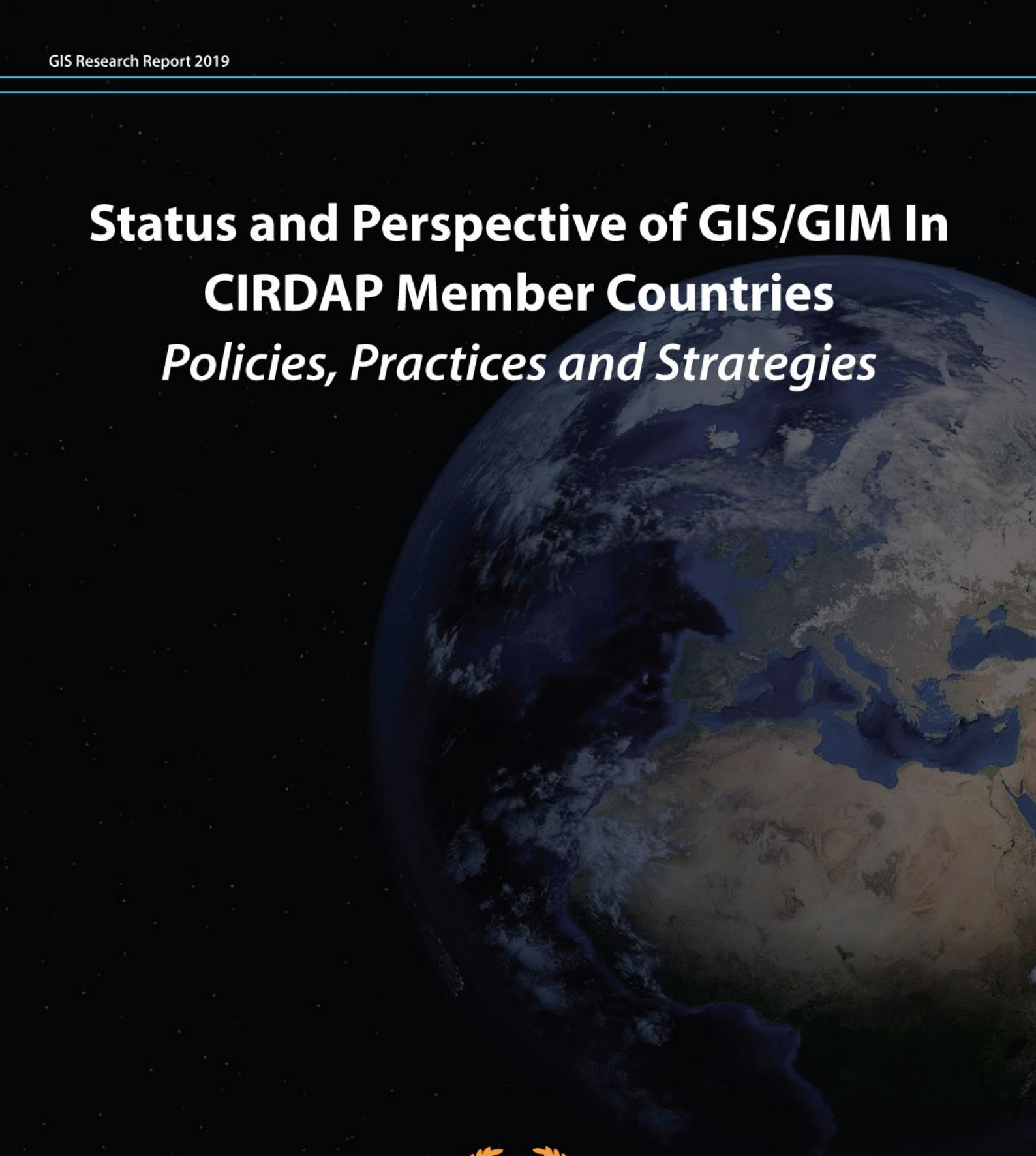
Status and Perspective of GIS/GIM In CIRDAP Member Countries

Policies, Practices and Strategies



CIRDAP

Centre on Integrated Rural Development for Asia and the Pacific

Status and Perspective of GIS/GIM in CIRDAP Member Countries
Policies, Practices and Strategies

CIRDAP Publication

CIRDAP

CENTRE ON INTEGRATED RURAL DEVELOPMENT FOR ASIA AND THE PACIFIC

GIS Research Report 2019

Status and Perspective of GIS/GIM in CIRDAP Member Countries

Policies, Practices and Strategies

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Foreword

It is important to have a strong information base as a platform to effectively plan, implement, monitor and evaluate development activities. More so, when the area where these development activities are targeted is remote, backward, poverty stricken, has a rural characteristic and with people whose abilities and experience to utilize and harness the development process is itself low.

GIM/GIS is proving to be very good platform in spatial technology tool for understanding earth features, planning for resource optimization, generation of decision alternatives, real-time monitoring and a host of related work, which has great potential in effective planning, management, monitoring of development initiatives, and policy support measures across CMCs.

The system has already created an enormous impact on virtually every field of activity that requires management and analysis of spatially distributed data. In particular, it has great potential to be the revolutionary technology to accelerate the sustainable development in the Asia and the Pacific Countries.

Some countries in the region have significantly progressed in this direction, whilst others are still in their infant stages. In the recent past, some countries in the CMCs, in which GIM has emerged as an effective tool in designing rural development programmes, with focus on sustainable poverty reduction and environmental conservation. The importance of the spatial dimension in assessing, monitoring and modeling various issues and problems related to sustainable management of natural resources is recognized all over the world.

This report express and analyse policies and programs, Data infrastructure, and structuring and best practices alternatives used by CMCs in order to make an inclusive Geospatial information technology for the Country's development.

I hope this report will be useful for the policy makers, researchers, development practitioners and other stakeholders working for rural development using GIS technologies in the Asia-Pacific region and beyond. I also hope that CIRDAP Member Countries will take heed of some policies and good practices shared in the Report.

Mr Tevita GB Taginavulau
Director General, CIRDAP
Dhaka, June 2020

Acknowledgement

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This report would have been impossible without the active support, suggestions and inputs from CIRDAP link institutes and link ministries. We sincerely acknowledge the organizations and the individuals whose articles, analysis and photographs have been used or consulted while preparing this report.

The Report has drawn extensively from the information and reports prepared by many international and regional organizations and research institutions. The preliminary ground-work of the report was done by Mohd Shanawaz Kashif, Project Scientist, Dr. Rajesh, Project Scientist, Mr. Sahara Bisoyee, Intern. Later, the report was shaped by the Editorial Team consisting of Mr. Tomasi V. Raiyawa, Strategic Planning Officer, Mr. George Chandra Babu, Program Officer, Research, Ms. Rafia Islam, Executive Officer, and Ms. Hurain Jannat, Communication Officer.

We acknowledge the continuous advice of our Director General, Mr Tevita GB. Taginavulau to ensure that this report materializes. Acknowledgement is also directed towards staff members in the Research Division for compiling the report; staff in the Office of the Director General in the final editing process.

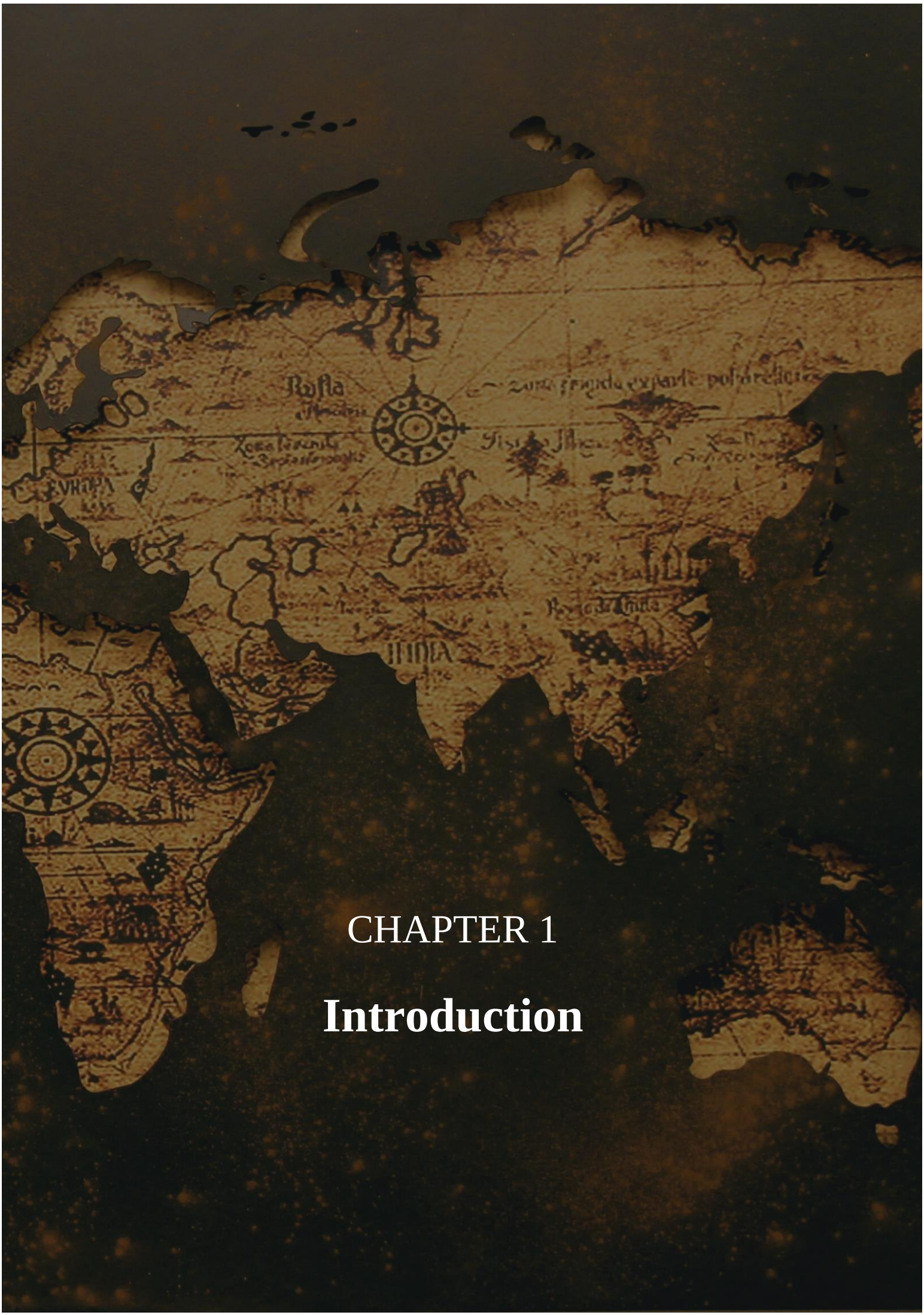
Contents

List of Tables, and Figures

Abbreviations and Acronyms

ADB	:	Asian Development Bank
AGCHO	:	Afghanistan Geodesy and Cartography Head Office
AGICC	:	Afghanistan Geo-Informatics Coordinated Committee
APSDI	:	Asia-Pacific Spatial Data Infrastructure
ARMM	:	Autonomous Region in Muslim Mindanao
ASDI	:	Afghanistan Spatial Data Infrastructure
BIG	:	Badan Informasi Geospasial
BRIS	:	Birth Registration Information System
CDE	:	Centre for Development and Environment
CIRDAP	:	Centre on Integrated Rural Development for Asia and the Pacific
CMCs	:	CIRDAP Member Countries
CSO	:	Central Statistics Office
CSW	:	Catalogue Service for the Web
DEM	:	Digital Elevation Model
DENR	:	Department of Environment and Natural Resources
DST	:	Department of Science & Technology
FDS	:	Fundamental dataset
FGDS	:	Fundamental geographic data set
GCP	:	Ground Control Points
GDPSS	:	Geospatial Data, Products, Services and Solutions
GIS	:	Geographic Information System
GISTDA	:	Geo-Informatics and Space Technology Development Agency
GIT	:	Geospatial Information Technologies
GNSS	:	Global Navigation Satellite Systems
GPS	:	Global Positioning System
GWS	:	Geospatial Web Services
IRD	:	Integrated Rural Development
ISO	:	International Organization for Standardization
ISRO	:	Indian Space Research Organization
iTLTB	:	iTaukei Land Trust Board
JICA	:	Japan International Cooperation Agency
JUPEM	:	Jabatan Ukur dan Pemetaan Malaysia
LAN	:	Local Area Network
LIS	:	Land Information Systems
LUC	:	Land Use Class
MaCGDI	:	Malaysian Center for Geospatial Data Infrastructure
MEMR	:	Ministry of Energy and Mineral Resources
MHA	:	Ministry of Home Affairs
FAO	:	Food and Agriculture Organization
MYGDI	:	Malaysia Geospatial Data Infrastructure
NAMRIA	:	National Mapping and Resource Information Authority
NCC	:	Iran-National Cartographic Center

NCGISU	:	National Council of GIS Users
NDCDB	:	National Digital Cadastral Database
NDEM	:	National Database for Emergency Management
NGD	:	National Geographic Department
NGIIP	:	Nepal-National Geographic Information Infrastructure Programme
NIRDPR	:	National Institute of Rural Development and Panchayati Raj
NMO	:	National Mapping Organization
NSDI	:	National Spatial Database Infrastructure
NTDB	:	National Topographic Data Base
OGC	:	Open Geospatial Consortium
OSM	:	Open Series Maps
PC-GIAP	:	Permanent Committee on GIS Infrastructure for Asia and the Pacific
PGIS	:	Participatory GIS
PNSDI	:	Philippines' National Spatial Data Infrastructure
PAK-NSDI	:	Pakistan National Spatial Data Infrastructure
PPGIS	:	People Participatory GIS
PSI	:	People's Science Institute
R&D	:	Research and development
RS	:	Remote Sensing
RTSD	:	The Royal Thai Survey Department
SATCOM	:	Satellite communication model
SDG	:	Sustainable Development Goal
SDI	:	Spatial Data Infrastructure
SNGS	:	Strengthening National Geographic Services
SOB	:	Survey of Bangladesh
SOI	:	Survey of India
SOP	:	Survey of Pakistan
SRSAC	:	State Remote Sensing Application Centers
SWOT	:	Strengths, Weaknesses, Opportunities and Threats
TISI	:	Thai Industrial Standard Institute
UCV	:	Unimproved Capital Value
UN-GGIM	:	Global Geospatial Information Management
USGS	:	United States Geological Survey
WFS	:	Web feature services
WMS	:	Web Map services
WMTS	:	Web Map Tile Service
WPS	:	Web Processing Service



CHAPTER 1

Introduction

Chapter 1

Introduction

Geographical Information System (GIS) has developed remarkably over the last two decades and will play a vital role in the development of nations in the 21st Century, after which many countries have formulated their strategic development plan for the application of GIS technology with huge financing efforts. Now it is time for all the decision-makers to discuss GIS technology and its applications for rural development, natural resource management, urban development planning, Land information system, suitability for agricultural development and educational infrastructure development, with special emphasis on rural areas.

Information technology has emerged as an indispensable event that affects every ride of people's lives in all sections of this society. With the ease of availability of huge computing power and with great volume and convenient access to the diversity of data and information, the structure and functions of all human organizations will be deeply transformed in this century. The nations are engaged in exploiting this phenomenon for its many socio-economic needs. One area, which is engaging serious attention, is related to the use of information technology in the administration system, especially equipment and techniques for the acquisition and management of data related to GIS.

1.1 Background

The Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP) is an Intergovernmental Organization mandated to promote Integrated Rural Development (IRD) in Asia-Pacific through regional cooperation. CIRDAP has 15-member countries namely Afghanistan, Bangladesh (Host State), Fiji, India, Indonesia, Iran, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam.

