
Royal Government of Bhutan

Foreword

The Centre for Geo-Information (CGI) under NLC is pleased to present the Geospatial Data Management, Update, and Sharing Framework for the National Spatial Data Infrastructure (NSDI) System. This framework establishes a comprehensive approach to governing geospatial data in Bhutan, fostering collaboration and optimizing information access for informed decision-making.

The Royal Government of Bhutan established the NSDI in recognition of the critical role geospatial information plays in national development. Fragmented data management across various institutions previously hindered optimal data utilization and creation of duplicate data amongst the data producers. The NSDI addresses this challenge by creating a common platform, the NSDI System, to streamline data management, sharing, and updates.

This framework outlines key principles guiding the NSDI, including data creation, standardization, harmonization, and accessibility. It emphasizes the "Single Source of Truth" (SSOT) principle, assigning clear ownership and update responsibility for each dataset to a designated agency. This ensures data accuracy and facilitates efficient data lifecycle management.

The framework draws upon the Geo-Information Policy 2018, which lays the foundation for fostering data sharing and collaboration across the diverse backgrounds of users. By establishing clear roles and responsibilities for the CGI, member agencies, and data users, the framework promotes effective data management practices within the NSDI System.

Ultimately, this framework aims to unlock the full potential of geospatial information in Bhutan. By promoting "one time creation, multiple use" of spatial data, the NSDI empowers informed decision-making across diverse sectors, contributing to the nation's continued progress.

Introduction

In November 2003 the Royal Government of Bhutan established the National GIS Coordination Committee, for which the Centre for Geo-Information (CGI) erstwhile the Centre for GIS Coordination (CGISC) was instituted under the Department of Survey and Land Record, Ministry of Agriculture. In 2007, with the enforcement of the Land Act 2007,

the Department of Survey and Land Record along with the CGI was delinked from the Ministry and established as the National Land Commission Secretariat.

As per the section 6.1.3 of the GI Policy 2018, it mandates the Centre for Geo-Information to develop the National Spatial Data Infrastructure. The office is a body that aims to enhance data discovery, accessibility, and sharing mechanism without ensuing duplication or silos in operation; and to promote sustainable and optimal use of geo-information and technologies among the members promoting “one time creation, multiple times use” of data philosophy.

The Geo-Information Policy of Bhutan, 2018 defines National Spatial Data Infrastructure as:

It (NSDI) is to denote a framework of technologies, policies, and institutional arrangements that together facilitate the creation, exchange, and use of geospatial data and related information resources across an information sharing community.

A definition of spatial data infrastructure can be found on the Global Spatial Data Infrastructure Web Site (www.gsdi.org) and it conveys some of the complexity of the issues involved:

A spatial data infrastructure supports ready access to geographic information. This is achieved through the coordinated actions of nations and organizations that promote awareness and implementation of complementary policies, common standards and effective mechanisms for the development and availability of interoperable digital geographic data and technologies to support decision making at all scales for multiple purposes. These actions encompass the policies, organizational remits, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the national and regional scales are not impeded in meeting their objectives.

In a small country like Bhutan, geographic information or spatial information is dispersed across various institutions, each adhering to different or in few cases no established standards, and lacking a cohesive system to monitor its availability, utilization, and storage methods. National Spatial Data Infrastructure (NSDI) is a system that brings together “many of the datasets collected and held by many different organizations.” To qualify for the inclusion, a dataset must conform to the agreed and developed national data standards.

Scope

This framework addresses the data governance and life cycle management of geospatial information within the NSDI system. It encompasses data originating from various data-producing agencies within the country. The framework recognizes different user levels with varying access privileges and functionalities within the data management and governance processes.

Goals and Objectives

Goal:

To Facilitate Data Management, Sharing, and Update for the NSDI System.

Objectives:

1. Establish Data Management

Implement a common technical approach and standard to effectively create, collect, store, protect, and share data across the department, the interagency, and with the public through the NSDI system.

2. Enhance Data Governance

Consistent data governance throughout the data owners advances the ability of offices to more easily manage, share, and use the data while reducing the time and resources required to do so.

Data Management, Sharing and Update

Data management involves the procedures of securely and efficiently gathering, organizing, storing, and utilizing data, aiding organizations in making informed decisions. Its significance is underscored by the increasing volume of geographic information system (GIS) data handled by organizations, necessitating safe and effective data handling methods.

Data Creation

The creation of data for the National Spatial Data Infrastructure (NSDI) must adhere to the established agreed Single Source of Truth (SSOT). These principles should be formulated through stakeholder consultation during the NSDI development process. Section 6.2.3 of the Geo-Information (GI) Policy 2018 further emphasizes this concept, stating that “the CGISC shall ensure a single source of truth identifying responsible agencies in producing fundamental as well as thematic GI data.”

Within the context of Geographic Information (GI) management, SSOT refers to the practice of assigning ownership of specific GI datasets to a designated organization or entity. This designated entity bears the responsibility for producing, managing, and disseminating the most accurate, complete, and current data for that set.

To ensure the discoverability, usability, and smooth integration of newly created geospatial data with the NSDI System, a standardized Data Product Specification (DPS) will be implemented. The Data Product Specification should be defined in the Bhutan Standard for Data Product Specification.

Data Standards

Established geospatial data standards serve as a foundational framework that facilitates the seamless integration of geographic information across diverse systems, platforms, and applications. These standards play a critical role in ensuring and maintaining data interoperability, data quality, data consistency, and effective data sharing among various stakeholders.

- Within the NSDI framework, all geospatial data producers are mandated to adopt and adhere to the established Bhutan Standards (BTS) for Geographic Information.
- The development and amendments of the Bhutan Standards (BTS) for Geographic Information will be guided by the evolving requirements of geospatial data standards within the NSDI.

Data Categorization

The NSDI framework leverages a geospatial data categorization process established by the Geo-Information (GI) Policy 2018. The policy categorizes the spatial data into:

a. **Open Data:** Open data can be disclosed to the public without any restriction. This type of data does not require any security controls when used or stored. The open data shall be made available to the public domain through the NSDI system of data-sharing platform.
b. **Common Data:** Common data will be freely exchanged among government agencies and academia, while corporate and private entities may incur associated costs depending upon the agreement between the data producer and the consumer. Such data shall be shared after filtering the sensitive contents in confinement with the interest of the data-producing agency.
c. **Restricted Data:** Restricted data are those which can be shared only among authorized agencies. The authorized agency shall be determined by the respective data-producing agencies.

This categorization facilitates the effective organization, management, and dissemination of geospatial data. It enhances data discovery, analysis, visualization, and ultimately, informed decision-making.

Standard Operating Procedure (SOP) for Data Categorization

- The framework mandates the establishment of a Standard Operating Procedure for Geographic Information Categorization & Identification of Single Source of Truth (SSOT) for each dataset as stated in the Article 6.2.3 and Article 6.3.1 of the GI Policy under the **availability of reliable geo-information** and **data discovery, accessibility and sharing mechanism without duplication or silos in operation** sections respectively. The SOP should provide clear guidelines to ensure consistency and accuracy in data classification and SSOT designation.
- All geospatial data producers within the NSDI framework are obligated to adhere to the established procedures for data categorization, particularly for datasets designated as their SSOT responsibility.

Data Sharing

Agencies designated as Single Source of Truth (SSOT) for specific datasets are entrusted with the complete data lifecycle for their assigned data through the NSDI system. This approach signifies a departure from current data-sharing practices. Within the NSDI framework, all data must undergo a categorization process adhering to the Standard Operating Procedure for Geographic Information Categorization & Identification of Single Source of Truth (SSOT) before dissemination via the NSDI System.

Data Access

The framework mandates the establishment of well-defined roles and responsibilities within the National Spatial Data Infrastructure (NSDI) System. To ensure efficient operation and data governance, the Standard Operating Procedure for NSDI should detail the various user roles within the NSDI System, along with their associated responsibilities.

Access control pertains to determining the degree of accessibility of data, based on the different data categorization levels. The access control for the data sharing through the NSDI System should be defined in the Standard Operating Procedure for Geographic Information Categorization & Identification of Single Source of Truth (SSOT).

Operation and User Manual for Data Sharing

- The Operation Manual for NSDI System should guide the NSDI system's functions, roles, and responsibilities of different users with adherence to established legal and policy guidelines.

- The NSDI user manual should serve as a comprehensive guide, providing step-by-step instructions on how to use the NSDI system to fulfil the roles and responsibilities specified in the Operation Manual for NSDI System.

Data Integrity

Update

The agency designated as the SSOT for a specific dataset bears the primary responsibility for ensuring its timely update and maintenance. This ensures the data remains current, reliable, and meet the needs of the users.

- Following the update process, the SSOT agency is obligated to update the revised data to the NSDI System. This ensures the dissemination of the most current and accurate information to users.
- While the SSOT agency holds primary update responsibility, the framework acknowledges that end users may encounter situations where existing data:
    - Does not meet their specific requirements.
    - Contains inconsistencies.