The Centre's goal is to meet the felt needs of the developing countries and act as a servicing institution for promoting Integrated Rural Development (IRD) in the region. CIRDAP promotes regional cooperation, operating through designated contact ministries and link institutions in member-states and plays a supplementary and reinforcing role in supporting and furthering the effectiveness of IRD programmes in Asia and the Pacific region.

Capturing emerging challenges in rural development, CIRDAP undertakes researches to identify gaps in GIS implementation to address the rural development policies, practices and challenges amongst member countries.

We were intended to produce a report comprising the analysis of policies, programs, Data infrastructure, and structuring and best practices alternatives used by CMCs in order to make an inclusive Geospatial information technology for the Country's development.

As intended, this report comprises of the findings on gaps and best practices findings based on the analysis of the Data infrastructure, Institutional Advancement, GIS application diversification, policies, programs and alternatives being implemented in CIRDAP member countries in the context of CIRDAP's Focus areas (CIRDAP, Website).

1.2 Relevance of the Study

The use of geospatial information is increasing rapidly. There is growing recognition between the government and the private sector that understanding of location and place is an important component of making effective decisions. The geographical information in which there is no recognized expertise who are not likely to be familiar with the term, are increasingly using and talking with geospatial information. In some cases, they are contributing to their collection (John Carpenter and Jevon Snell, 2013).

It is believed that various CMCs are at very different stages in country development, geospatial-data infrastructure and sophistication analysis of the data to generate valuable information. It is an inevitable truth that all CMCs will not be in position to invest and realize the full capacity of Geo information for their county government, business and citizen's needs.

The current research is investigating the process of GIS implementation in CMCs, while putting the research in the context of a developing country. The term "implementation" is understood as the process through which communities of users within an organization setting become aware of, adopt and use GIS tools and techniques for the development purpose at macro & micro-level. It is focused on three stages of GIS implementation process: initiation, execution and stabilization, by examining in detail the actions and perceptions of GIS users and the organizational context within which these actions take place. It explores a range of factors – social, political, economic, cultural and technological which pattern the process of GIS implementation.

1.3 Research Scope and Objectives

The objective of this research is to contribute evidence and analysis that will improve understanding of spatial database infrastructure, Geospatial policies, institutional advancement and GIS Best practices for Geospatial technology implementation in CMCs. The research included comparative analysis alongside in-depth studies of programmes and policy initiatives. Findings will contribute to the evidence of what alternative Practices, Data

structure utilization, Policies and Institutional arrangements to deliver improved Geospatial information application development outcomes in CIRDAP Focus area contexts within the contemporary global context.

The Research Goals are:

1. **Investigate the Process of GIS implementation in CMCs:** In this research the concern area is the process of GIS implementation in the dimension of Why? How? And By Whom? GIS is implemented.
2. **Find the Best practices of GIS in Different Government and Private sector in Asia and Pacific:**

a. The categorization and exploration of best practice will be in accordance with the five CIRDAP Focus area mentioned below and their respective concerned targets:

   (i) Sustainable Development and Efficient use of Natural Resources;

   (ii) Livelihoods;

   (iii) Access to basic Services;

   (iv) Climate Change and Impact; and

   (v) Governance.

b. The research is addressing a range of questions related to the following themes:

   (i) How GIS can be implemented with SDGs in CMCs?

   (ii) What is the Status of National Spatial Data Infrastructure in CMCs?

   (iii) What is the Status of National Geospatial Policies in CMCs?

   (iv) What is the Status of National Mapping Agencies and Governments' recent initiatives?

   (v) What are the existing Best practices in different Government and Private sectors in Asia and Pacific?

   (vi) SWOT analysis of GIS in terms of Policies, Management, Infrastructure, Hardware and Software of GIS, Data sharing and Education.

1.4 Methodology and Approach

Literature review (Research reports, country profile, annual reports, seminar reports, books, articles, and official websites) through the internet mainly used to collect updated and quality data as well as information. The study has been formulated following a well-thought-out and endorsed study outline. However, the outline further attuned to the inclusion of country specificities and nuances. The findings of CMCs have been collated within an analytical framework to inform the policy links.

The research project involves the comparative analysis of Policies, management, infrastructure, fundamental datasets, and Data sharing as well as their wider

institutional and agency linkage arrangements, in selected emerging /developing countries. It will include thematic studies, cross-country comparative work and in-depth GIS programs on selected countries. Comparative research is carried out in countries where significant changes have occurred in recent years in GIS implementation and diverse applications, and which are potentially important to conduct shared ideas and experiences in the CMCs in terms of conceptualization, implementation, and adaptation.

1.5 Organization of the Report

The Report is structured in eight chapters. After the brief introduction:

(i) Chapter two gives an overview on the compliance of GIS implementation in CMCs with SDGs;

(ii) Chapter three gives an overview of NSDI and a brief about geospatial data, metadata, clearinghouse, standards, framework and partnerships;

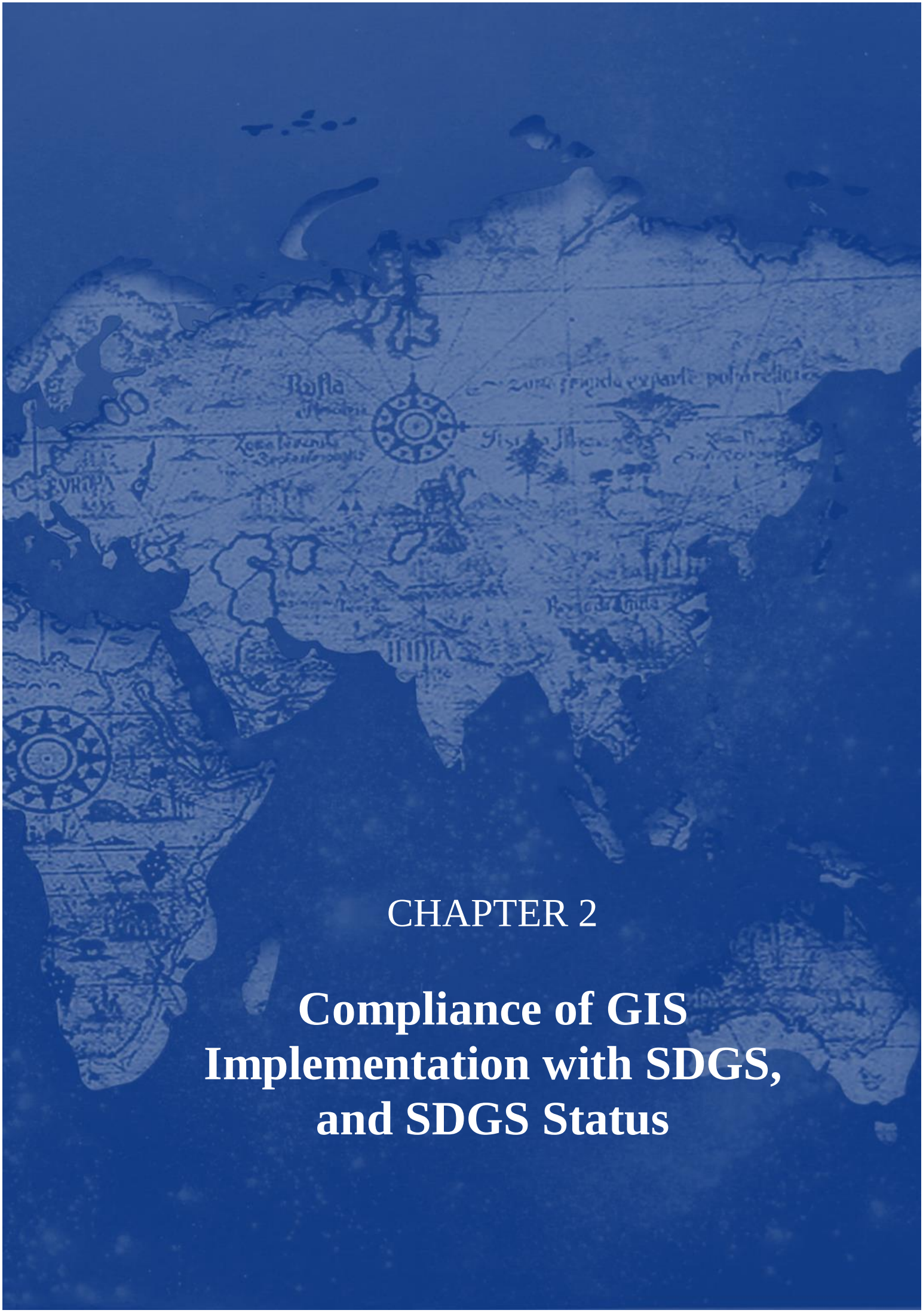
(iii) Chapter four introduces the relevant Geospatial policies existing in CMCs that face challenges in relation to lack of availability, quality, accessibility, and sharing of geospatial data;

(iv) Chapter five gives a brief account on the Status of National Mapping Agencies and their infrastructure, database and governments' recent initiative in geospatial development;

(v) Chapter six deals with the Good practices adopted or implemented by the Government and private organizations of CMCs; and

(vi) Chapter seven gives a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis; and identifies the Gaps in terms of Policies, management, infrastructure, hardware and software of GIS, and Data sharing.

Findings will contribute to the evidence of what alternative Practices, Data structure utilization, Policies and Institutional arrangements can deliver improved Geospatial information application development outcomes. Chapter eight concludes the discussion and make recommendations.



CHAPTER 2

Compliance of GIS Implementation with SDGS, and SDGS Status

Chapter 2

2.0 Compliance of GIS implementation with SDGs, and SDGs Status

2.1 Compliance of GIS implemented with SDGs in CMCs

Geospatial information is spatial data referenced to a place—a set of geographic coordinates—that can often be collected, managed, and visualized in real time. A Geographic information system (GIS) is a computer system capable of capturing, storing, analyzing, and displaying spatial data. In recent years, client demand has increased for geospatial information and for tools like GIS. Geospatial Technology helps to monitor any spatial data that is needed for development activities. These data includes; climate change, natural resource, bio diversity, education, welfare, food security, life style or patterns amongst others.

The GIS data collected using satellite is used to monitor or analyze the ground situation to give quick and proper solution. For example , using geospatial technology , effect of climate change can be monitored and give timely alert to improve natural resource management and there by prevent threat to bio diversity Similarly, satellite mapping and data analysis provide real time information on resources allocation and consumption. Also, it can be used to increase the crop production and reduce hunger. Drones can be sent to a farm in order to monitor crop growth, irrigation problems, soil variation, and insect infestation and fungal infection.

HOW CAN GIS BE IMPLEMENTED ON EACH SUSTAINABLE DEVELOPMENT GOAL?

There are 17 Sustainable Development Goals (SDG) set by the United Nations Development Program. These goals are broad and mutually dependent, yet each has a separate list of targets to achieve. SDG has included issues of social and economic development including poverty, hunger, health, education, gender equality, water, cleanliness, global warming, energy, urbanization, life below water, life on land, environment and social justice (Sustainable Development Goals, UN).

2.1.1 No Poverty

SDG has started, and by 2030, it is boldly committed to end poverty in all forms and dimensions. One in seven of us live in extreme poverty (Goal 1, Global Partnership for Sustainable Development Data). Ending this will be the biggest global challenge but this is possible only when we know where the people living in poverty are and what they want.

With the help of GIS, the Poverty level of the community can be assessed and even area which needs different level of development can be elucidated. This

includes services, employment opportunity, livelihood opportunity and etc. The struggle that takes place in the day-to-day life can be recorded and analyzed for developing poverty alleviation programme.

Poverty Map can provide information about the poor and weaker people, agro-ecological regions, marginal or productive land, major food crops, livestock production systems, market access, and livelihood systems.

2.1.2 Zero Hunger

This goal of SDG is to end all forms of hunger and malnutrition by 2030, ensuring that all people - especially children - have access to adequate and nutritious food throughout the year. It includes promoting sustainable farming practices: supporting small-scale farmers and allowing equal access to land, technology, and markets.

GIS can be used to make more effective and efficient farming techniques. It can be employed to analyze soil, water, air quality and used to determine the best crop for planting and nutrition required for crop best performance.

With the help of mobile GIS, farmers can also be updated weather conditions, market price etc. GIS can also help in the strategic planning of organic pest control and management of inorganic fertilizer application, and other agricultural inputs. Using GIS, suitable location for collection of harvest, storage and distribution can be easily identified.

It is fully integrated and widely accepted to helping government agencies to support farmers and manage the programs that protect the environment. This can increase food production in different parts of the world so that the world food crisis can be nullified.

2.1.3 Good Health and Well Being

In this sector, GIS can be used to collect and overlay different data layers like blood group, hospitals, ambulance etc. In the field of healthcare, we may have centralized information on health clinics and spread of disease, as well as data from individuals and families. These databases help us in obtaining information about the health and welfare of a region and its residents and can also help the Government, to better target their services to improve health services of a particular region.

Every day hundreds of women die during pregnancy or from childbirth related complications (Sustainable Development Goals, UNDP). In many rural areas, only few births are handled by skilled professionals. Maternal death and neonatal death data can help eliminate maternal and newborn mortality through GIS technique.

2.1.4 Quality Education

Education is one of the most powerful and proven vehicles for sustainable development. This goal ensures that all girls and boys complete primary and secondary schooling by 2030. It also aims to provide equal access to affordable vocational training, to eliminate gender and wealth disparities, and achieve universal access to a quality higher education (Sustainable Development Goals, UNDP).

GIS can be used to determine that how many children are enrolled, their level of education, and the number of teachers in primary, secondary schools and even in higher level.
GIS can also be track the development of educational facilities, and to determine whether there are adequate facilities for education in a particular area. All the spatial data related to education can be combined for better understanding of which villages and in what area of education are need to be strengthened. The network analysis tools in GIS make these assignments easy to perform and interpret.

2.1.5 Gender Equality

Elimination of all forms of discrimination against women and girls is not only a basic human right but also important for accelerating sustainable development. The SDG goal is built on these accomplishments to ensure that discrimination against women and girls will end.

In some areas there are still differences in the labor market. Women are denied of equal access to jobs. Sexual violence and exploitation, unpaid care and uneven division of domestic work, and discrimination in the public office are all major obstacles.

It is imperative to measure gender differences in education, political empowerment, health and survival, and economic involvement and opportunity. It is targeted to study whether a girl is denied education or forced into marriage. Data is important in the fight for gender equality. Reporting violence against gender with geographical location allows the authorities to see where incidents occurred and resolve them. Further, data on gender-based discrimination can be used to develop and implement policies to overcome such discrimination.

GIS also has the ability to see land ownership, school enrollment, health services and other relevant factors through gender-specific lenses. This will help agencies working against sexual harassment to keep such incidents under check through relevant government department and other agencies.

2.1.6 Clean Water and Sanitation

In many countries around the world, the government does not know the exact number of people who have access to clean water and sanitation or even where they live (Sustainable Development Goals, UNDP). In order to invest in water and sanitation for these communities, we need basic data.

With the help of GIS technology, data on water resources (well, hand pump, cisterns, canal etc.) and water consumption can be collected and visualized. GIS can also help in understanding how water is consumed, and how to prevent drinking water wasted or contaminated. This data can be used to develop a target specific programme and expanded to the whole community or country. With the help of GIS, collected annual rainfall data, and the calculated potential amount of water flow can be stored in appropriate places for proper use. GIS technology allows finding proper location for dumping garbage and individual waste, which will in turn prevent the contamination of drinking water sources.