  In these instances, users are empowered to update the data based on their requirements, provided they share these updates with the designated SSOT agency. This collaborative approach facilitates the ongoing improvement of data reliability and accuracy, even for datasets outside a user's primary ownership. Upon receiving user-provided updates, the SSOT agency can then review, and update deem necessary into the official dataset and subsequently share them through the NSDI System.

Data Backup and Archiving

To mitigate the risk of data loss, ensure data availability, and safeguard the integrity and reliability of geospatial information, the NSDI system should implement a robust geospatial data backup strategy.

- The system should have a periodic data backup to ensure the availability of the shared and maintained data in the system.
- Every data administrator needs to maintain independent backup procedures for their data shared to the NSDI System.

Data Use

Integration

- The framework emphasizes the importance of metadata for effective data utilization. Users are encouraged to refer to the detailed metadata associated with

each geospatial dataset within the NSDI System. By reviewing the metadata, users can make informed decisions about the suitability of a particular dataset for their specific needs and analysis. This promotes the selection of "fit-for-purpose" data, ensuring the validity and accuracy of their research or applications.

- The framework establishes the NSDI System as the primary platform for accessing and downloading geospatial data.
- The framework mandates the development and deployment of an Application Programming Interface (API) within the NSDI System.

Terms of Use

- Data User Liability and Data Producer Responsibility: The framework acknowledges the importance of data quality and user accountability.
    - Data User Liability: Users who download or access data through the NSDI System or API are responsible for ensuring the proper use and interpretation of the data for their intended purposes. Any errors or misinterpretations resulting in incorrect information generated from the data will be the user's responsibility.
    - Data Producer Responsibility for Metadata Accuracy: Data-producing agencies, as defined by the Single Source of Truth (SSOT) principle, are held accountable for the accuracy and completeness of the metadata associated with their contributed datasets. The framework will enforce adherence to established metadata standards to minimize the possibility of misleading information within the metadata.
- The framework encourages a culture of data attribution. Users who utilize data accessed through the NSDI System are recommended to acknowledge the data-producing agency in their publications, reports, or any outputs derived from the data.

Report

The framework recognizes the importance of data quality and continuous improvement. To ensure the accuracy and reliability of geospatial data within the NSDI System, users are encouraged to report any identified discrepancies in the data.

The framework establishes two clear channels for reporting data discrepancies:

- NSDI System Admin: Users can report discrepancies to the NSDI System administrator.
- Data Admin Defined by Operation Manual for NSDI System: Alternatively, users can report discrepancies to the data administrator responsible for the specific dataset in question.

Acknowledgment

The Centre for Geo-Information (CGI) gratefully acknowledges the Royal Government of Bhutan for its visionary leadership in initiating the National Spatial Data Infrastructure (NSDI) project. We extend our sincere thanks to the Government of Japan and the Japan International Cooperation Agency (JICA) for their generous support and technical assistance. The Geo-Information Policy 2018, which provides the strategic framework for the NSDI initiative, has been instrumental in guiding our efforts. We are deeply appreciative of the unwavering support, collaboration, and valuable insights provided by our colleagues from all relevant departments and agencies. While this document represents a preliminary draft, we believe it provides a solid foundation for establishing effective data management practices and promoting the efficient utilization of geospatial information within Bhutan.

The Project for Promotion of Utilisation of Geospatial Information through Development of National Spatial Data Infrastructure

Kingdom of Bhutan

NSDI : GIS Tools Training

Web GIS (Basic)

Organized by NLCS and JICA Project Team

Table of contents

1. How to create free ArcGIS online account **2**

2. Add files from your device to ArcGIS Online **4**

3. Add files using URL **5**

4. Demonstration of layer settings by trainer **5**

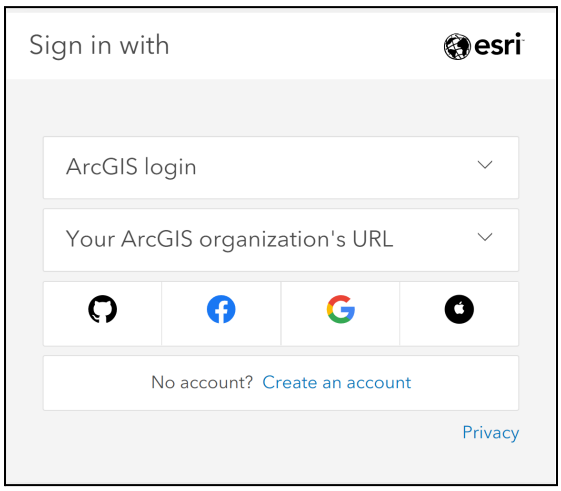
5. Creating Map **5**

6. Creating Web Application **6**

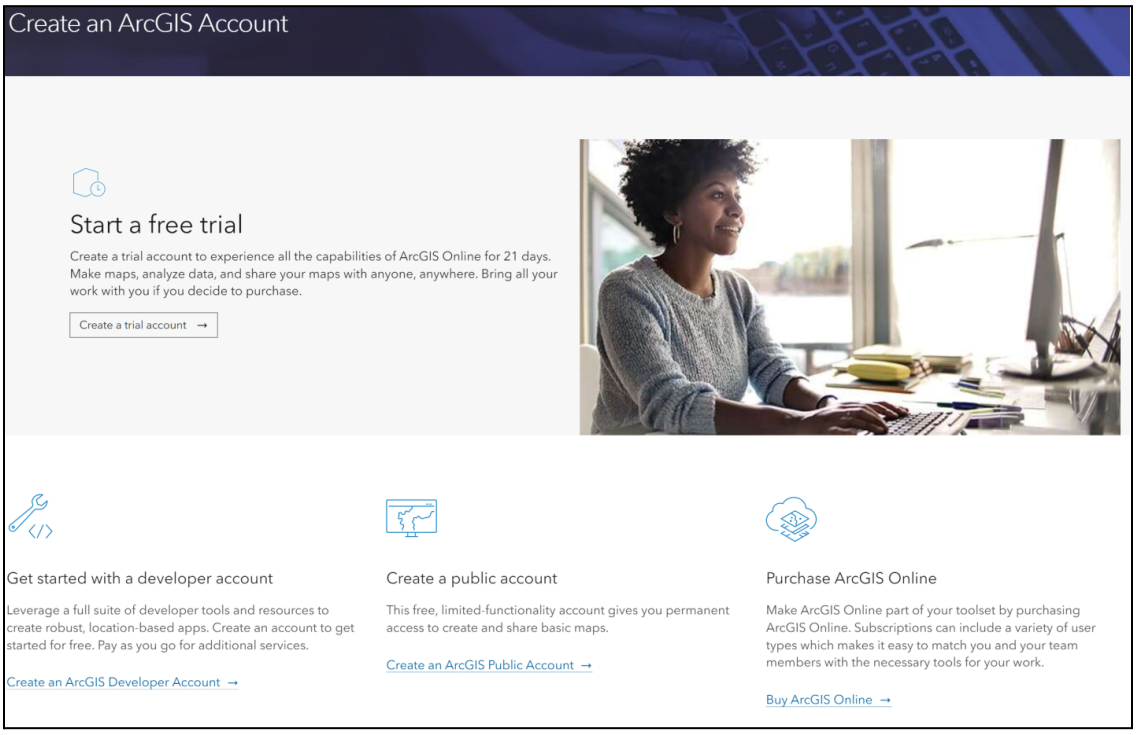
1. How to create free ArcGIS online account

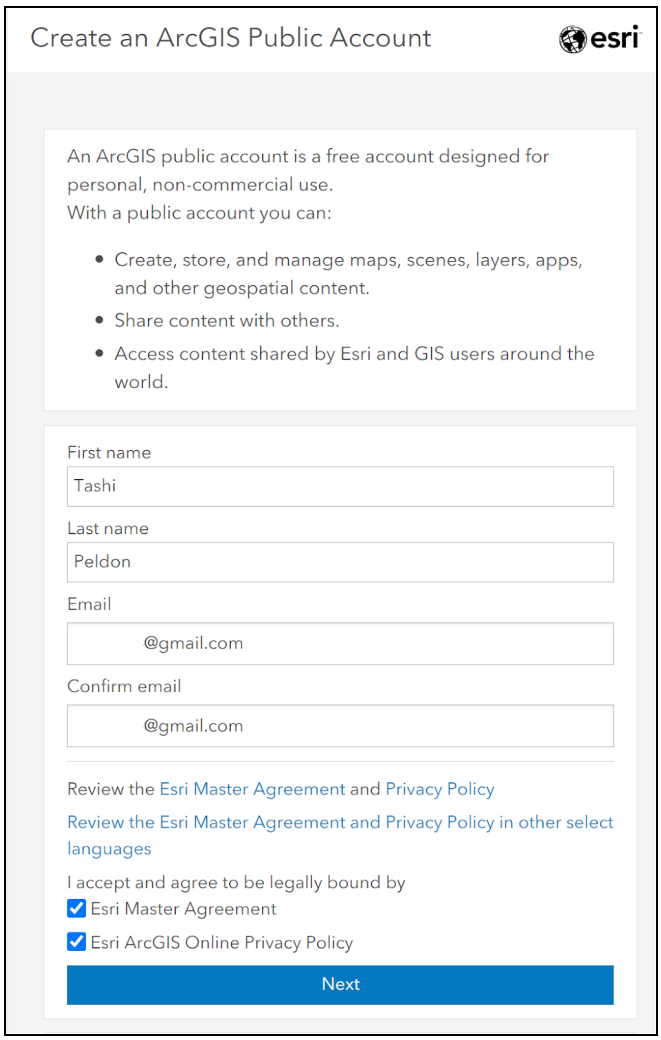
To get started, type ArcGIS Online as a Google search and click the first link and navigate to the sign-in button.