2.1.7 Affordable and Clean Energy

Geospatial technology provides a mean for identifying and quantifying factors that affect the potential of available solar energy. In addition, it also helps in enriching the database. The spatial database helps in regional energy planning for resource availability and demand.
The development of renewable energy sites can be planned using GIS. Potential locations can be examined and evaluated to maximize the effectiveness of energy collection. The analysis of a roof provides information on exact locations which receive maximum light during the day. Wind patterns and strength, tidal strength and river flows can be evaluated and assisted in helping more efficient, more targeted renewable energy development.

2.1.8 Decent Work and Economic Growth

Economists need precise decision-making tools that help them to analyze, demonstrate and disseminate results. These results are translated into simple terms for finding new businesses or developing existing ones. GIS technology has proved to be powerful and effective in delivering these capabilities to help economists initiate economic reforms and development. GIS tools provide a necessary platform for visualization, modeling, analysis and collaboration.

With GIS, many factors that contribute to economic development can be detailed and mapped. For example, data can be overlapped on all types of employment, average income, type of employment etc. in relation to each other, where economic and employment growth is happening. Successful policies can be identified and implemented in low performing area. GIS is a very marketable skill for a variety of employers, along with a technique. Teaching students to think geospatially (in terms of how data relates to other data on the ground) allows them to look at the whole world instead of different parts and see it completely.

2.1.9 Industry, Innovation and Infrastructure

When it comes to infrastructure, GIS can provide relevant and essential data. Without accurate population and population growth data it is difficult to predict the needs of future generation, such as schools, roads and hospitals and other infrastructures.

GIS can also generate socio-economic data to encourage innovation and business at the local and state level. This data can connect farmers with markets; and consumers with producers. It

can help to determine where any kind of infrastructure should be developed to get maximum impact of such development. The human resource development depends on availability of infrastructure facilities of an area or region which can be enhanced by application of GIS.

2.1.10 Reduce Inequalities

Inequality can have a strong geographical component and maps are a powerful tools to understand such factors. Maps can show the spatial distribution of age, gender, disability, race, origin, and religion, economic, social, or political inclusion. The data relevant to Public-policies can be used to analyze the current situation and offer new public policies.

GIS can provide fundamental knowledge for comparison factors for inequalities, which can be easily seen. Invisible factors and patterns of inequality can be found by overlapping or comparing data through GIS.

The difference between the rich and the poor increases every year. It is a sad fact that the poorest people are always left behind. Using the citizen data mapping tool, communities can be mapped and existing surveys can add people who are often excluded from these efforts. We can ensure that the data of poor people help in implementing policies to make society more equitable.

2.1.11 Sustainable Cities and Communities

Through GIS, we can know the number of people living in towns and cities across the country and especially those living in slums where the conditions are dire. GIS can measure the quality of water, air, transport and infrastructure in those cities through GIS. GIS can help to identify areas that are undeveloped in a particular region. Maps of crime, discrimination and disaster sensitivity are some examples of applicable GIS data which can be used for making policy and programme for undeveloped people. Through GIS we can not only predict the impact of projects but can actually visualize what is needed to move an area in the right direction.

2.1.12 Responsible Consumption and Production

Our understanding of consumption and production is often based on estimates and old figures. Without transparent systems, accurate population data, precise birth and mortality data, we cannot accurately predict the food and water requirements. GIS technology can be used to investigate the supply and demand in markets. Through this technique, we can identify areas where consumption and production are high and more effective methods of supply consumables to cities.

2.1.13 Climate Action

GIS technology can be used for environmental understanding, strategic decision making, monitoring climate change, forests strength and agriculture sectors. This valuable technique

can also be used to identify the present and future risks and the vulnerabilities due to climate change, and it can be helpful to design and implement optimization of operations.

GIS models can be useful in identification and implementing on of geographic plans and in environmental changes action plans. This technique makes it possible to provide GIS web-based applications for climate change identification and future climate predictions.

2.1.14 Goal 14- Life below Water

Marine and aqua life are threatened by global warming, extreme weather, natural and man-made pollution and excessive human disturbances. GIS technology is a tool that helps oceanographer to manage, analyze and visualize spatial and thematic marine data through map generation. It can be used to map the marine habitats, water quality, species distribution, population and behavior, fishing grounds and other factors that impact marine life (P. Michael, 2006).

Using satellite images, data collected through sonar and other remote sensing techniques can see life under water. ArcGIS software suite is a tool that can show at-risk areas in danger of biodiversity loss, habitat degradation, and resource depletion.

GIS technology can be used to determine spatial data for aquatic resource assessment and management system. It is widely used in the ocean industry sector and gets information about various commercial activities. This technology can promote sustainable fishing by collecting data on aquatic population, oil spill and other natural disasters, which can be mapped and their effects and patterns can be displayed.

2.1.15 Life on Land

Satellite and aerial imagery data are very important for studying land cover and land use changes. Satellite imagery taken over time is capable of providing useful information for changes due to land changes, biodiversity loss and desertification.

Reliable data on land use and land cover is required to face the destruction of the ecosystem. This data can be used to understand the actual cost of human action and to remove the effects of excessive use of land.

Mountains and coast are also in danger because the land is being exploited due to drought and flood which in turn causes food and water deficiency. Private organizations and governments related to these issues can collaborate with the help of ground data and work out to create new policies.

2.1.16 Peace and Justice Strong Institution

Without peace, stability, human rights and effective governance, based on the law - we cannot expect sustainable development. Some areas enjoy sustained levels of peace, security and

prosperity, while others fall into endless cycles of conflict and violence.

GIS can expose situations of inequality and provide the basics for true sustainable development through the comparison of the data. Information on governments, organizations and the private sector can all be available and comparable. Violence against children, human trafficking, sexual violence crime rates, income disparity, government projects and spending, and even corruption, can all be mapped, viewed and compared via GIS.

2.1.17 Partnership for the Goals

Today, the world is more interconnected than ever before. Improving access to technology and knowledge is an important way to share ideas and innovation.

National Spatial Database Infrastructure (NSDI) is a platform to share the spatial data, best practices and other information among the stakeholders and countries through GIS. The Successfully implemented programs in one place by sharing best practices can be implemented in another place. Through NSDI, information about successes and failures or policies and programs are widely available. The future development will affect all of us and we believe that GIS plays an important role in making comprehensive and collaborative decisions for a sustainable future.

GIS can provide data to meet global goals and commitments. Global partnership for sustainable development data brings governments, international organizations, private sector, civil society groups, and statistics and data communities together, which are dedicated to achieving global sustainable development goals in all areas of the world by 2030.

2.2 CMCs' SDGs Progress Report

This chapter presents an SDG index and dashboards for 14 CIRDAP member Countries on their attainment of the Sustainable Development Goals (SDGs). The report also provides a ranking of the Country based on the overall performance across the SDGs.

In 2018, Malaysia, Vietnam, and Thailand ranked first, second, and third on the attainment of the SDGs. whereas Afghanistan rank last among 14 CMCs and Fiji not included in the 2018 SDG Index due to insufficient data availability. All countries, in fact, must make significant progress if they are to achieve the SDGs by 2030.

The 2018 index overall findings include:

(i) No Country is on track to meet the corresponding SDGs by 2030;

(ii) Countries perform relatively well on SDG 1 (No Poverty), SDG 5, SDG 8, SDG 13 and SDG 14 Major progress is needed in fighting Zero Hunger (SDG 2), Good Health and Well-Being (Goal 3), Industry, Innovation and Infrastructure (Goal 9), Inequalities (Goal 10), Life below water (Goal 14), and injustice (Goal 16);

(iii) Most countries are making progress in ending extreme poverty, improving health and education outcomes and providing access to basic services, though not all countries are on track to meet the corresponding SDGs by 2030;

(iv) The index highlights structural inequalities in social, environmental, and economic outcomes within and across the countries that must be addressed in order to achieve the SDGs; and

(v) Ensuring that Countries do not leave anyone behind will require improved and inclusive spatial data collection. There is a particular need for improved data on Goal 17 (Partnerships for the Goals).

The SDG index score presents an overall picture of the extent to which countries are attaining the Sustainable Development Goals. For each indicator, country positions are rated between 0 and 100. A score of 0 signifies the worst performance and a score of 100 signifies the attainment of the respective SDG indicator. India's overall Index score (65) suggests that the country is on average 65% of the way to the best possible outcome across the 17 SDGs.

The overall results and rank are shown in Table (1) below. Malaysia ranks first, with the highest score, followed by Vietnam. At the lower end of the rankings, Afghanistan has made the least progress towards achieving the SDGs. Afghanistan will require significant efforts to get on track for 2030.

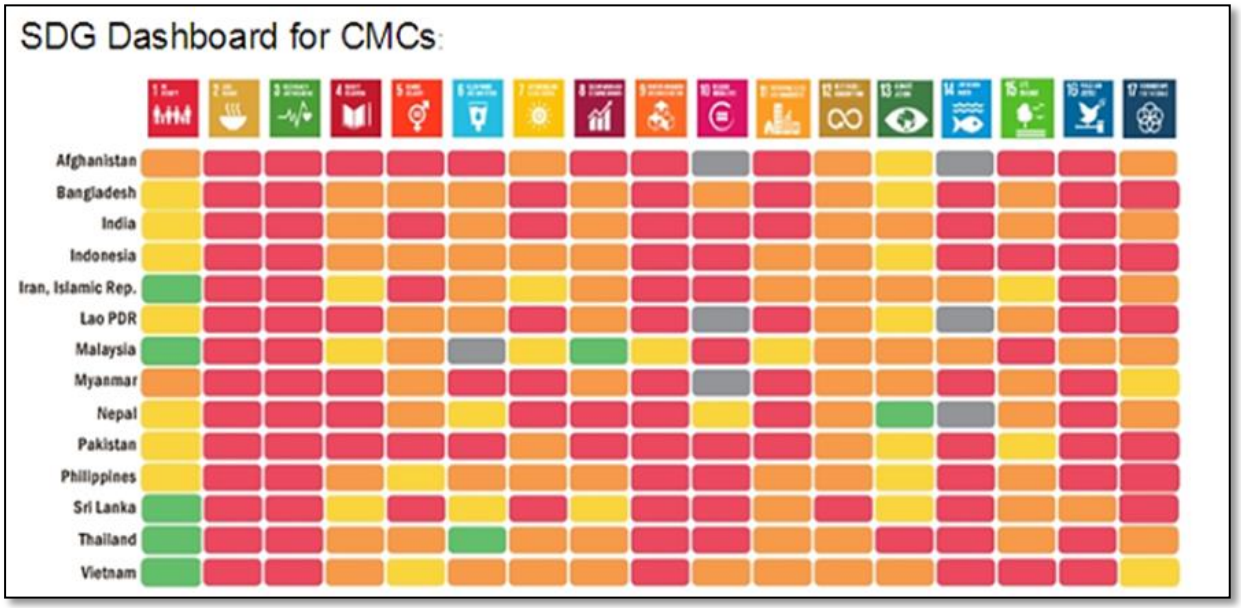
Country	Score	Rank
Malaysia	70	1
Vietnam	69.7	2
Thailand	69.2	3
Iran, Islamic Rep.	65.5	4
Philippines	65	5
Sri Lanka	64.6	6
Indonesia	62.8	7
Nepal	62.8	8
Lao PDR	60.6	9
Bangladesh	59.3	10
India	59.1	11
Myanmar	59	12
Pakistan	54.9	13
Afghanistan	46.2	14

(Table 1: CMCs SDGs Index)
(Source: SDG Index and Dashboards Report 2018)

- **Fiji is not included in the index due to insufficient data availability**

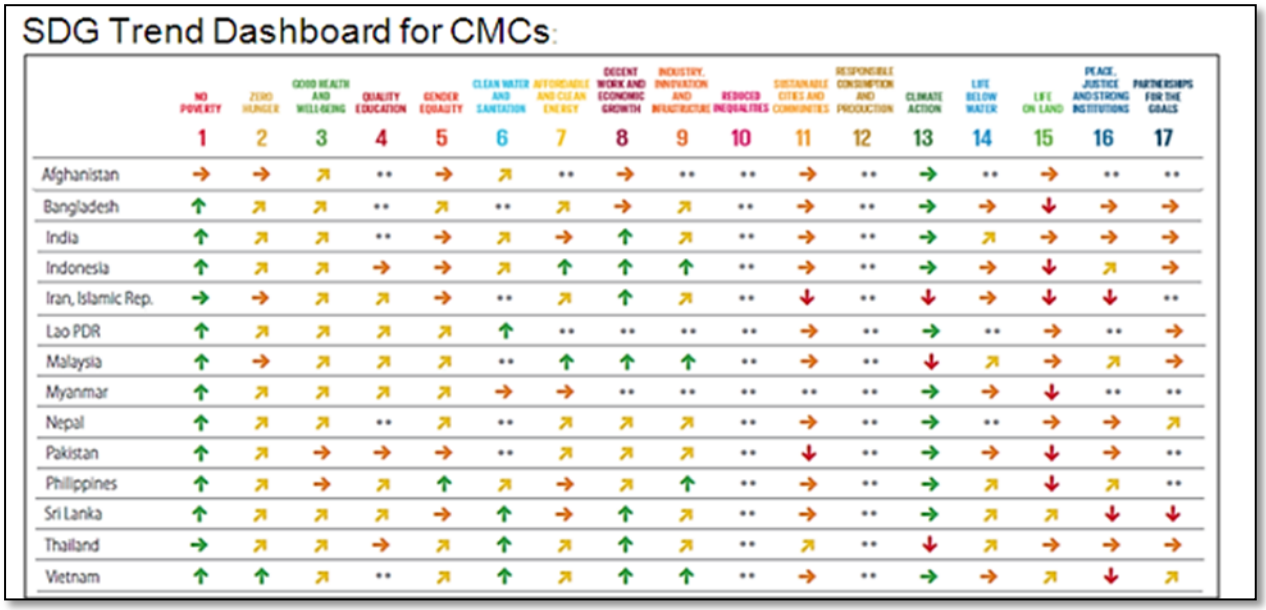
The dashboard and trend dashboard shows a visual representation of the 14 Countries' average performance on each of the SDGs. Figure 1 orders the Countries by overall performance on the index. While figure 2 indicate whether a country is on track to achieve a particular goal by 2030. The countries are color-coded on a dashboard. The dashboard colors

vary from red (worst), orange (significant challenges remaining), yellow (challenges remaining) and green (on track for SDG attainment, best performance, or in some cases, SDG attainment).



(Figure 1: SDGs Dashboard for CMCs)
(Source: SDG Index and Dashboards Report 2018)

The Trend dashboard arrow colors vary from red (Decreasing score, i.e. Country is moving in the wrong direction), Orange (Score remains stagnant or is increasing at a rate below 50% of the growth rate needed to achieve the SDG by 2030) Yellow (Score is increasing at a rate above 50% of the required growth rate) green (Score is increasing at the rate needed to achieve the SDG or score is level and trend remains at or above SDG achievement).



(Figure 2: SDGs Trend Dashboard for CMCs)
(Source: SDG Index and Dashboards Report 2018)

Yet it is important to note that even the best performers have not achieved any of the Goals, and all countries have some Goals that are still in the red zone.