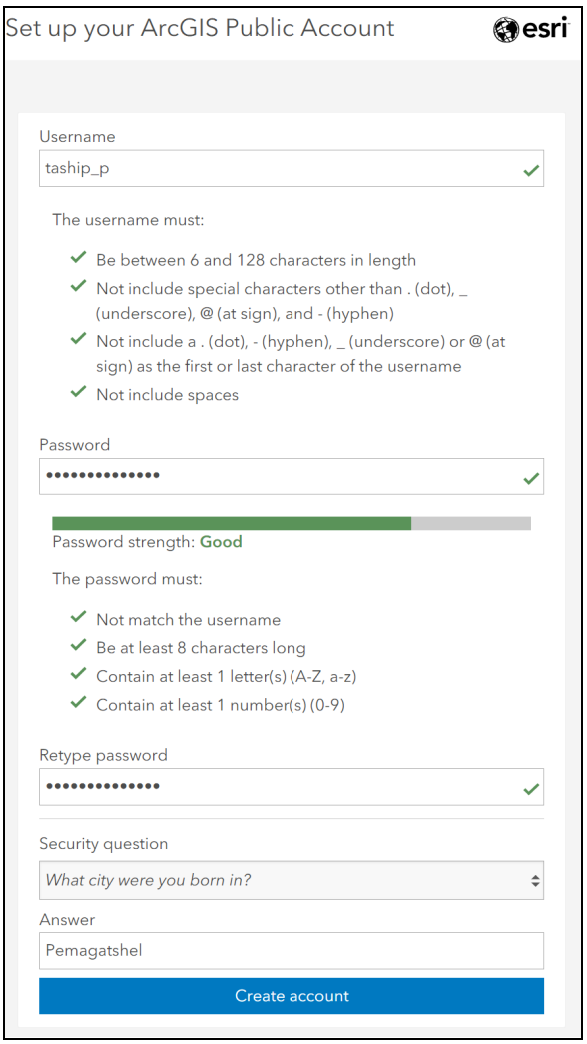
https://www.arcgis.com/home/index



You also have an option to either login with facebook or google account.







An activation link will be sent to your email. Click the link in the email to complete account activation.

Fill in all the details and press Create account.

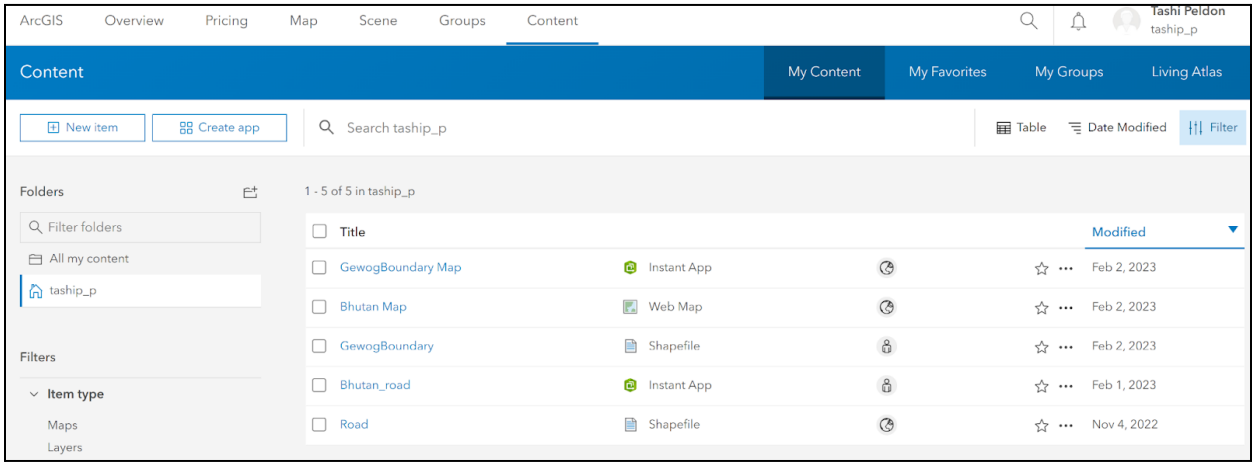
Next, go to Sign in and enter username and password.

https://www.arcgis.com/home/index

2. Add files from your device to ArcGIS Online

1. From the **My Content** tab of the content page, click **New item**.
2. Click **Your device** to choose the file from your device or drag the file into the drop zone.
3. If you uploaded a .zip file, choose the contents of the file from the **Item type** drop-down menu, for example, map template or code sample.
4. Click **Next**.
5. Type a title and as many tags as possible to enable easy search.
6. Choose a folder in **My Content** where you want to save the item.
7. Separate the terms with commas (for example, Federal land is considered one tag; Federal, land is considered two tags).

   As you type, you can select any of the suggested tags that appear; suggestions are generated from tags you have added previously.
8. Optionally, provide a summary that describes the item.
9. Click **Save**.



3. Add files using URL

1. Go to the **Content** tab
2. Select **New item**
3. Choose the URL option and enter the URL.
4. Choose the **Type** “ArcGIS Server web service” and press **Next**
5. Type a title and as many tags as possible to enable easy search and press **Next.**

Url for data:

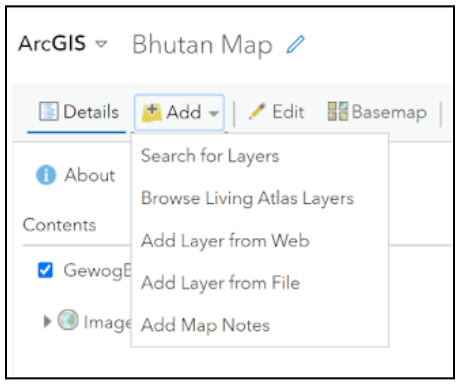
https://cgi.nlcs.gov.bt/server/rest/services/Hosted/Centre_Schools/FeatureServer

4. Demonstration of layer settings by trainer

- Renaming the file name and tags,
- Sharing to the public,
- Deleting the data,
- How to create a new folder and move the data from one folder to another, etc.

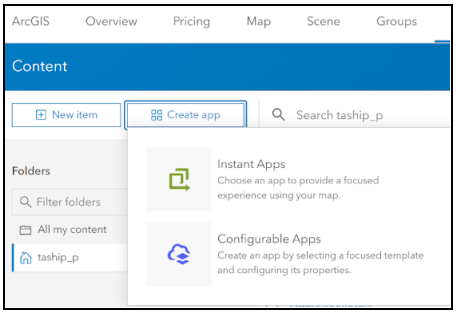
5. Creating Map

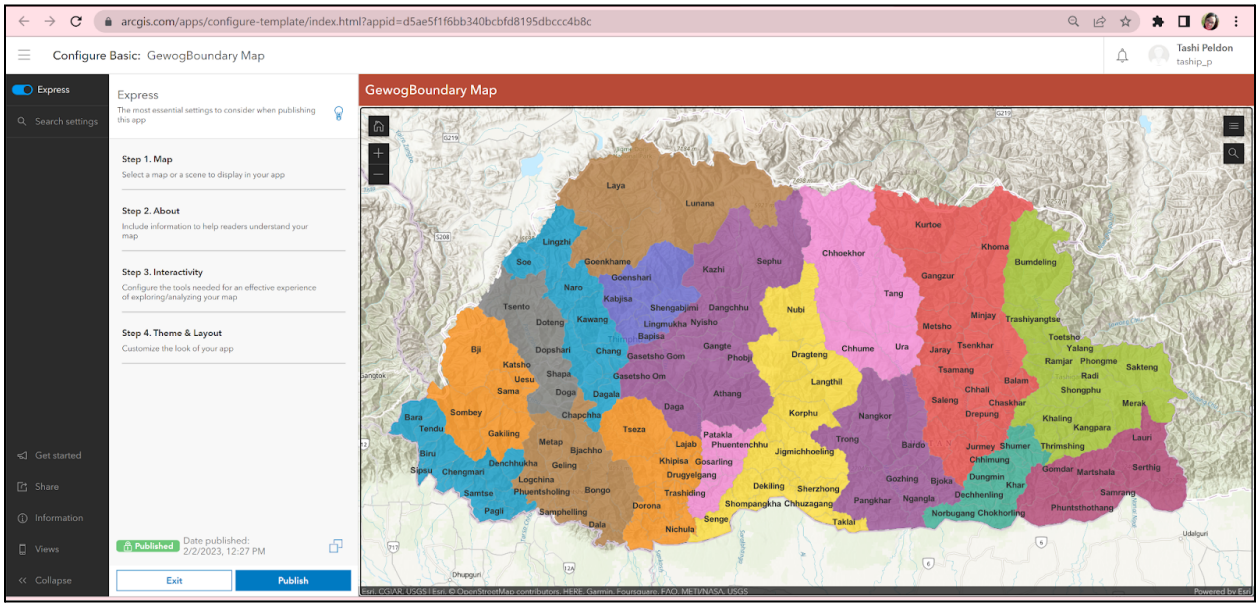
1. Go to **Map** tab
2. Add layer
   - Search for layers
   - Select layer from **My Content**
3. Open the attribute table
4. Change the symbology
5. Create labels
6. Filter
7. Change the order of the layer, etc.
8. Save the layer
9. Save map.