2.3 Conclusion

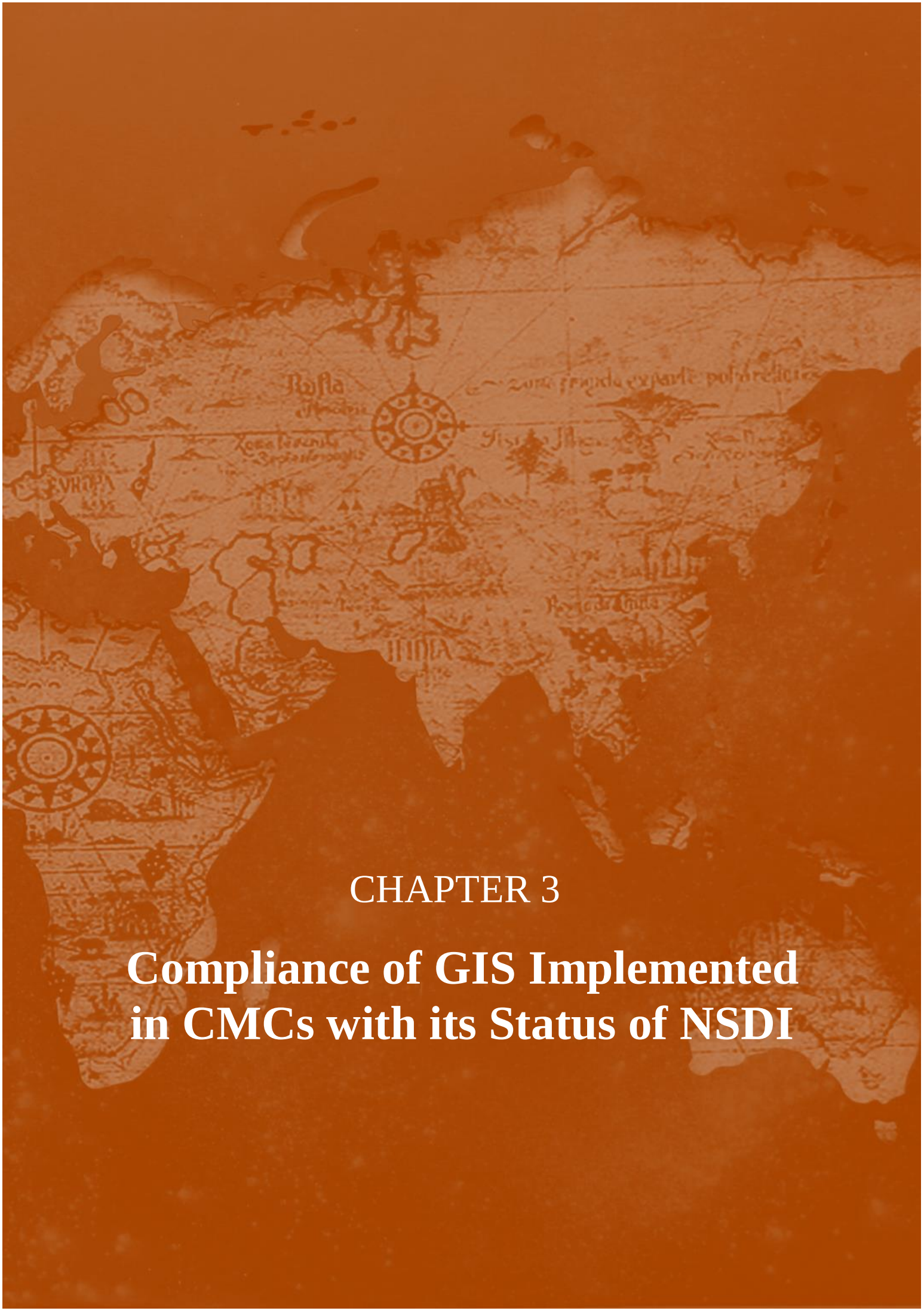
CMCs need to accelerate progress towards all Sustainable Development Goals of the United Nations 2030. Concerning its current status, Asia and the Pacific will not achieve any of the 17 Sustainable Development Goals. To achieve the agenda of 2030, accelerated progress is required on all fronts. The dashboard shows that progress has been made towards some SDGs in Asia and the Pacific, but the rate of progress is insufficient. In particular, Asia and Pacific have made relatively more progress on SDG 1 (No Poverty), SDG 5, SDG 8, SDG 13 and SDG 14 although there is still progress to be made but the major progress is needed in fighting Zero Hunger (SDG 2), Good Health and Well-Being (Goal 3), Industry, Innovation and Infrastructure (Goal 9), Inequalities (Goal 10), Life below water (Goal 14), and injustice (Goal 16). Moreover, the CMCs are doing better on some indicators than their international peers.

The lack of reliable data to effectively measure progress towards the SDGs remains one of the biggest challenges in CMCs. There is also a wide gap in data availability and sharing across CMCs. There is a lack of data preventing a comprehensive analysis of issues ranging from social protection, violence against women and girls, child and forced labor, food waste and loss, marine pollution, national and local planning of forest management, justice for all and more.

The CMCs are making slow progress on strengthening partnerships for the Goal 17. While many Goals are inter-related, this one is most intimately tied to every single Goal's chance of success: If the country fails to meet this Goal, all Goal achievements are at potential risk.

The UN has set the deadline for the achievement of the SDGs for 2030. With coordinated efforts and community leadership, countries have an opportunity to use the next 11 years to make these Goals a reality for the people who make that country their home. Countries need a global community to share successes and learn from individual country achievement.

Considering the broad range of goals of the SDGs, geospatial data is one of the most important tools for monitoring their achievement. Geospatial data, when combined with other statistical data, enables nations to create visualization tools to help inaccurate assessment and evaluation of the development impact across the 17 goals to improve accountability. Organizations like UNGGIM and GEO are constantly stressing on and advocating the need for the aggressive use of geospatial information and technology to enable societal benefits of SDGs. These organizations promote partnership with the geospatial community – such as National Mapping Agencies, space agencies, private industry players, academia, for successful implementation of programs for the SDGs (Narain, A., 2017).



CHAPTER 3

Compliance of GIS Implemented in CMCs with its Status of NSDI

Chapter 3

3.0 Compliance of GIS implemented in CMCs with its Status of NSDI

3.1 Spatial Database Infrastructure

A Spatial database infrastructure is a database infrastructure implementing a framework of spatial data, metadata, user, and devices which are interactively connected to using spatial data in an effective and efficient manner.

Another definition from SDI cookbook version 2.0 (2004) says that "Spatial Data Infrastructure" (SDI) is often used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data (Nebert et al, 2007).

National Spatial Database Infrastructure (NSDI) ensures that spatial information is accurate and accessible to state, local as well as for academic and private sector. NSDI adheres to four primary values:

(i) Privacy and Security of raw and processed citizens' personal data and accuracy of statistical data;

(ii) Access to these data;

(iii) Protection of proprietary interests to these data; and

(iv) Interoperability between various federal agencies' information systems within these data.

3.1.1 The Goal

The goal of the spatial database Infrastructure is to reduce duplication, improve quality and reduce costs related to geographic information, to make spatial data more accessible to the public, to increase the benefits of using available data, and to establish key partnerships with Central/State/tribal government, academia and the private sector (Kumar, N., 2015). It provides a structure of practices and relationships among users and data producers that facilitates data sharing and use. It is a set of actions and new ways of accessing, sharing and using spatial data that enables far more comprehensive analysis of data to help the decision-makers.

SDI integrates six key components: Spatial data, metadata, clearinghouse, standard, framework, and partnership. Whereas, GIS integrates five key components:

Hardware, software, data, people, and methods.

In order to understand better, a comparison of GIS and SDI is presented in Table 1 which displays the value of GIS for SDI and Table 2 displays the value of SDI for GIS.

3.1.2 Relation between GIS and SDI

In order to better understand, present a comparison of GIS and SDI. The comparison is based on their components. Considered SDI components are geospatial data, metadata, clearinghouse, standards, framework and partnerships whereas GIS components are data, software, hardware, humans and set of organizational protocols. Table 1 displays value of GIS for SDI whereas Table 2 displays value of SDI for GIS.

GIS Component	Value for SDI
Data	This is one of the core components of any SDI. Without data in digital format, SDIs can never be developed.
Software	Data needs to be processed and manipulated for decision making which is not possible without software.
Hardware	Data or information once generated needs to be stored, exchanged and shared among SDI stakeholders. To capture, store, share and exchange the data, hardware resources such as computers, servers, network technologies and storage media are considered vital. Therefore, hardware resources are essential to embed sharing, accessibility and retrieval of data that will ultimately increase operational efficiency of SDIs and lower response time in provision of data and services to potential users.
Humans	Although GIS is developed by a group of experts, it demands input from people of diverse disciplines which also serves as foundation for SDI development. The degree of success of SDI can be accessed by the degree of participation of organizations and user groups. Hardware and software resources require humans to interact and operate these technologies.
Set of organizational protocols	Organizational protocols are essential not only for GIS but the same can be scaled up for SDI development.

(Table 2: Value of GIS for SDI)
Source: (Ahmad, Munir & Ali, Asmat. Nov, 2015).

DI Component	Value for GIS
Geospatial Data	SDI enables access to multiple interoperable Spatial-o-temporal datasets.
Metadata	Metadata helps GIS developer to select right dataset of desired spatial and temporal resolution.
Clearinghouse	Clearinghouse makes data available 24/7 to GIS users.
Standards	Standardized datasets facilitate GIS application Development
Framework	Institutional, technical and legal framework helps the GIS user to get rid of procedural delays in getting desired data.
Partnerships	Partnerships help to reduce GIS data cost as well as to get various types of spatial and non-spatial data/services.

(Table 3: Value of SDI for GIS) Source: (Ahmad, Munir & Ali, Asmat. Nov, 2015).

3.2 Asia-Pacific Region and SDI Activities

The Asian and Pacific region is geographically and culturally diverse. Due to logistic reasons, many common projects on regional basis have not been developed in the area of spatial data. Most development has been done by the country-wise only. Spatial data and Information are traditionally collected and disseminated by a range of mandated national organizations according to a wide variety of national standards. A major difficulty in relation to these types of data and information is the lack of coordination. However, in the region of Asia, there are three organizations promoting spatial Data Initiative, which are the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PC-GIAP), The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM)) and Technical Committee 211 on Geographic Information/Geomatics of the International Organization for Standardization (ISO/TC 211).

Through the efforts of the United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP), the national mapping agencies in Asia and the Pacific region formed the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) in 1995 to develop a Regional SDI for Asia and the Pacific region. The aims of the PCGIAP are to maximize the economic, social and environmental benefits of geographic information for nations across the region to cooperate in the development of the Asia-Pacific Spatial Data Infrastructure (APSDI) and contribute to the development of the global infrastructure (Rajabifard, Abbas & Williamson, Ian. 2003).

The PCGIAP has developed a conceptual model for its Regional SDI initiative that comprises four core components; institutional framework, technical standards, and fundamental datasets and access networks. According to this model, the APSDI is not a centralized database but a network of fundamental spatial databases maintained by custodians and linked through the adoption of consistent standards, policies, and administrative principles.

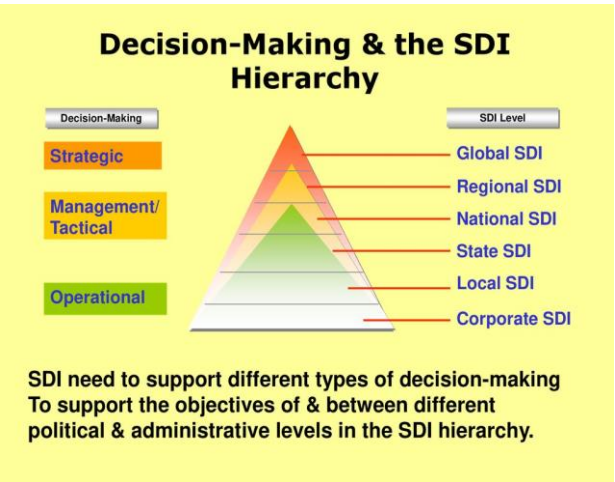


Figure 3- SDI Hierarchy
(Source: Rajabifard Abbas, Escobar Francisco and Williamson Ian P. 2000. Journal of Cartography)

The countries in Asia and the Pacific are developing SDI to better manage and utilize their spatial data assets. This is mainly due to the fact that an SDI at the national level has stronger relationships as well as a more important role in building the other levels of SDI. The role of a National SDI in an SDI hierarchy (Figure 3) displays a particularity not present in the other levels of the SDI hierarchy. This particularity is that bottom levels of an SDI hierarchy such as Corporate, local and state, have no strong links to the upper levels of the hierarchy, like the GSDI. So, the National SDI provides a crucial link between the lower and higher levels, ensuring ongoing alignment of standards and policies for spatial data sharing (Rajabifard, Abbas & Williamson, Ian., 2003).

Islamic Republic of Afghanistan

Form of Government: Representative democracy
Capital: Kabul
Population: 31,822,848
Languages: Dari (Afghan Persian), Pashto
Currency: Afghani
Area: 251.83 square miles (652,230 square kilometers)

3.2.1 Afghanistan Spatial Data Infrastructure (ASDI)

Good information is needed to make good decisions. Many organizations require similar information. In Afghanistan, like most countries, there is no structure to effectively coordinate and share these data among different organizations. Afghanistan Spatial Data Infrastructure (ASDI) has been conceived to support the coordination and sharing of fundamental geographic information in the government and supporting institutions of the country.

The first major workshop to present the concept of National Spatial Data Infrastructure (NSDI) for Afghanistan was organized on 17-20 July 2006. The workshop was co-sponsored by the Central Statistics Office (CSO), the Afghanistan Geodesy and Cartography Head Office (AGCHO), the United States Geological Survey (USGS) and the United States Agency for International Development (USAID). This "Workshop Statement and Proposed ASDI Program and Road Forward" defines an approach for moving an ASDI Program forward in a manner that addresses both urgent, near-term needs as well as longer term strategic planning and the need for incremental program development over time (Afghanistan Spatial Data Infrastructure, 2007).

The main objective of this program was to identify all the key institutional players and encourage them to work together on common needs, as well as build awareness and appreciation of international standards.

In Afghanistan, the security forces, international donors, United Nations, non-government organizations, and the private sector play special and important roles in the development of GIS. In addition, there are regional and international initiatives including but not limited to the United Nations SDI Strategy, Global SDI, ISO, Open GIS Consortium (OGC), Open GIS,

and others in Afghanistan can align with to mutual benefit on SDI (Afghanistan Spatial Data Infrastructure, 2007).

ASDI Programs/Plans

A multiple-stakeholder team is assembled to carry out the activities outlined in this Work Plan which are:

(i) **ASDI Stakeholder Assessment and Strategic Plan** This program is proposed to identify the agencies, institutions, organizations, and companies that are the primary producers and patrons of the most essential statistical and spatial information;

(ii) **Major Project Data Coordination** There are several ongoing projects that are developing statistical and spatial data in the Country. This program will seek to help align the data development efforts of ongoing projects in the Country in a manner that does not disrupt the project progress but optimize data output in a way that will be beneficial to the entire ASDI stakeholder community;

(iii) **ASDI Initial Portal** This program is proposed to develop a website to provide basic information about ASDI, its components, and participants;

(iv) **National Topographic Base Map Database and Map Atlas** up-to-date digital topographic base map series is not available in Afghanistan. This program is for development of such a database, as well as the production of related Ortho-photography and vector line mapping;

(v) **National Statistical Database and Atlas** in Afghanistan, up-to-date statistical Atlas is not available. This program is for the development of such a database of base-level statistics, along with the production of a statistical and Geo-statistical atlas to effectively communicate this information; and

(vi) **Agency Enterprise Capacity Building Program** Once the fundamental dataset (FDS) is created, it will be important that custodian agencies continuously undertake data updating. The project team will be prepared to mobilize the support of select FDS custodian agencies in the necessary and technical and human infrastructure implementation.

Afghan Geoportal

On 26 March 2018, the Asian Development Bank (ADB) with the Government of Afghanistan launched the "Afghan Geoportal" to help increase the access of accurate and comprehensive geospatial data from a central information system in the country (ADB, 2018).

Main activities of the project are:

(i) Design and development of standard-based WEB solution for publishing, displaying and disseminating geospatial data.