6. Creating Web Application

1. Go to **Create app** and select **Instant Apps**
2. Select the **Basic** from the list of applications
3. Go to **Map** and add the layer from My content. Then press **Next** until the setting is completed.
4. Go to the **Share** setting and choose **Public**.
5. Go to the **Views** setting and choose either **Desktop, Portrait** or **Landscape**.
6. Then **Publish** and **Launch.**





Last updated 2/2/2023

NSDI : GIS Tools Training
Web GIS (Basic)

General guidance about NSDI and this course

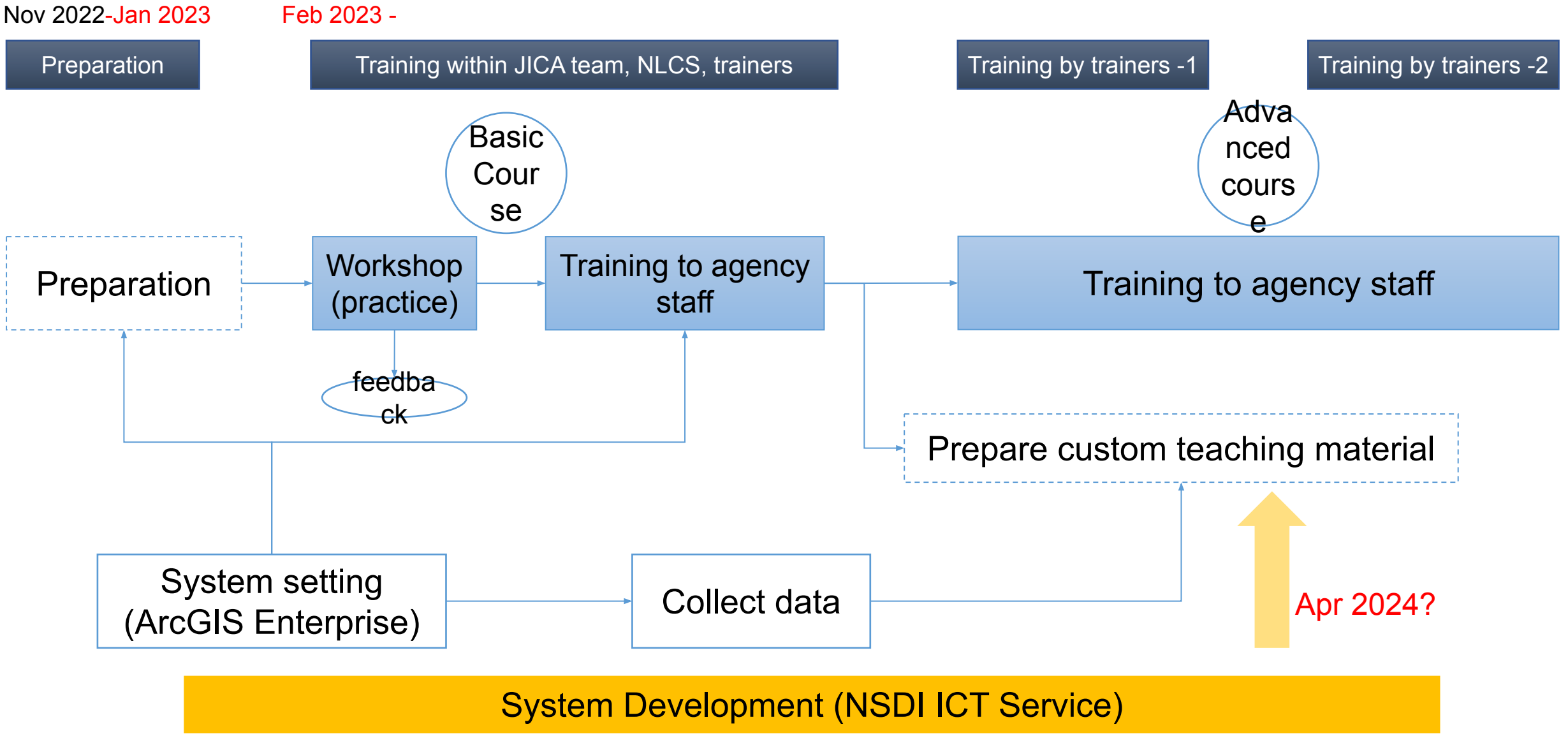
Quick Review of Previous Lesson

- The Training of Trainers (ToT) model is intended to engage master trainers in coaching new trainers
  - A ToT workshop can build a pool of competent instructors who can then teach the material to other people

- Instead of having just one trainer who teaches a course for a long time, there are multiple trainers teaching the same course at the same time in the ToT model

- New participants watch an experienced trainer teach, complete exercises, and then practice teaching segments to other participants.

ToT Training Procedure



Course Outline ~ Web GIS

Conceptual study

- Concept of web GIS
- Data sharing
- Capability of web GIS
- Examples of web GIS system

xx min

1

Assignment

To reinforce comprehension

3

Q&A

To answer trainees' questions

4

2

Detailed tutorial

Basic
- Explore maps on the web
- Create a thematic map using NSDI data
- Publish and share a thematic map
- Create app

Advance
- Collaborate with other users (collaborative edit)
- Combined use with desktop GIS
- Mobile GIS (Survey 123)
- Spatial Analysis
- Edit a layer (create new layer and edit the existing layer)

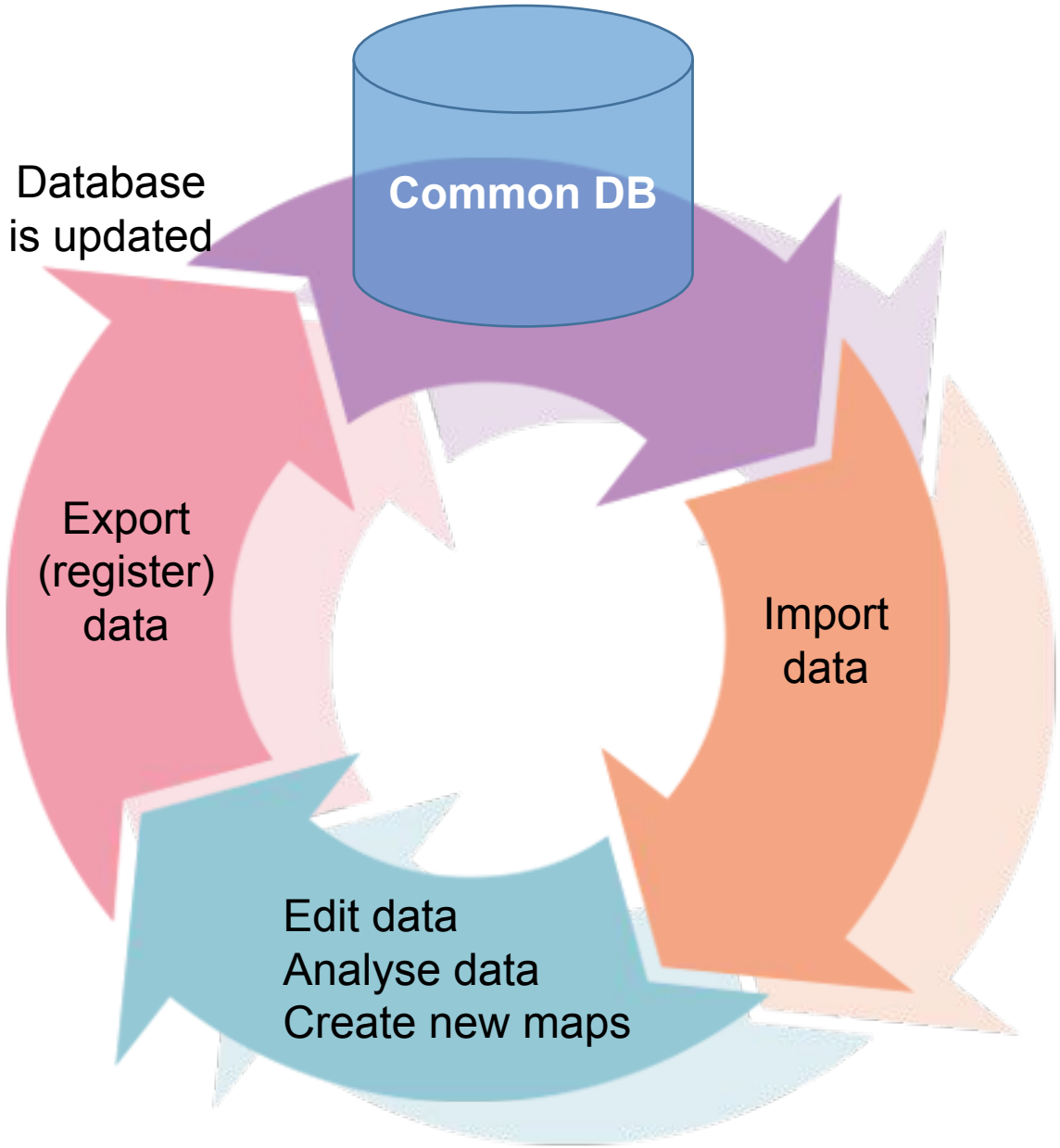
Consideration
Scenario & data

Agenda

- About NSDI
- What we can do with NSDI
- Difference between NSDI and ordinary open data
- List of NSDI datasets
- What is metadata?
- Introduction on concepts of web GIS, Data sharing - How to access NSDI data (ArcGIS online for practice)
- Examples of web GIS system
- General function of web GIS - Capability of web GIS
- Introduction on application builder
- Development of training course and management of training course
- Training records of respective organizations given within the NSDI project period (at least 20 people in total)

Activity Flow of NSDI Users

Cyclically repeat this process.
Our exercise may do 2 cycles.