(ii) Collection, formatting, and publication of a minimum set of data layers, compiling metadata, developing Web Map Services for Web-GIS, and publishing data for download.

(iii) Development of documentation.

(iv) Organization of training courses and workshops for local capacity development.

This project is going to collect or generate a large amount of geo-spatial data on agriculture and natural resources. The need to develop the capacity to share information efficiently and consistently for improved access by all interested stakeholders is recognized by the same project. Sharing this information with decision-makers and donors is critical for future sustainable development planning, as well as monitoring of project activities or additional fundraising. The Afghanistan Geospatial Data Management System (Geo-Portal) is proposed as the technical solution to develop this capacity. It is an integrated information management solution with the role of managing and disseminating spatial and non-spatial data that the project will collect or generate during its activities. The system will include a WEB portal for static information and WEB based applications for searching and displaying geographic information and data, metadata records and downloadable datasets which will populate the applications. Part of the same initiative will be the development of the local capacity to sustain the system after the end of the project lifetime.

GIS Data Framework

The US Geological Survey (USGS) developed an integrated GIS data framework for Afghanistan in order to provide the fundamental databases and current, state-of-the-art maps to support natural resource assessment programmes and to aid in restoring Afghan geosciences ministries to operational status (USGS develops GIS data framework for Afghanistan, 2011).

The USGS' Geospatial Infrastructure Development Project collected compiled and digitized existing geologic, topographic and remote sensing data and has also initiated work on a national spatial data infrastructure (NSDI) for Afghanistan. The team is also responsible for developing and maintaining this website. All products of the Geospatial Infrastructure Project are available at https://afghanistan.cr.usgs.gov/geospatial-infrastructure-development-publications-maps

In 2018, Geospatial Infrastructure Development Project became known as the Data Management Component. Its primary deliverable is to give Afghanistan Geological Survey, the tools to manage its own geologic data distribution. To achieve this objective, the component activities focus on reestablishing the Afghanistan Geological Survey data processing, and on strengthening its spatial data infrastructure (SDI) by establishing a Geoportal website.

People's Republic of Bangladesh

Capital: Dhaka
Population: 163 million
Area: 143,998 sq km (55,598 sq miles)
Major language: Bengali
Major religion Islam, Hinduism
Currency: Taka

3.2.2 Bangladesh- National Spatial Data Infrastructure (NSDI)

The rapid development of Geospatial informational technologies, as well as accumulation of the solid information in various fields, raised issues of regular and systematic maintenance, management and transformation of data because often high-quality spatial information was unavailable due to functional incompatibility, absence of data establishing, publishing, sharing, standards. The same or similar data were often collected and maintained in different organizations, that caused unnecessary additional costs and time, that's why the Bangladesh government decided to establish National Spatial Data Infrastructure (NSDI) to resolve the above issues and achieve Digital Bangladesh by 2021.

Survey of Bangladesh and Japan International Cooperation Agency (JICA) jointly organized an international seminar on National Spatial Data Infrastructure (NSDI) for Bangladesh on 1st and 2nd June 2016. Keynote speakers from Japan, Indonesia and India shared the international experience with the participants (JICA, 2016).

Through this integrated platform, valuable geospatial information stored by various agencies so that any user can take advantage and accesses the information for the socio-economic development of Bangladesh such as urban/rural planning, disaster management, natural resource management, sophisticated public service delivery, infrastructure structure, etc. All products of the Geospatial data from different organization are available at https://nsdi.gov.bd

Major Stakeholders

Eighteen organizations with 154 layer and 6 maps including administrative boundaries, physical infrastructure, educational institutions, settlement patterns, agriculture, and socio-economic infrastructures participated in this portal (NSDI Portal, website). In which, the major stakeholders are:

(i) Bangladesh Water Development Board;
(ii) Local Government Engineering Department;
(iii) Bangladesh Computer Council;
(iv) Water Supply & Sewerage Authority;
(v) Institute of Water Modelling;
(vi) Survey of Bangladesh;
(vii) Dhaka North City Corporation;

(viii) Dhaka South City Corporation;

(ix) Bangladesh Bureau of Statistics;

(x) Bangladesh Space Research and Remote Sensing Organization;

(xi) Department of Land Records and Surveys;

(xii) Water Resources Planning Organization;

(xiii) Department of Disaster Management;

(xiv) Bangladesh Inland Water Transport Authority;

(xv) Bangladesh Telecommunication Regulatory Commission;

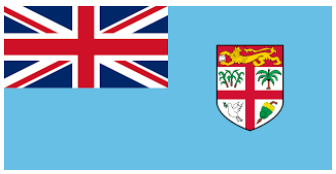
(xvi) Bangladesh Meteorological Department;

(xvii) Urban Development Directorate; and

(xviii) Streams Tech Ltd.

Republic of the Fiji Islands

Capital: Suva
Population 876,000
Area 18,376 sq km (7,095 sq miles)
Major languages: English, Fijian, Hindi
Major religions: Christianity, Hinduism, Islam
Life expectancy: 67 years (men), 72 years (women)
Currency: Fijian dollar



3.2.3 Fiji: Vanua-GIS

The amount of spatial data and the number of organizations working with GIS in Fiji is growing rapidly. In common with the majority of GIS projects, the initial phase in all these organizations has been concerned with data collection, in some cases on a large scale. The data collection, storage, and management have been the primary activity up to now. But, organizations hold onto their manual data processes and most kept both the digital and paper formats where updates have to be factored in both.

Therefore, The Fijian Government has recognized the importance and capabilities of geospatial information and its technologies such as Geospatial Information Systems, the use of Remote Sensing Images and Global Positioning Systems (GPS) and has started to turn towards high-level data analysis and integration (Naicegucegu, S., 2012). Therefore, Government provided a significant budget of closer to $5 million over the past 3 years to the Ministry of Lands and Mineral Resources for the development of **Vanua GIS,** for the modernization of very own datum, purchase of satellite images and a mapping drone (Minister's Speech. FGIC Meeting, 2017).

On the 25th of November 2016, Minister for Tourism, Lands and Mineral Resources has launched the Vanua Geographic Information System (GIS) web portal platform for sharing the spatial data sets. The sets of information that various organizations collects and use to

keep in paper form, now all that information is available digitally and accessed by authorized users with a click of a button. This portal enables the organizations to share data, and respond more effectively and essentially and make it easier for all components of the nation to function as a better team.

The Vanua Geographic Information System integrated data-sets from different organizations such as Fiji Elections Office, Ministry of Sugar, Ministry of Infrastructure, Ministry of Agriculture, iTaukei Lands Trust Board, Water Authority, Fiji Electricity Authority, Fiji Roads Authority & Telecom Fiji Limited and brought it all together in one place and in one platform. All products of the Geospatial data from these organizations are available at http://vanuagis.lands.gov.fj/VanuaGIS/ for the authorized users.

Vanua GIS Winston Emergency portal has assisted the Government during disaster preparedness with the help of Damage Assessment Maps and also in the creation of digital maps of all evacuation centers. Further, through using this portal, the Government was able to map coastal communities that are most vulnerable to rising sea levels and assist in the relocation of these communities (Boila, Sainiani, 2016).

Another major development is that, Fiji has become the first country in the Pacific to launch a Police Geographic Information System (GIS) Crimes Database. GIS will help the police to answer the critical questions what, how, when, and hopefully give them the answer as to why the crimes was being committed.

Fiji Roads Authority GIS Portal

This portal contains a range of maps and data sources showing the location and properties of Fiji Road Authority (FRA) assets and activities. There are also a number of non-asset maps and data sets that provide context and support information to the core FRA data.

This portal is providing the spatial and attributes information of carriageway, traffic cameras, vehicle crashes, jetties, street lights, bridge restrictions, utility programmes, road works programme, and other road projects. The user can access all these available information from https://gis.fijiroads.org/arcgis/home/index.html

This portal will give access to the underlying data services for use in desktop GIS (ArcGIS Desktop, MapInfo, QGIS, RAMM GIS, and Auto CAD) or other applications using the ArcGIS API. Map services (WMS) can be viewed and queried, and feature services (WFS) can be exported for off-line use.

Fiji DRM Geoportal

Fiji Disaster Risk Management Geoportal is a geospatial data sharing platform for Disaster Risk Reduction and Sustainable Development. This portal provides information to assist with planning and coordination for disaster preparedness and response. On this portal, the available data is being provided by Fiji's data repository agencies and managed from the National Disaster Management Office (NDMO). Various types of data including geospatial data, documents, etc. can be easily accessed, visualized, downloaded from

http://www.fijigeoportal.gov.fj/

Republic of India

Capital: New Delhi
Population: 1.3 billion
Area: 3.1 million sq.km (1.2 million sq miles), excluding Kashmir
Major languages: Hindi, English and more than 20 other official languages
Major religions: Hinduism, Islam, Christianity, Sikhism, Buddhism
Currency: Rupee

3.2.4 India- National Spatial Data Infrastructure

India has a very long tradition of collecting spatial data through various organizations at national, state, and district levels, which forms a broad and powerful base. But these organizations have worked in a historical way with limited sharing of data or applications not only for citizens and the private sector but also for other government agencies. Keeping in mind the importance of sharing spatial data and its applications, the Government of India constituted a task force in October 2000 to suggest ways and means to create a SDI (Kumar, N., 2015).

The National Spatial Data Infrastructure (NSDI) portal has been launched through a joint initiative of the Department of Science and Technology and the Department of Space in December 2008. The purpose of the initiative is to develop and maintain a standard digital collection of spatial data, general solutions for the exploration, access, and use of spatial data in response to the needs of diverse user groups and awareness and understanding of vision, concept, and benefits of NSDI (R, Shivakumar & PS Acharya, 2013). Since December 2008, Geoportal has been accessing data holdings of various agencies through interoperable Geographic Information Services, such as Web Processing Service (WPS), Catalogue Service for the Web (CSW), Web Map Service (WMS) and Web Feature Service (WFS). The user can access all these available information from https://nsdiindia.gov.in/

Vision of NSDI

The current, accurate and organized geospatial data will be readily and continuously available and will be accessible on a national, state, district and village level basis to contribute to the economic, environmental and social growth of the country (NSDI Portal Website).

Current Status of NSDI

Major Contributions are:

(i) Provision of Standards-compliant Web Map Services from Survey of India (SOI), National Remote Sensing Center (NRSC), Geological Survey of India (GSI), Forest

Survey of India (FSI), Central Water Commission (CWC), Central Ground Water Board (CGWB), National Disaster Management Authority (NDMA), National Bureau of Soil Survey and Land Use Planning (NBSSLUP), Central Pollution Control Board (CPCB), and Ministry of Statistics & Programme Implementation (MoSPI);

(ii) Developed and maintain National Standards for Spatial Data, Metadata, Data Exchange, Web Map Service, Web processing services and Web Feature Service, etc.;

(iii) The demonstrated utility of National Data Registry (NDR) for NSDI (catalog/ Registry Service) to support GIS application development;

(iv) Training courses to increase the awareness of the importance of metadata;

(v) Geospatial service applications demonstrated through assigning a unique ID to each parcel with the Department of Land Resources (DoLR); and

(vi) NSDI has become the first govt. agency to host OGC compliant metadata on the web which will be helpful in planning for development activities of the nation as such.

NSDI Collaborative Agencies and their Website Link

NSDI Collaborative Agencies	Website link
Department of Science & Technology	http://www.dst.gov.in/
Survey of India	http://www.surveyofindia.gov.in/
Department of Space	http://www.isro.org/
National Remote Sensing Center	https://www.nrsc.gov.in/
Ministry of Earth Sciences	https://moes.gov.in/
Geological Survey of India	https://www.gsi.gov.in/
Ministry of Defense	https://mod.gov.in/
National Bureau of Soil Survey and Land Use Planning	https://www.nbsslup.in/
Forest Survey of India	http://fsi.nic.in/
Ministry of Home Affairs	https://mha.gov.in/
Ministry of Environment and Forests	http://envfor.nic.in/
Central Ground Water Board	http://cgwb.gov.in/
Ministry of Urban Development	http://mohua.gov.in/
India Meteorological Department	http://www.imd.gov.in/
Ministry of Rural Development	https://rural.nic.in/
Central Water Commission	http://cwc.gov.in/
Department of Land Resources	https://dolr.gov.in/
National Informatics Center	https://www.nic.in/
National Atlas and Thematic Mapping Organization	http://www.natmo.gov.in/
Census of India	http://censusindia.gov.in/
National Disaster Management Authority	https://ndma.gov.in/
Central Pollution Control Board	https://cpcb.nic.in/
National Council for Applied Economics Research	http://www.ncaer.org/
Ministry of Statistics and Programme Implementation	http://www.mospi.gov.in/

(Table 4: India NSDI's Collaborative agencies and websites)

State Spatial Data Infrastructure (SSDI)

At the state level, State Spatial Data Infrastructures (SSDIs) are being set up during the XII Plan period in collaborative mode between Department of Science and Technology (DST) and the state governments for providing access to various geospatial data sets relevant to state's jurisdiction, e.g. cadastral plot, land ownership, groundwater, soil, mining, and geology (Kumar, N. 2015). State Geo-Portal prototypes have been developed in

(i) DSSDI: Delhi State Spatial Data Infrastructure
(ii) KSSDI: Karnataka State Spatial Data Infrastructure
(iii) KSDI: Kerala State Spatial Data Infrastructure
(iv) NESSDI: North Eastern State Spatial Data Infrastructure
(v) MPSSDI: Madhya Pradesh State Spatial Data Infrastructure
(vi) JSSDI: Jharkhand State Spatial Data Infrastructure
(vii) OSDI: Odisha Spatial Data Infrastructure
(viii) HRSDI: Haryana Spatial Data Infrastructure
(ix) UKSDI: Uttarakhand Spatial Data Infrastructure
(x) WBSSDI: West Bengal Spatial Data Infrastructure

Village Information System (VIS)

Village information system is a GIS based web application, which provides detailed information pertaining to demography, political boundary, infrastructure and natural resources for every village, district, and state. It displays georeferenced maps of virtually any political boundary in India – from village to a district, a state or the entire country with data of about 175 parameters from the census of 1991 and 2001 (VIS website).

This system allows users to create, query and print their own interactive GIS map as well as they can download readymade thematic maps. The system is currently designed for the state of Uttarakhand, Haryana, Himachal Pradesh and Bihar. People's Science Institute (PSI) is developing it for the entire country. The Users can view detailed information and prepare and download the map from http://www.villageinformationsystem.org/

BHUVAN, Indian Space Research Organization (ISRO)

ISRO's online Geo-portal, Bhuvan (www.bhuvan.nrsc.gov.in) was released in 2009, which initially focused on image and map visualization services and earth observation data to the user in the public domain. However, the diverse applications on Bhuvan platform have grown over a period of time. Bhuvan is being used by diverse users as per their requirements, enabling specific applications of their choice. Bhuvan provides versatile viewing capabilities and photo-realistic textured pictures draped on the image-based footprint to provide a unique viewing/ animation capabilities on the fly (Bhuvan portal of NRSC/ISRO).

As per the press Information Bureau, Department of space in March 2016, in less than 6 years of Bhuvan existence, it has more than 70,000 registered users; 800 GB of data is transacted per month and it witnesses 60 Million hits per month. About 4.6 lakh satellite data products have been downloaded by users. The customized application tools and datasets are being used by more than 30 Central Ministries and about 20 State Governments in various sectors.

National Database for Emergency Management (NDEM)

It is a web based geospatial national repository of data coupled with a set of decision support tools to assist the disaster managers at various levels in decision making for managing emergency situations. NRSC/ISRO implemented NDEM for Ministry of Home Affairs (MHA). Subsequently NDEM Version 3.0 with improved features was launched on internet domain with secured access. Value added products are hosted on NDEM portal for major disaster events since 2013 onwards (NDEM website).

National Land Records Modernization Programme (NLRMP)

For modernization of land records system in the country, the National Land Records Modernization Programme (NLRMP) has been started since 2008- 09. The activities being supported under the Programme, inter alia, include completion of computerization of the Records of Rights (RoRs), digitization of maps, survey/resurvey using modern technology including aerial photogrammetry, computerization of registration, training and capacity building of the concerned officials and functionaries, connectivity amongst the land records and registration offices and land records management centers at lower units of administration viz. tehsil/taluka/circle/block level. Under the programme, significant progress has been made with the completion of computerization of land records in 31 states/Union territories, computerization of registration process in 30 states, digitization of revenue maps in 10 states and updating of land records through survey/ resurvey in 16 States (Country Report, 2017. UN-GGIM).

Republic of Indonesia

Capital: Jakarta
Population: 243 million
Area: 1.9 million sq km (742,308 sq miles)
Major languages: Indonesian, 300 regional languages
Major religion: Islam
Currency: Rupiah

3.2.5 Indonesian Spatial Data Infrastructure (ISDI)

Geospatial information activities in Indonesia started with several digital mapping projects in the 1980s and 1990s in which major projects were nationwide land systems used for regional planning, Marine Resource Evaluation, and Planning project and Land Resource Evaluation

Project (LREP) (Poniman, A. et al., 2004). But the government was facing the problem of data duplication and data sharing. To solve these problems, the government took initiative to established NSDI under the leadership of National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL) with the vision to make the national fundamental datasets available, accessible and integrated into one national data standard.

NSDI development was initiated in 1991 during the first meeting of a group called National Geographic Information System (*The Sistem Informasi Geografis Nasional)* Forum comprised of different government agencies (Diaz, L., et al., 2012). The main objective of the meeting was how to make GIS data accessible and interchangeable with other institutions? Afterward, In 2000, NSDI was formally announced at the National Coordination Meeting of Survey and Mapping, and its objective was to provide easily accessible, good quality, and integrated spatial data for national development. In July 2007, the establishment of NSDI was institutionalized by a Presidential Decree Number 85. The decree was expected to support NSDI implementation by providing a platform for data sharing among government agencies and private agencies (Tandang Yuliadi Dwi Putra, et al., 2019).

Bakosurtanal developed a national information system called *Sistem Informasi Spasial Nasional* (SISN) in 2007 to build a platform for e-government applications based on Fundamental data sets. At that time, many government agencies provided their database. The fundamental data sets comprise of the geodetic framework; physiographic database, topographic database, natural resources database, bathymetric database. The geodetic control network includes the National Geodetic horizontal, vertical and gravity control networks spanning the whole Archipelagoes of Indonesia. Other than this, various thematic databases cover International and National Boundaries, Land and Marine resources databases, Indonesian Economic Exclusive and Continental shelf databases, etc (BIG, 2012).

The National Geoportal, Ina-Geoportal (http://tanahair.indonesia.go.id), was launched in October 2011 (FUJITSU. Case study: Badan Informasi Geospasial). This portal facilitates access and sharing of geospatial data between government and private institutions. It utilizes web services to retrieve maps provided by data providers and then reuses them to create thematic data services. Currently, users are able to download geospatial information in the GIS format. The service supports the Open Geospatial Consortium Web Map Service (WMS), Web Feature Service (WFS), and another open standard (GeoJSON files) as well.

Since 2013, *Bakosurtanal* has developed a large computing infrastructure equipped with more than 300 servers, 3,200 terabytes of data storage, and 1 GBPS internet bandwidth. This helps support Ina-Geoportal and maintain the operation of NSDI network (Nurwadjedi, 2013).

The One Map Policy Portal or *Kebijakan Satu Peta (KSP) Portal* (https://portalksp.ina-sdi.or.id/) was developed by the Geospatial Information Agency (BIG) and supported by the Coordinating Ministry for Economic Affairs. The KSP portal was built using the open source platform as a gateway for accessing and sharing Thematic Geospatial Information (IGT) data contained in the relevant Ministries / Institutions / Local Governments as a reference for

spatial-based national development planning. This portal is the mandate for the implementation of Presidential Regulation No. 9 of 2016 concerning the Acceleration of One Map Policy at the Accuracy Level of Map Scale of 1: 50,000 (Kebijakan Satu Peta Website).

Thematic maps in the Implementation of the One Map Policy cover 7 (seven) themes, namely boundaries, forestry, spatial planning, infrastructure, licensing and land, natural resources and the environment, special areas and transmigration. The seven themes are spread in 34 Provinces which become the authority of 19 (nineteen) Ministries / Institutions which are:

Ministry/Institution	Website Link
Coordinating Ministry for Economic Affairs	Https://ekon.go.id/
Ministry of National Development Planning / Agency (BAPPENAS)	Https://www.bappenas.go.id/id
Ministry of foreign affairs	Https://kemlu.go.id
Ministry of Home Affairs	Http://www.kemendagri.go.id/
Ministry of Defense	Https://www.kemhan.go.id/
Ministry of Agrarian Affairs and Spatial Planning	Http://www.bpn.go.id/
Ministry of Environment and Forestry	Http://www.menlhk.go.id/
Ministry of Public Works and Public Housing	Https://www.pu.go.id/
Ministry of Energy and Mineral Resources	Https://www.esdm.go.id/
Ministry of Transportation	Http://www.dephub.go.id/
Ministry of Communication and Information	Https://www.kominfo.go.id/
Ministry of Villages, Disadvantaged Regions and Transmigration	Https://www.kemendesa.go.id/
Ministry of Marine Affairs and Fisheries	Http://www.kkp.go.id/
Ministry of Education and Culture	Http://www.kemdikbud.go.id/
Ministry of Agriculture	Https://www.pertanian.go.id/
Ministry of Industry	Https://kemenperin.go.id/
Geospatial Information Agency	Https://www.big.go.id/
Agency for Meteorology, Climatology and Geophysics	Http://www.bmkg.go.id
Central Bureau of DStatistics	Https://www.bps.go.id/

(Table 5: Indonesian NSDI's Collaborative agencies and websites)
(Source: Kebijakan Satu Peta Website)

Islamic Republic of Iran

Capital: Tehran
Population: 75 million
Area: 1.65 million sq km (636,313 sq miles)
Major language: Persian
Major religion: Islam
Life expectancy: 71 years (men), 74 years (women)
Currency: rial

3.2.6 Iran-National Spatial Data Infrastructure (NSDI)

Like many other developing countries, the main goal of Iran is to achieve sustainable development (development in economic, social and environment sectors). Therefore, in order to achieve sustainable development based on wisdom, existence, availability, and use of appropriate, reliable and high-quality spatial data in the process of decision-making and planning is inevitable. For this reason, the government of Iran highly considered the need for spatial database infrastructure at national, provincial and local levels. The main purpose of SDI is to provide governments, organizations and executives with access to basic, processed, layered and up-to-date data at the lowest cost possible.

During the last 14 years (2005–19), many attempts have been made to develop the NSDI of Iran. Conducting primary studies in the context of SDI establishment, developing national standards for metadata and spatial data, designing a national clearinghouse Geoportal, creating an appropriate culture, paying attention to organizations and human resources in the context of SDI and establishing a coordinating committee for SDI were the most important attempts at development made by various organizations (Kalantari Oskouei. Et al., 2018).

In June 2010, the implementation of NSDI was assigned to the "National Cartographic Center" of the Islamic Republic of Iran. For this, the National Cartographic Center (NCC) has established the National SDI Cooperative Committee to carry forward the related duties. In order to achieve the goal of national SDI, the cooperative Committee had to provide a way for government organizations to participate, collaborate and also facilitate inter-organization cooperation to implement NSDI (Baktash, P., 2012).

The committee is chaired by NCC. At present, members of the committee are Ministry of Interior, Ministry of Roads and Urban Development, Ministry of Agriculture JAHAD, Ministry of Energy, Ministry of Petroleum, Ministry of Industry, Mine and Trade, Ministry of Information and Communications Technology, Iran Department of Environment, Geological Survey of Iran, National Geographical Organization, National Cartographic Center, Iranian Space Agency, State Organization for Registration of Deeds and Properties, and Statistic Center of Iran.

NCC is responsible for carrying out, steering and cooperating with SDI implementation from all local to national levels. In addition, the NCC produces coverage maps across the country on 1:25000, 1:50000, 1:100000, 1:250000 and 1:1000000 scales. Since 2005, a

comprehensive study has been done in the field of National SDI that its results are in the compilation of the National SDI Strategic plan. The important outlines of the strategic plan are as follows (Peyman Baktashm., 2012):

(i) Developing the general pattern for provincial and local SDIs;

(ii) Study and establishment of Organizational SDIs;

(iii) Study and establishment of disaster management SDI;

(iv) Technical, policy-making and outreaching workgroups;

(v) Training, promoting and improving the level of awareness;

(vi) Designing and establishing the national spatial data clearinghouse;

(vii) Compiling required standards and instructions based on ISO 19115 standards;

(viii) Performing Cost-Benefit analysis for SDI and compiling the initial financial model; and

(ix) Providing, completing and organizing of topographic based maps and organizing spatial data of other organizations.

NCC has designed and implemented a National Geoportal. In the form of an input clearinghouse network port, the National Geoportal has been designed and established to create the appropriate tools for search, retrieve, access and share of spatial data. Geoportal has been accessing data holdings of various agencies through interoperable Geographic Information Services, such as Web Processing Service (WPS), Web Map Tile Service (WMTS), Catalogue Service for the Web (CSW), Web Map Service (WMS) and Web Feature Service (WFS).

The portal is designed to enable all agencies and organizations to share their information services and spatial data layers. In order to ensure data security, the Linux operating system has been used as a Geoportal open-source operating system. Thirty ministries and national organizations that were relevant to spatial data (producer, value-adder, or user) were assessed with respect to spatial data, from the SDI perspective (A. Mansourian and M. J. Valadan Zoej., 2008). The user can access all available information from https://iransdi.ir/

General Department of GIS and SDI of NCC

GIS and SDI General Department is an active and interactive department of NCC, especially in the direction of sustainable development of the Islamic Republic of Iran. This department is the reference to provide online spatial data and maps, offered by NCC to users and is also the reference to lead and coordinate the establishment of spatial databases. In addition, it is the administrator of organizing National and Provincial Geospatial Information System (GIS) and is the references to coordinating and guiding the Spatial Data Infrastructure (SDI) at the organizational, district, urban, provincial and national levels in the Islamic Republic of Iran.

Many administrative organizations in Iran have been to dealing with production, usage, management, education and research on SDI and spatial data in Iran. In public sector, the major organization working on SDI is NCC. According to its duties and needs, the scope of these organizations' activities is defined as follow (NCC, Website):

Organization	Activity	Website
National Cartographic Center	Produce base maps of the country and centralizing all surveying and geographic activities.	(www.ncc.org.ir)
National Geographical Organization	Produce maps for military activities and around the international boarders of Iran.	(www.ngo-iran.com)
Geological Survey of Iran	Prepare, complete, and publish geological maps of Iran.	(www.gsi-iran.org)
Iranian Remote Sensing Center	providing production and distribution of satellite data,	(www.iran-irsc.com)
Tehran GIS Center	Produce maps of Tehran in urban scale for urban GIS purpose.	(www.Tehran-gis.org)

(Table 6: Iran NSDI's Collaborative agencies and websites)

Lao People's Democratic Republic

Capital: Vientiane
Population: 6.4 million
Area: 236,800 sq km (91,400 sq miles)
Major languages: Lao, French
Major religion: Buddhism
Life expectancy: 66 years (men), 69 years (women)
Currency: kip

3.2.7 Lao PDR-National Spatial Data Infrastructure

The major issue in the Lao PDR is the unplanned use of natural resources and environmental degradation. Most of the ministries/departments have laws to improve the situation, but the actual implementation is delayed due to two reasons related to spatial data. The first one is the lack of accurate and up-to-date data and the second is the lack of co-operation between different organizations. To solve the above issues, the LAO PDR government decided to establish sustainable National Spatial Data Infrastructure (NSDI) under the leadership of the National Geographic Department (NGD) and supported by Finnish funded Strengthening National Geographic Services (SNGS). The establishment of NSDI is based on two approach method (Sami JANNE, and Khamvanh LORKHAMYONG., 2015).

(i) **Database Approach** The first approach has increased NGD's technical capacity to produce accurate and up-to-date data. This has included aerial photography of Lao PDR, the establishment of a seamless GIS database and building up of a test Geo-portal for data distribution; and

(ii) **Institutional Approach** To improve the co-operation between NGD and different organizations enabling data and information sharing. This has included the establishment of a GIS committee and related technical working groups.

The National Geographic Department (NGD) under the Ministry of Home Affairs (MoHA) is considered the highest survey and mapping authority in Lao PDR. In the last two decades, NGD has received Official Development Assistance (ODA), most recently from Finland (1998-2003; Vientiane Plain Large Scale (1:5,000) Mapping Project and Japan 1998-2003; Mekong GIS Project to update of 1:100,000 scale topographic maps). SNGS has promoted NGD to establish the National Spatial Data Infrastructure (NSDI) to Lao PDR.

One of the first steps, to improve data distribution and establishing a nationwide NSDI, is the creation of web-based tools for accessing geographic information and services. In the first stage the Geoportal named the National Cooperative Geoportal of NGD, was used to allow limited access to data including orthophotos, base maps, and DEM. Later on, the plan is to include other providers as well by collaborating and sharing data. Currently, the Geoportal is used to display orthophotos and the seamless map database of NGD with watermark for general public and without watermark for professionals from http://www.ngd.la/?page_id=3521&lang=en

Professional users can make a request to purchase access rights to private Geoportal which features high definition orthophotos and vector data through WFS. Use NGD contact form to request access rights to private Geoportal (Geoportal Professionals).

Towards the 2015 Geoportal has gone through several improvements. The operating system in service is updated to Ubuntu 14.04 LTS version and geospatial software stack based on Geo-Server, Open Layers, Post GIS, and GDAL is also updated with new features. Using Open Layers 3 JavaScript framework enables new visual outlook in client demos on the public web, and Geo-Explorer (part of Open-Geo Suite) and QGIS are used mostly in internal data service demos.

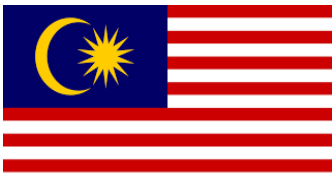
SNGS targets with its institutional capacity building, besides adding technological solutions to the marketing and data distribution, to improve the skills of NGD personnel to approach clients. This requires training that covers different sectors and their needs. NGD, to better provide or at least propose services, needs to understand basic needs and methodologies related to different line sectors such as land management, forestry, environment, etc(Sami JANNE, and Khamvanh LORKHAMYONG., 2015).

GIS Committee

NGD established formed a GIS Coordinating Committee in 2003 by an Agreement of the Prime Minister's Office (No: 0593/PMO). The main objective of the committee is to improve geospatial cooperation and coordination between inter-ministerial in the country to prevent duplication of work. One of the most important tasks of the committee is to coordinate the establishment of National Spatial Data Infrastructure (NSDI). NSDI includes improving data policies towards "open data" policies, technologies more usable ways to share data or information about data and create national standards

Other important task of the committee is to provide communication structure and channels for the GIS community. NGD web pages offer discussion forum for GIS-committee members and non-members. The committee also aims to raise awareness of the use of geospatial data and understanding of the NSDI as an important national resource (KL, 2012).