Major Objectives of NSDI

1. Eliminate duplicate investment in Geographic Information

2. Improve efficiency in the work using other agency's data

3. Infrastructure for creating new industries and new services

Metadata

Metadata: data or information about a data.

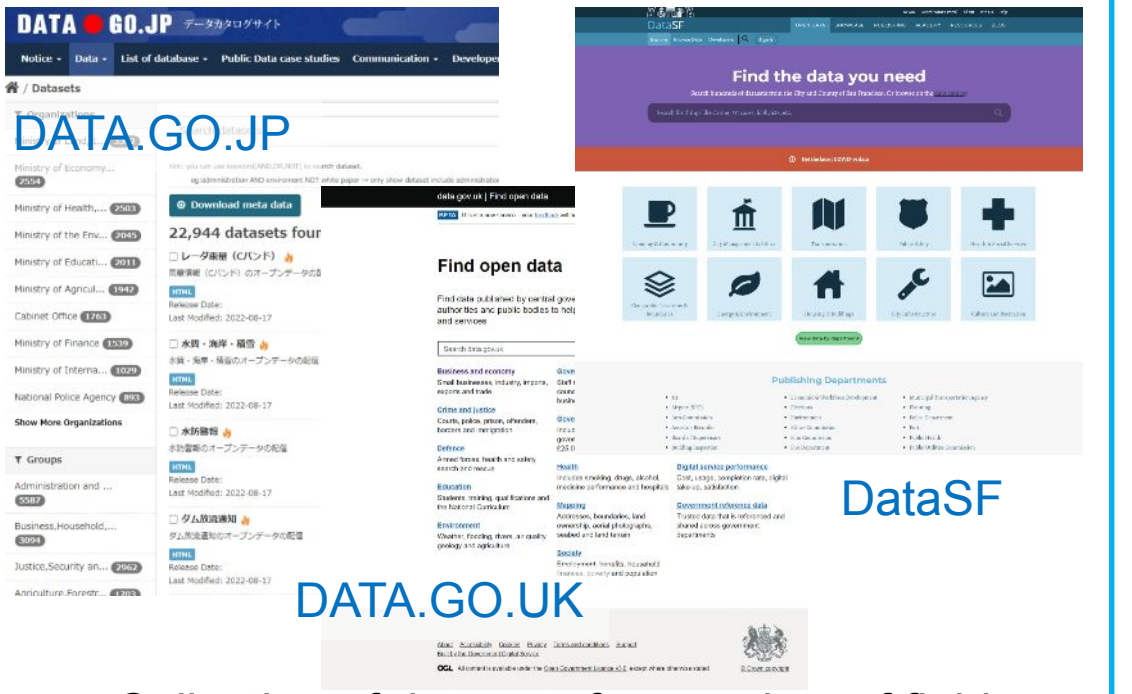
of your data

Who	• created the data? • manages the data?
Where	• is the study area? • can I access the data?
What	• is the data content? • source data was used?
How	• was the data created? • is the data distributed?
When	• was the data created? • When was it last updated?
Why	• was the data created?

NSDI and Open Data

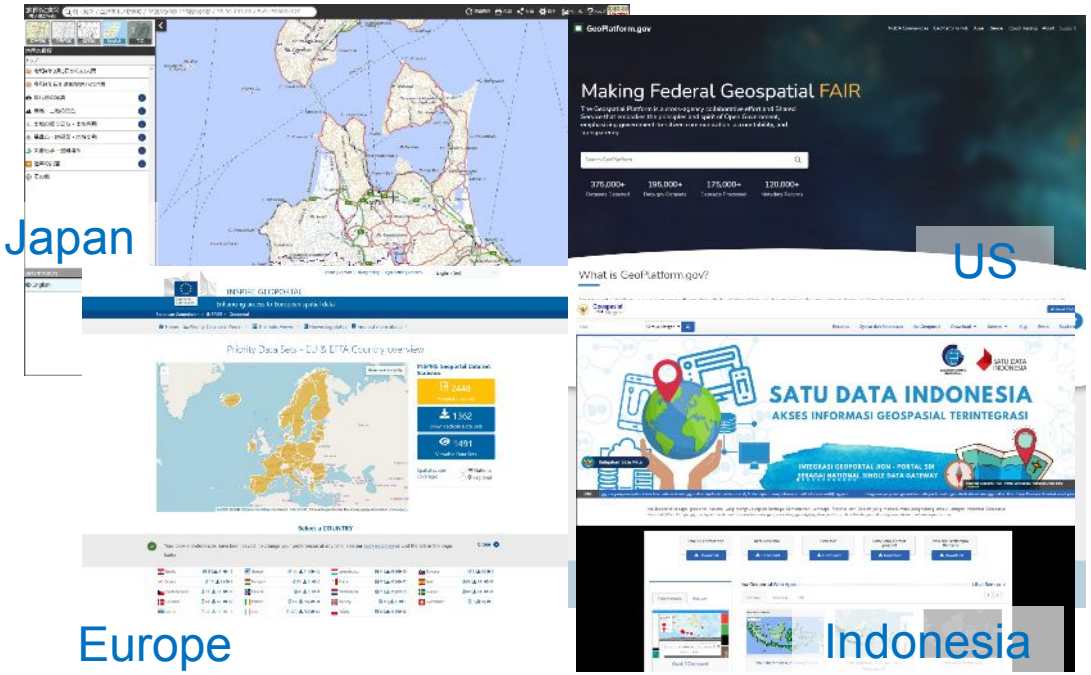
- Open data > SDI
  - NSDI is one kind of Open data, but specialised in Spatial data

Open data site



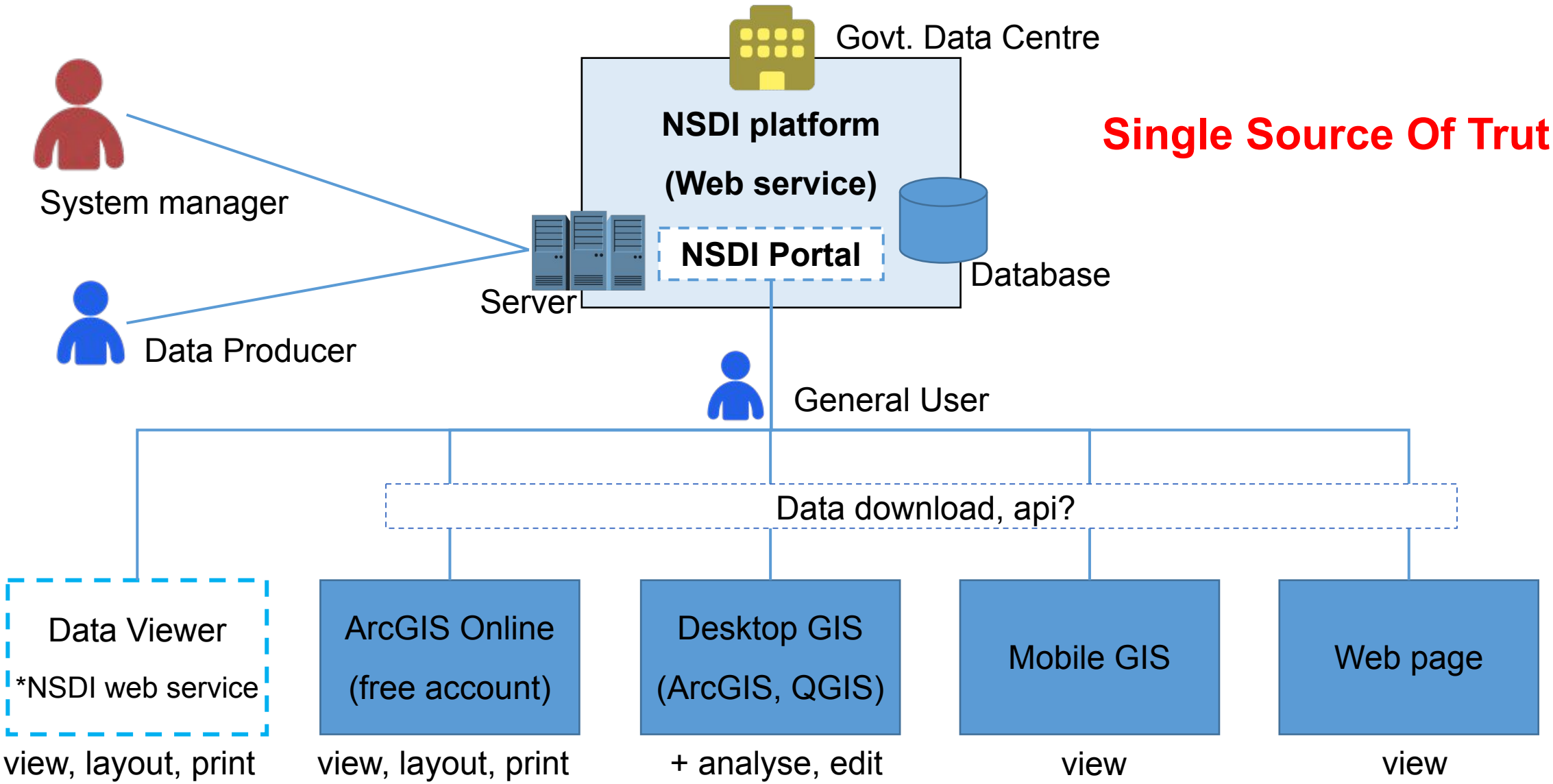
- Collection of datasets from variety of fields
- Search, download, etc.
- Contribution from public & private sectors