Federation of Malaysia



Capital: Kuala Lumpur
Population: 29.3 million (UN, 2012)
Area: 329,847 sq km (127,355 sq miles)
Major languages: Malay (official), English, Chinese dialects, Tamil, Telugu, Malayalam
Major religions: Islam, Buddhism, Taoism, Hinduism, Christianity, Sikhism
Life expectancy: 73 years (men), 77 years (women)
Currency: Ringgit

3.2.8 Malaysia Geospatial Data Infrastructure (MYGDI)

Geospatial information is recognized by the government of Malaysia as an essential resource that supports the economic, social and environmental development. Demand for accurate, up-to-date, relevant and accessible geospatial information at the various levels of government in Malaysia is critical to the delivery of many government services. Due to that the government of Malaysia was set up the Malaysian Center for Geospatial Data Infrastructure (MaCGDI) under the Ministry of Water, Land and Natural Resources in December 2002 (Sr Azlim Khan, Abd.Raof Khan., 2011). MACGDI is responsible for the management and promotes the development of Malaysia's Geospatial Data Infrastructure (MyGDI) as National Spatial Data Infrastructure (NSDI). MaCGDI is also responsible for coordinating the access and distribution of geospatial information organized by all government agencies. The main role of the center is to provide accessible and accurate spatial data, which promotes a sustainable environment, economic development and social progress for the public (Malaysia Geoportal Website).

MyGDI is an initiative of the government to develop a geospatial data infrastructure to increase awareness of data availability and improve access to geospatial information. This can be accomplished by sharing data between targeted agencies. MyGDI is a geospatial data infrastructure that includes policies, standards, technology, research and development, and skilled human resources.

Through this infrastructure, a smart partnership is being developed to produce and share geospatial information amongst the government, the private and non-profit sectors, and the academic community.

In general, the benefits received through the implementation of MyGDI are as follows (Malaysia Geoportal Website):

(i) Avoiding duplication of effort in collecting, processing, maintaining, providing and dissemination of spatial data;
(ii) Providing stability in the use of geospatial data through the formulation of policies and standards;
(iii) Apart from increasing the varieties of value-added products, increase the level of usage and awareness of geospatial data;
(iv) Expediting the implementation of electronic government and knowledge-economy;
(v) Promoting the local geospatial data industry; and
(vi) Strengthening institutional capacity to produce knowledge workers through the human resource development program.

MyGDI development is divided into several main components as follows:
(i) Geo Spatial data Development;
(ii) Standard Development;
(iii) Policy Development and Guidelines;
(iv) Sharing Infrastructure Development;
(v) Human capital development; and
(vi) Research and development.

In order to manage the development and operation of MyGDI, a MyGDI National Coordinating Committee (MNCC) was formed with the role of central policy and decision-making body on issues related to the implementation, development, and operations of the MyGDI programs and initiatives. In addition to the coordinating committees, there are three technical committees - Framework Technical Committee, Standard Technical Committee, and the Clearinghouse Technical Committee. MaCGDI activities are mainly operated by these three technical committees (MyGDI Governance, Malaysia Geoportal Website).

MYGDI INITIATIVES

The MyGDI Initiative, which supports the "Spatially Enabled Government", started in 2004 with the initiative of digitalizing hardcopy plans available in local authorities, State town and country planning departments (JPBDs).

In addition, MaCGDI also helps the state in creating a State Geospatial Data Center known as the State MyGDI Clearinghouse which serves as a Data Sharing Center with state agencies. The states include in this initiative are Johor, Melaka, Negeri Sembilan, Selangor, Pahang, Terengganu, Kelantan, Perak, Sabah, Kedah, and Perlis.

My Geoportal is a gateway to the geospatial information and activities in Malaysia. My Geoportal enable users to explore, view and access MyGDI Implementation, Initiatives programs and applications are related to it.

In 2005, MaCGDI developed the National Geospatial Information Catalog, also called as MyGDI Explorer. MyGDI Explorer is a reference or catalog application for any geospatial information. This application was developed to support and promote any geospatial-related

initiatives undertaken by government agencies, higher educational institutions (IPTs), private sector, NGOs and individuals. MaCGDI also developed Collaborate and Share Geospatial Information (Platform for user and government agencies to promote sharing of geospatial information.), My Geo-Map (for user to search any place of interest), My Geo-ranslator (To help and facilitate agencies data provider use the geospatial data standards), MyGDI Data Services (provides an interface to access data that can be shared between government to government agencies (G2G).

Through the information contained in these applications, the repetition of efforts in the development of geospatial activities can be avoided. Apart from this, it also promotes strategic collaboration between different organizations in the development of the geospatial industry and encourages the sharing of geospatial information between users and agencies.

Malaysia Geoportal enables GIS users, developers and data suppliers to evaluate, access, visualize and publish geospatial information online and users can use it from anywhere and at any time.

At the end of 2009, the MyGDI program focused on providing more coordinated geospatial information. In 2009, an initiative for the development of a national geospatial database or fundamental dataset (NGDC) was started with federal agencies. National Geospatial Data Center serves standardized geospatial data within the 12 main data categories i.e. Aeronautical, Environment, Vegetation, Demarcation, Hydrography, Hypsography, Geology, Soil, Transportation, Utility, Special Use, and General. These datasets provide the basic GIS layer to be used by GIS users and developers to develop various GIS applications (MyGDI data service Application, Website).

Republic of the Union of Myanmar

Capital: Nay Pyi Taw
Population: 48.7 million
Currency: Kyat
Area: 676,552 sq km (261,218 sq miles)
Major language: Burmese, minority languages
Major religions: Buddhism
Life expectancy: 64 years (men), 68 years (women)

3.2.9 One Map Myanmar

Advances in technology have made it easy to generate, collect and share large amounts of information and data related to people, land and natural resources. This information allows governments, development agencies and civil society organizations to make informed, evidence-based decisions. For this, it is necessary that the data should be accurate, accessible and available in a format that is easy to understand.

The Government of Myanmar initiated to democratize access to data, information and knowledge to enable government and citizens to make more sustainable and evidence-based decisions on land management and comprehensive development planning. This initiated named as One Map Myanmar. The initiative benefits from the financial support of the Swiss government, through the Swiss Agency for Development and Cooperation (SDC) for an initial duration of eight years. Technical support for the process is coordinated by the Centre for Development and Environment (CDE) of the University of Berne, partnered with the Myanmar Land Core Group. In coordination with CDE, additional technical support is provided by the United Nations interagency service, the Myanmar Information Management Unit, and the Asian Disaster Preparedness Centre.

It started in 2016, One Map is strongly institutionalized, with 25 government agencies, civil society organizations, and private sector working together and jointly produce, verify, and analyze data and information on the land. After 18 months of implementation, One Map has managed to successfully engage in multi-stakeholder processes at national and regional levels. The data and knowledge are made available on an online open-access spatial data platform so that users can display, search and use data in multiple perspective and claims on land in a spatially explicit manner (Bastide, Joan & Heinimann, Dr., 2017).

ONEMAP'S APPROACH

To achieve the objective of providing access to accurate information for sustainable development, One Map focuses on four areas of activity (CDE, Research):

(i) Designing and expanding the online data platform, with emphasis on data consolidation and integration, accuracy, and user accessibility;
(ii) Strengthening technical and analytical capacities of government agencies, civil society organizations, and research institutions;
(iii) Generating knowledge for development through research and data analysis, which decides on major key development challenges; and
(iv) Supporting multi-stakeholder platforms and dialogues aimed at resolving complex land-related issues and supporting national land governance reforms.

THE ONE MAP MYANMAR ONLINE PLATFORM (GEOPORTAL)

The One Map Platform (https://portal.onemapmyanmar.info/omm/home/) launched in 2018 and brings consolidated data from all government and nongovernment sectors together in an integrated way. The Platform allows registered users to (OneMap Myanmar Portal website):

(i) Access information about the One Map initiative;
(ii) Search the expanding catalog of data sets;
(iii) Display selected data on an interactive map;
(iv) Share and print custom maps;
(v) Conduct advanced data analysis;
(vi) Access technical documentation and training materials; and
(vii) Download data in different formats to share and use.

The platform also includes a section dedicated to participatory mapping, were locally prepared maps and related documents can be uploaded and displayed against other national-level datasets. Instead of providing access to data in a spreadsheet or graph, the One Map enables the "spatial" presentation of data through its integrated Geographic Information System (GIS) platform where users can see the geographic maps, which makes easy to identify patterns and trends of the spatial data.

MYANMAR - NATIONAL SPATIAL DATA INFRASTRUCTURE

A meeting on the National Spatial Data Infrastructure Project was jointly organized by the Center of the International Cooperation for Computerization (CICC) and the Ministry of Education of Myanmar, and the Ministry of Economy, Trade, and Industry of Japan on May 20, 2015. The objective of this meeting was to include a platform in the NSDI initiative that will provide easy access to the necessary data for the projects that would be implemented by the respective ministries. All the government offices and private sector will be able to access the necessary data in line with the data sharing policies (MITV, 2015).

The Use of NSDI system will contribute substantially to the development of the country, The NSDI system will be useful for many people to disclose new employment opportunities, industrial establishments, urban planning, disaster management for effective coordination and time facilities.

Federal Democratic Republic of Nepal

Capital: Kathmandu
Population: 31 million
Area: 147,181 sq km (56,827 sq miles)
Major languages: Nepali
Major religions: Hinduism, Buddhism
Life expectancy: 68 years (men), 70 years (women)
Currency: Nepalese rupee

3.2.10 Nepal-National Geographic Information Infrastructure Programme (NGIIP)

Poverty reduction, good governance, social justice, environmental protection, sustainable development, and gender equity are major national issues in Nepal. Several agencies are created spatial data on these issues as per their needs and did not share to other organizations due to data ownership (Rabin K. SHARMA and Babu Ram ACHARYA., 2004). In the year 2002, the Government of Nepal realized the importance of data sharing and to solve the data sharing issue, His Majesty's Government of Nepal initiated National Geographic information Infrastructure Programme (NGIIP) in 2002 under the guidance of Survey department of Nepal. The NGII program supports the development of spatial data infrastructure and a geographic information system at the national level. NGII Programme has the overall objectives of strengthening planning and resource management in Nepal and its specific

objectives are to develop a platform to facilitate data sharing among Survey Department, Central Bureau of Statistics, Ministry of Local Development, Ministry of Health, Ministry of Agriculture, Ministry of Population and Environment and participating agencies. It is clear that active participation and commitment from key stakeholders can play a decisive role in the creation of NSDI (Chhatkuli R.R., & Kayastha, D. M., 2005).

As part of its contribution to the NGIIP, Survey Department provides spatial data ranging from 1:25,000 to 1:1,000,000. To facilitate the success of the NGII initiatives several approaches have been undertaken. Some of them are: the identification of the key players and developing a stakeholders' institutional coordination mechanism, the situational analysis and needs assessment, developing an implementation strategy, and conceptualization of a NGII center of excellence for promoting sustainability (R.R. Chhatkuli. 2004).

Spatial Data Users/ NGII Stakeholders

The digital spatial database users are diverse and their applications are equally diverse. The users range from individual students and researchers to organized sectors like agricultural department, rural development agency, roads and irrigation authorities, local bodies, government departments and ministries. It is, therefore, no doubt that a NGII is necessary to support these diverse users.

The potential stakeholders in the NGII in Nepal are all producers and users of spatial data. Simply said, the same agencies who have been the major users of paper maps in the past are the major stakeholders in the NGII in the new set-up. Some of the important agencies are (R.R. Chhatkuli. 2004):

(i) Survey Department;
(ii) Central Bureau of Statistics;
(iii) Department of Forests;
(iv) Department of Hydrology and Meteorology;
(v) Department of Mines and Geology;
(vi) Department of Roads;
(vii) Department of Irrigation;
(viii) Department of Urban Development;
(ix) Water and Energy Commission;
(x) Municipalities/ VDCs;
(xi) District Development Committees;
(xii) Consultants;
(xiii) Planners and developers;
(xiv) Ministry of Land Reform and Management;
(xv) Ministry of Population and Environment;
(xvi) Ministry of Agriculture and Cooperatives;
(xvii) Ministry of Health;
(xviii) Ministry of Education; and
(xix) Ministry of Local Development.

Conceptual System Architecture of NGIIP

NGIIP provided two basic services namely "Metadata Services" and "Clearinghouse Services". Metadata service provided the description of data to the users. The clearinghouse service helps the users to access and retrieve data of their interest. It facilitates the users to query, download and integrate the data from different sources and connected to each other by a communication network. User can access this portal through this link (http://nationalgeoportal.gov.np/).

Data Availability

(i) Fundamental data sets

The fundamental data sets of Nepal is the National Topographic Data Base (NTDB) which have various layers such as administrative boundaries, geodetic data, transportation networks, buildings, Topography, Hydrography, utilities, Land use, Land cover, and designated areas and organized at sheet level. The basis for NTDB is the digitization of topographic base maps of scale 1:25 000 for the Terai (Plain Areas) and the middle mountains, and of scale1:50 000 for high mountains. In addition, a large scale Ortho-photo database (1:5 000 to 1: 10 000) is provided for densely populated areas.

(ii) Framework data sets

The framework data sets are the database obtained from different sources of the related disciplines such as National Database of Population Census, Agricultural, Soil, Geological, etc. The aggregation and integration of fundamental data sets and framework data sets solved the purpose of NSDI. This makes the works of the user's community more simple, efficient and effective in terms of time and resources.

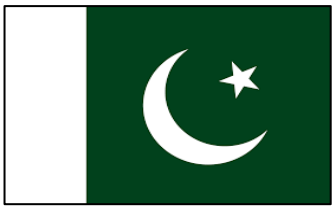
(iii) Metadata

In the NGII, one of another service provided to the users is Metadata service. The metadata holds the information of data such as Information policy, data standard, and norms, copyright policy, specifications, pricing policy, security, and protection, etc. The users can easily access to metadata to enable to find total information about their requirements, to evaluate the existing dataset, to understand the procedure for acquiring the dataset, etc. It also helps to maximize data sharing and to minimize the data duplication.

(iv) Electronic Clearinghouse

In the SDI, one of the services provided to the users is Electronic Clearinghouse service. This service helps the users to find out and access the data of its interest. So based on user's selection, data will be retrieved from the respective database and the data will be sent to the user. The user then can view, make a query or download the data (Rabin K. SHARMA and Babu Ram ACHARYA., 2004).

Islamic Republic of Pakistan



Capital: Islamabad
Population: 193 million
Area: 796,095 sq km (307,374 sq. miles), excluding Kashmir
Major languages: English, Urdu, Punjabi, Sindhi, Pashto, Balochi
Major religion: Islam
Life expectancy: 65 years (men), 67 years (women)
Currency: Pakistani Rupee

3.2.11 Pakistan National Spatial Data Infrastructure (PAK-NSDI)

In 2005, the Government of Pakistan (GoP) announced its e-government program to ensure quick supply of information to user communities. However, the focus has been more on the production and dissemination of non-spatial component of the information while ignoring the location or spatial part of this information.

In Pakistan, spatial data is available with various public and private sector organizations. Although, Government of Pakistan (GoP) is funding public sector organizations to develop spatial data, but, there are redundancies in the collection and maintenance of spatial data in the country. The public sector organizations are independently acquiring and maintaining potentially duplicative and costly datasets and systems. Therefore, a lot of public money and effort can be saved annually by controlling duplication of efforts in spatial data production through the establishment of NSDI in the country (Ali, Asmat & Ahmad, Munir., 2013). After a couple of years, Pakistan National Spatial Data Infrastructure (PAK-NSDI) was initiated on May 6, 2015, during 2nd GIS Conference that was held at Ministry of Planning Development and Reform, Planning Commission, Energy Wing, Islamabad (GSDI Newsletter, 2015). The Government of Pakistan had given responsibility to the Survey of Pakistan (SoP) to establish PNSDI in the country. SoP is practicing and implementing the PNSDI concept in its domain. The objectives of PNSDI can be better achieved if other geospatial data producers collaborate with SoP for PNSDI development.