SDI



- Collection of spatial data + tools
- Search, download, view, etc.
- Most data are provided govt. / local govt.

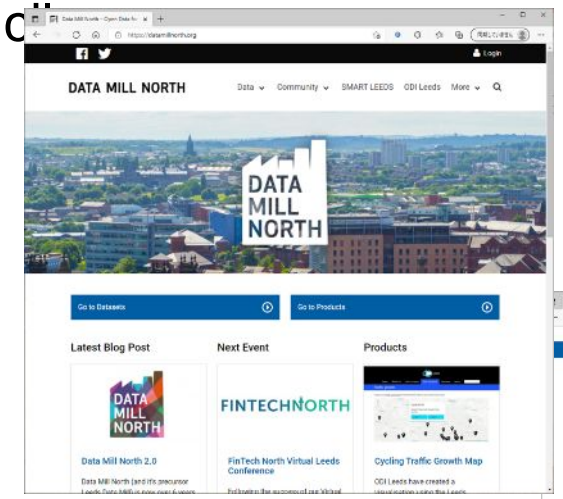
Type of Data Access



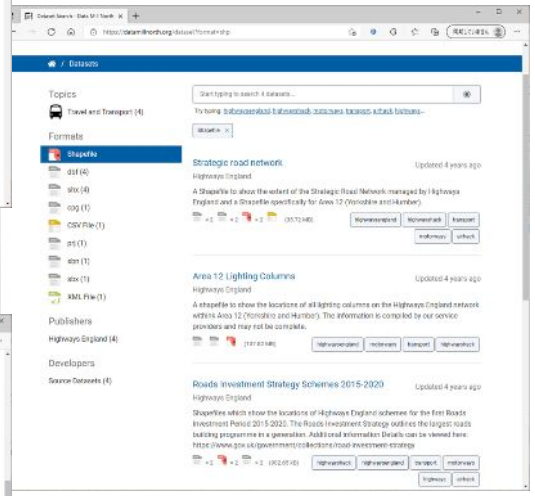
Example of NSDI : Data Mill North of Leeds, UK

- A collaborative website set up by Leeds City Council
  - Today, other cities use this platform as their data repository
- First platform in the UK that brings together Open Data information from multiple sectors across the city
- Harness the skills and creativity right across the entire region
- Data quality and consistent data standards are also a top priority
- Future collaboration with Greater Manchester and Greater London

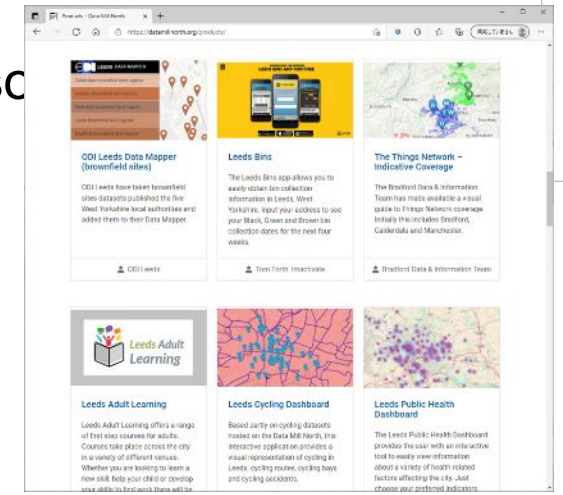
https://datamillnorth.org/



Portal site
(more than 1m page view since launch)

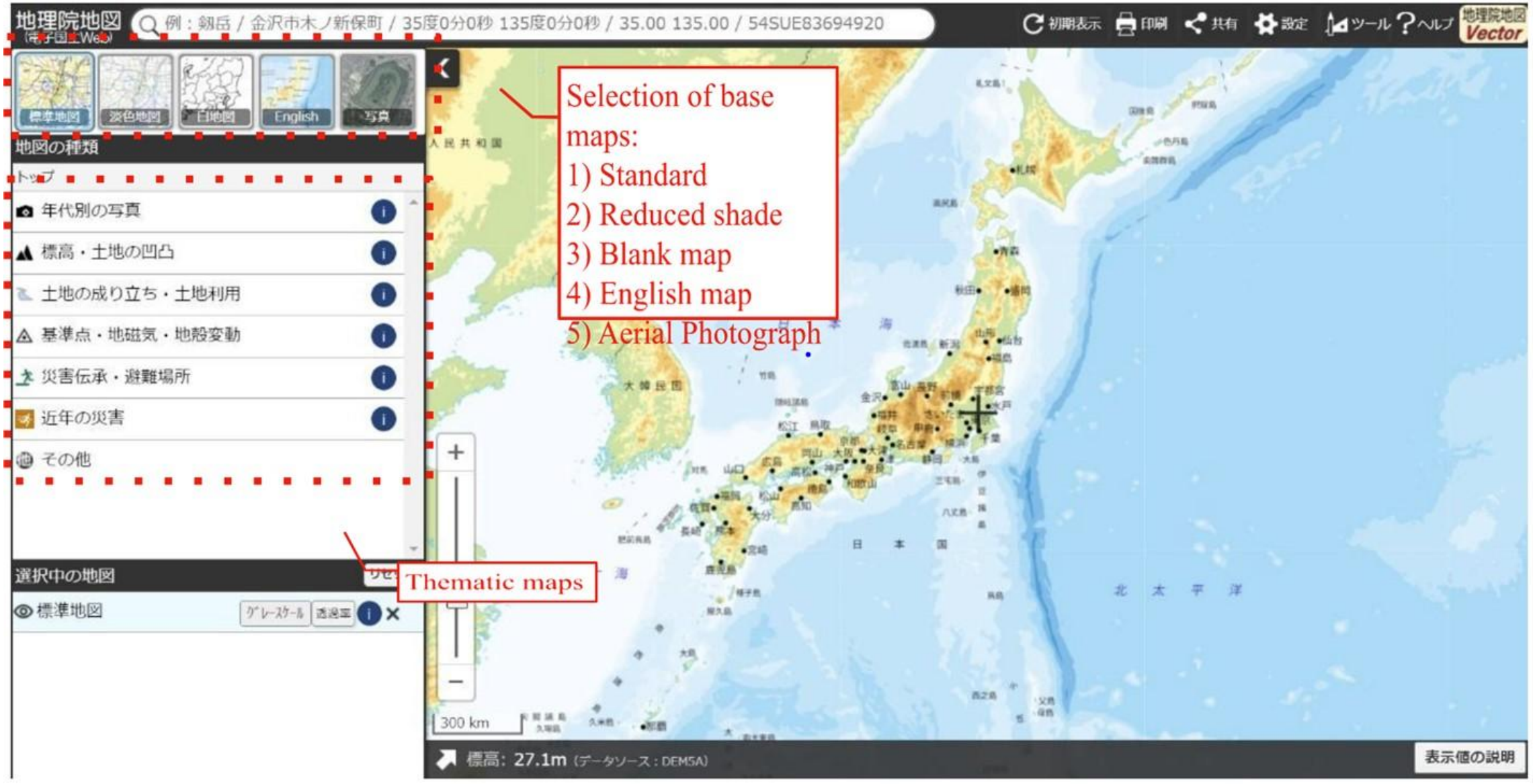


Data repository
(580 published data)

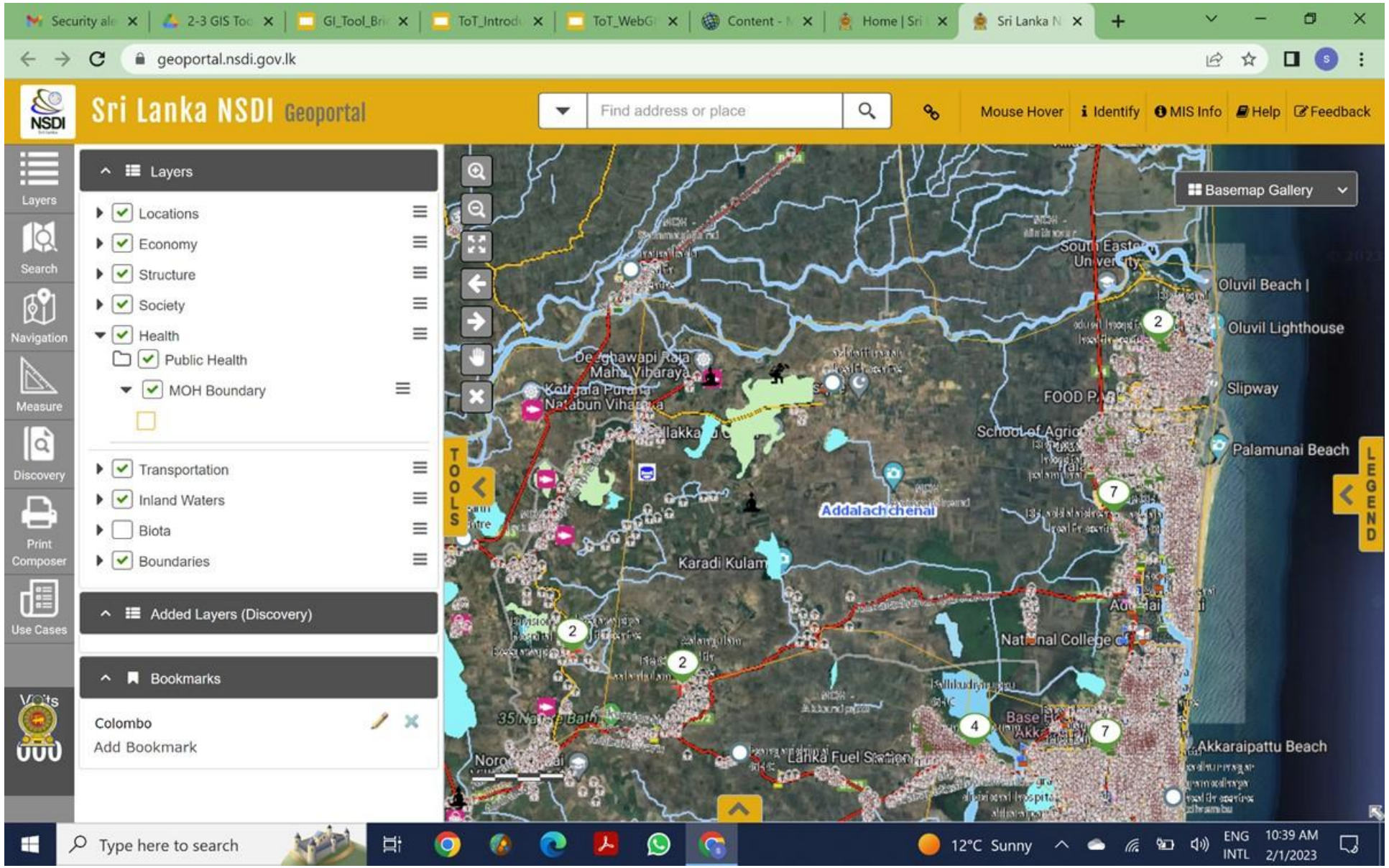


Applications

Example of NSDI : GSI Maps of Japan



Example of NSDI : Sri Lanka NSDI Portal since 2016



General Function of Web GIS - Capability of Web GIS

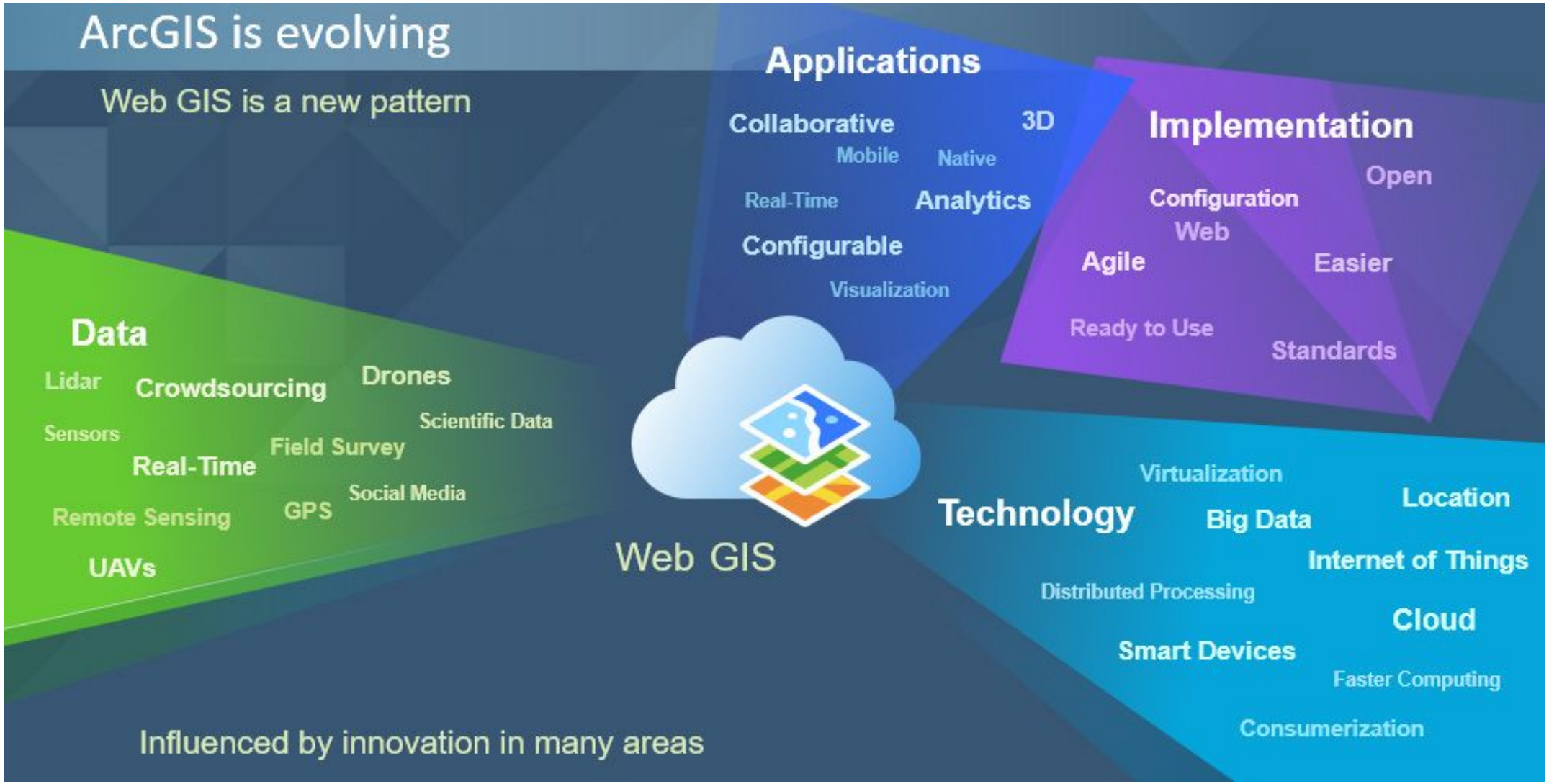
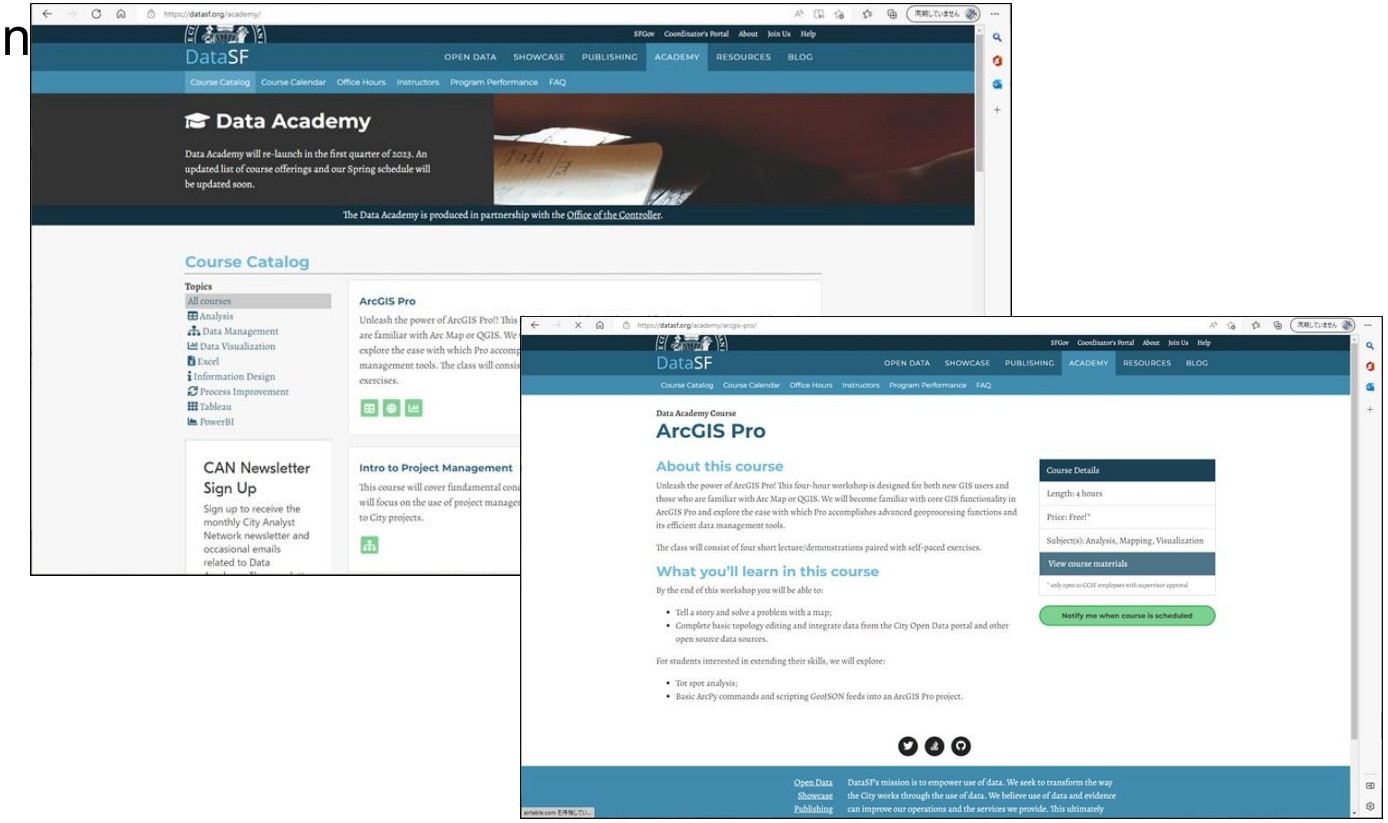


Image source: http://www.esri.com/about/newsroom/wp-content/uploads/files/2016/06/webgis2.jpg

Course Management

- Management office shall facilitate and maintain

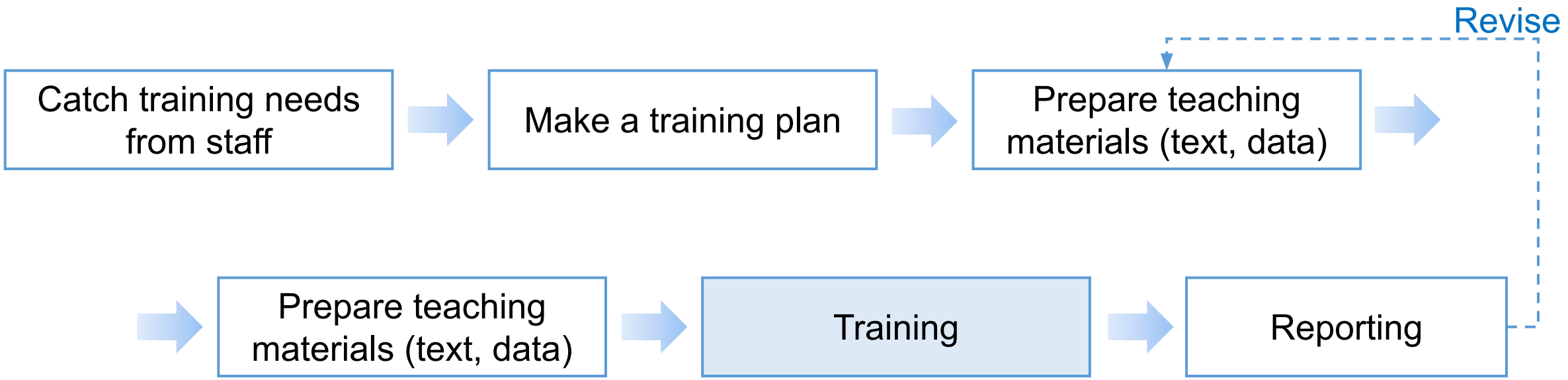
  - Registration of new course
  - Course catalogue
    - Available course (content, duration
  - Course calendar
  - Contact
  - Trainers (Human Resource)
    - Trainers and available courses
  - FAQ



Further Development of Training Program

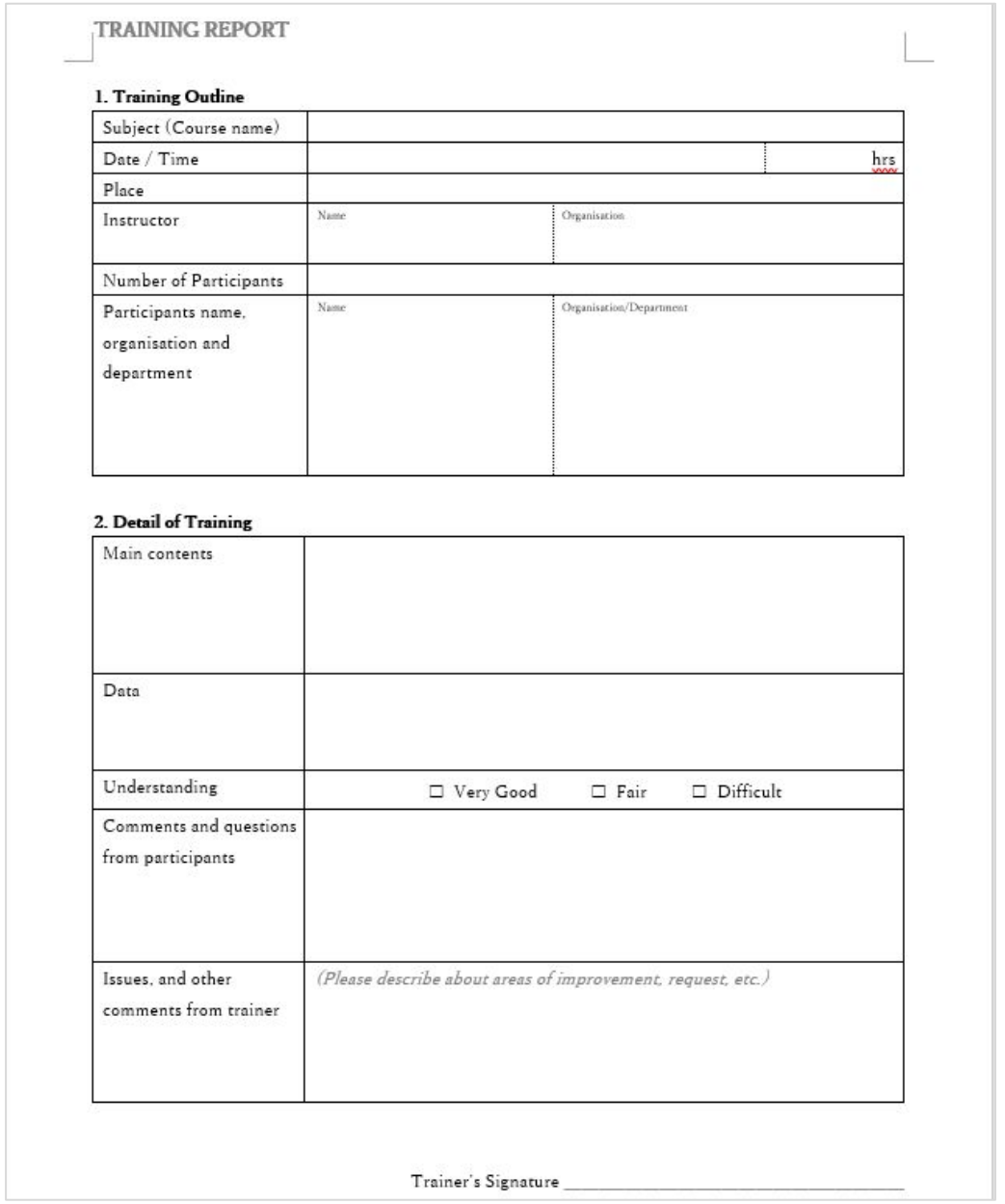
- Each agency can independently create new courses
- Contributing developed training resources is encouraged
- NSDI project team offers advice to develop training courses

How to organise a new training



Training Report

- During the period of NSDI project
- Feedback from participants is beneficial to improve the quality of training
- Sharing the report to NSDI team is encouraged to catch requirements from users
  - NSDI project team will occasionally organise ToT meeting to share the experience



TRAINING REPORT

1. Training Outline

Subject (Course name)		
Date / Time		hrs
Place		
Instructor	Name	Organisation
Number of Participants		
Participants name, organisation and department	Name	Organisation/Department

2. Detail of Training

Main contents	
Data	
Understanding	☐ Very Good ☐ Fair ☐ Difficult
Comments and questions from participants	
Issues, and other comments from trainer	*(Please describe about areas of improvement, request, etc.)*

Trainer's Signature _____

Updated : 05.Jan.2023