In Pakistan, spatial data is mostly being produced by public sector organizations that include Survey of Pakistan (SoP), Space and Upper Atmosphere Research Commission (SUPARCO), Pakistan Agricultural Research Council (PARC) and Census department, etc. According the research of Ali, Asmat. (2010), it shows that in Pakistan, spatial data is mostly being produced by public sector organizations that include Survey of Pakistan (SoP), Space and Upper Atmosphere Research Commission (SUPARCO), Pakistan Agricultural Research Council (PARC) and Census department, etc. The major stakeholders and their role to support PNSDI are:

Stakeholder	Datasets Produced/Supplied/ Used	Category
Survey of Pakistan (SoP)	Topographical maps, Geodetic control	A, B, C
Geological Survey of Pakistan (GSP)	Geological Map	A, B, C
Ministry of Environment (MoE)	Fauna and Flora, vegetation	A, B,
Ministry of Health	Health facilities	A, B, C

Space and Upper Atmosphere Research Commission	Satellite images, remote sensing data	A, B, C
Soil Survey of Pakistan (SSP)	Land use and soil map	A, B, C
Ministry of Water and Power	Water bodies, wetland, Groundwater information	A, B, C
National Metrological Center	Weather information	A, B, C
Census department	Census information	A, B, C
Forest Department	Vegetation	A, B, C
National Highway Department	Transportation network	A, B, C
Ministry of Tourism and Culture	Tourism & Cultural	A, B, C
Private Organizations	Large scale data	A, B C
NGOs	Socio-economic data	A, C
Ministry of Lands	Land use and Cadastral	A, B, C
Municipalities	Address, Building, utilities	B, C
Academic and Research institutes	Usage of all kinds of spatial as well as non-spatial data	C
Ministry of Railways	Usage of all kinds of spatial as well as non- spatial data	C
Ministry of Information Technology	Usage of all kinds of spatial as well as non-spatial data	C
Pakistan Agricultural Research Council (PARC)	Land use and land cover data	C

(Table 7: Stakeholders and their role to support Pak-NSDI)
(Source: Ali, Asmat. (2010)

As per the result of the research Ali, Asmat. (2010) shows that out of 20 listed organizations, 16 organizations that make up 80% of the total are engaged in data production activities. Therefore, there is a tendency of duplication of efforts in producing and maintaining the same datasets that may already be available in some other organization. However, it is a unique opportunity for GOP to bring all these stakeholders under the umbrella of PNSDI to minimize wastage of national money that is indeed the demand of the current financial crisis of the country.

SoP being in charge of the official geographic information and mapping of the country is in the process of floating NSDI proposal. SoP has envisioned NSDI and therefore designed, developed and implemented geoportal consisting of data catalog as well which is currently available on Local Area Network (LAN) and is believed to be available on the Internet after initiation of NSDI implementation.

Republic of the Philippines:

Capital: Manila
Population 96.5 million
Area 300,000 sq km (115,831 sq miles)
Major languages Filipino, English (both official)
Major religion Christianity
Currency Philippine peso

3.2.12 Philippines National Spatial Data Infrastructure (PNSDI)

The country's geospatial information development in Philippines' started in 1990's. The same or similar data were often collected and maintained in different organizations, that caused the Philippines' government was facing the problem of data duplication and data sharing. To solve these problems, the government took initiative to establish NSDI under the leadership of National Mapping and Resource Information Authority (NAMRIA's) with the vision to make it the suitable government agency to lead the development of the NSDI in the country. NAMRIA's functions related to NSDI are as follows (NAMRIA, 2012):

(i) To integrate geographic and related information to facilitate access to and analysis of data and its transformation into useful information;

(ii) Establish and implement technical standards and quality specifications;

(iii) Operate information services and networks; and

(iv) Provide photogrammetry, cartographic and RS and mapping services to accelerate the development of a comprehensive databank and information systems.

In 2003, NAMRIA and the National Statistical Coordination Board developed the PNSDI Framework Plan. In 2011, The Philippine Geoportal started to concretize the ideas set forth in the PNSDI Framework with the vision "a spatially enabled nation with a comprehensive and consistent geospatial dataset widely available and shared for sustainable economic, environment and social environment and management" (John SF Fabic, 2012).

Philippine's Geoportal One Nation One Map Project

the Philippine Geoportal was launched on 16 January 2014 with the aim to provides a web based system for sharing of and access to geospatial data using one common multi-scale base maps. The system providing a mechanism for a clearinghouse network, data management and exchange standards and protocols, and institutional interface that facilitates the flow of information across all levels of government, the private and non-profit sectors, the academia, and other stakeholders.

Philippine Geoportal keeps and serves base map and fundamental datasets for the general public, which produces NAMRIA and all thematic datasets of other stakeholder agencies. It also promotes the participation of local government units having the mandate to produce subnational level geospatial data, e.g., land use plans, which is otherwise not being carried out by the national government agencies. The Philippine Geoportal provides an ICT platform for collaboration, data and resource sharing, integration, transparency, and resource optimization.

The development of Philippine Geoportal is divided into three phases, which include Application Development, ICT Infrastructure Installation, Data Build-up and Integration, Training and Capacity Building, Policy Framework and Institution, Forward and Sustainability Planning and Project Management (NAMRIA, 2012).

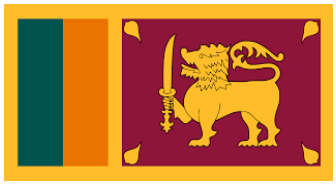
The Philippine Geoportal covers the following web-based portals: central, system administration, data maintenance, metadata, and system application programming interface.

Through this integrated platform, NAMRIA has stored the available topographic base maps namely at various scale (1:250k, 1:50k and 1:10K), LiDAR and orthophotos, geodetic control points, gravity stations, declination, bathymetry, lighthouses, tide stations, forest cover, and land classification.

As per the Geoportal Philippines Data Inventory, this integrated platform, 396 valuable geospatial information layers stored by 83 agencies including NAMRIA so that any user can take advantage and accesses the information for the development of Philippines. These include data on environment, climate and natural hazard, agriculture, health, education, tourism, national roads and infrastructure, transportation and communication. All products of the Geospatial data from different organization are available at *http://geoportal.gov.ph/*

Democratic Socialist Republic of Sri Lanka

Capital: Colombo
Population: 21.2 million
Area: 65,610 sq km (25,332 sq miles)
Major languages: Sinhala, Tamil, English
Major religions: Buddhism, Hinduism, Islam, Christianity
Life expectancy: 72 years (men), 78 years (women)
Currency: Sri Lankan rupee



3.2.13 Sri Lanka National Spatial Data Infrastructure (SL-NSDI)

Information and Communication Technology Agency of Sri Lanka (ICTA) implemented of a Sri Lanka National Spatial Data Infrastructure (SL-NSDI), in collaboration with stakeholder institutions and the platform was launched on 20 December 2018 with the aims of improving optimum use of spatial data across the government and making effective evidence-based decisions (Daily News, 2018). Since 2016, the primary focus of NSDI was to standardize spatial data, avoid data duplication, improve data quality, improve transparency in data sharing across departments and provide a platform for developing spatial data decision support tools where government and private sector organizations can collaborate to manage, improve and exchange spatial data and information.

Complying with the international standards like Open Geospatial Consortium and ISO guidelines, NSDI continues to institutionalize data sharing, standards, formats, policies, data creation and update process across the Government of Sri Lanka (NSDI Sri Lanka Website). The stakeholders are generating spatial data products that can be used with a range of applications covering the whole country to support planning, development, and land registration activities. Table 8 displays major stakeholders and their role to support NSDI.

Stakeholder	Data Contribution
Department of Archaeology Sri Lanka	Archaeological Monuments, Reserves, Buffer Zones layers
Department of Forest	Vegetation
Department of Irrigation	Irrigation related data layers
Department of Meteorology	Rainfall, Temperature, Humidity, Rainfall maps, Wind, Cloud amount, Visibility, Astronomical data
Department of Wildlife Conservation	Boundaries of the Protected Area, Fauna and Flora protection
Disaster Management Centre	Situation Reports, Weather Reports, Weather Forecasts, River Water Level, Landslide Warning
International Water Management Institute	Water bodies, wetland, Groundwater information
iRoad Project	iRoad selected rural roads
Land Use Policy Planning Department	Land Use Types in Sri Lanka
Ministry of Education	Government Schools, Teachers, Students, Student Teacher Ratio, Grade 1 Admissions
National Physical Planning Department	Thematic maps (images)
National Water Supply And Drainage Board	Water Supply Schemes Utility Data, Sewerage Schemes Utility Data
Natural Resources Management Centre	Spatial data related to agriculture,
Road Development Authority	National Highway Network, comprising the Trunk (A Class) roads, Main (B Class) roads and Expressways
Sri Lanka Tourism Development Authority	Hotels, Restaurants, Hotel Proposed, Tourism hot spots, Bank ATM, Shopping Malls, SLTDA Parcels
Survey Department of Sri Lanka	Six seamless data layers of the Topographic data, Some 10K and 1K sample data with 3D buildings
Urban Development Authority	Land Use, Zoning, Building lines, building footprints

(Table 8: Stakeholder and their data contribution to SL-NSDI)
(Source: Stakeholder, NSDI Sri Lanka Website)

There are a variety of data types available to discover and use on Sri Lanka Geo Portal. These include:

(i) Dynamic Data and Maps - GIS users can access live data and maps through Web Map Service (WMS), using software tools viz. Sri Lanka Geo Portal Map Viewer;

(ii) Downloadable Data - Data downloads enable users to perform custom downloads of digital data users are viewing to access locally with GIS Software. Visit the Free Viewers page for a list of GIS data viewers; and

(iii) Offline Data - Many publishers offer data that can be ordered online.

NSDI Platform - Geoportal

The NSDI is a platform consisting of a website, a metadata catalog and a Geoportal which facilitate accessing, analyzing and processing geospatial information for decision-makers. While the metadata catalog provide the service for searching and describe the spatial data between users and stakeholder.

Through this integrated platform, valuable geospatial information stored by various organizations so the users can be accessed the spatial data through this Geo-portal in a single window for:

(i) Tourism Development Authority;
(ii) Department of Agriculture;
(iii) Urban Development Authority;
(iv) Disaster Management Centre; and
(v) Department of Archaeology.

This is a platform that maintains a spatial database intended to create a common environment where all stakeholders and the public can corporate with each other, access relevant data, make timely decisions as well as contribute by providing relevant data for others to use. This will enable data sharing, avoid duplication in data collection, increase efficiency and collaboration among organizations.

The development of the Sri Lanka NSDI is a collaborative effort of many government organizations including the Survey Department of Sri Lanka, Disaster Management Centre, Department of Agriculture, Department of Wildlife, Department of Forests, Coast Conservation Department, Department of Census and Statistics, Department of Meteorology, Urban Development Authority, Sri Lanka Tourism Development Authority, Department of Irrigation, Road Development Authority, etc. and was facilitated by ICTA. NSDI can be accessed via nsdi.gov.lk. (Daily News, 2018).

Kingdom of Thailand

Capital: Bangkok
Population: 69.9 million
Area: 513,115 sq km (198,115 sq miles)

Major language: Thai
Major religion: Buddhism
Currency: baht

3.2.14 Thailand National Spatial Data Infrastructure

NSDI is an important mechanism for the integration of Thai geospatial data. It not only can decrease the cost and duplication of the geospatial data but also increase the opportunity to access and use the data through the internet.

The Government decided to set up National Geographic Information Committee (NGIC) on 16th June 2003 by the order of the Prime Minister's Office, which went to effect on July 9, 2003, with Geo-Informatics and Space Technology Development Agency (GISTDA) being appointed as Secretariat to the Committee. The National Geographic Information Committee (NGIC) marked policies for systematic progress, reducing repetition, promoting, sharing, and coordinating effectively on geospatial information development, cartography, and remote sensing (Phurith Meeprom, Kaew Nualchawee., 2012).

The components of NSDI are:
(i) Institutional Framework;
(ii) Geospatial Information Standards and Standardization;
(iii) Fundamental Geographic Data Set;
(iv) Metadata; and
(v) Clearinghouse or Portal.

The Thai SDI has been established as a platform for communication of activities dealing with all components of NSDI to promote activities in all sectors and all levels of operation.

Partnerships & Institutional Framework

The current institutional infrastructure includes GISTDA, Which is responsible for policy, regulation and institution structure, which leads to the cooperation and implementation of Geo-informatics development and The Office of Thai Industrial Standard Institute (TISI) is an official organization to disseminate the standard(s).

Geospatial Information Standards and Standardization

The NGIC, GISTDA, and TISI considered geospatial information standards which became to standardization for the country. Thai Industrial Standards Institute (TISI) is the main organization to develop national standards of products and services to be in line with the requirements and international practices. In 2005, a National standard Metadata (TISI.19115-2005) (adopted ISO/TC211) was announced by TISI.

GISTDA is the main organization has responsible to establish common standards for remote sensing and geo-informatics systems, and GISTDA has been formally announced 23 standards. NCGI established sub-committee to study and develop GI Standard and announced 14 standards (adapted ISO/TC211) in 2012. However, GISTDA realized that how to people

are adopting or using the standards in their everyday undertaking, so GISTDA has been carrying out the Outreach Program to build awareness and capacity in geospatial information area as well as all about NSDI (WIENTIAN KODCHABUDTHADA).

Fundamental Geographic Data Set (FGDS)

A survey was conducted by GISTDA in 2010 for the status of Thai geo-spatial data and development of NSDI. Thirteen layers from various organizations were collected for fundamental geographic data set (FGDS) into two areas, namely: development of base data, and development of FGDS themselves. The base data includes aerial-photographs, satellite images, geodetic control monuments, and digital elevation model (DEM) and the other 9 layers include administrative boundary, transportation network, hydrology, urban and town areas, land use, forest area, topographic map data, cadastral, and marine/oceanographic data on the National map scales (1:4,000 / 1:10,000 / 1:25,000 / 1:50,000 / 1:250,000) (Phurith Meeprom, Kaew Nualchawee., 2012).

Metadata

GISTDA has developed metadata Editor Program which is under the ThaiSDI Data Clearinghouse project for creating, edit, update, and search Metadata and try to promote Online.

This project leads to encouraging and supporting data services for users. The information has shown the appropriate elements for ThaiSDI derived from the study by collecting data from several government agencies, which involve fundamental spatial data in Thailand (Phurith Meeprom, Kaew Nualchawee., 2012).

Clearinghouse/ Portal

The National geospatial data clearinghouse/ map portal (http://www.ngis.go.th/home/) has been officially started on 9th February 2012 for access, analyze and process of the 13 FDGS layers. In addition, metadata services for searching and describe the data between users and producers.

Web Applications

GISTDA apply the geo-informatics technology and develop to various web map service for disaster monitoring, agricultural management, and etc. GISTDA provides natural disaster information such as disaster maps and spatial damage assessment through web applications. GISTDA has developed an online service geo-informatics platform: "GIS CHANGWAT". It provided the geo-spatial database as a multi-scale base map which was used by the central government or local government. GISTDA has also developed an agriculture web map service “GIS AGRO” for agricultural practices. The “GIS AGRO” system provides the agricultural information on five subsystems; crop monitoring system, pest, and plant diseases monitoring system, agricultural technology transfer system, weather forecast system, and productivity estimation system.

GISTDA has supported various thematic maps to the various organizations for natural disaster management, environmental and resources management, land use and land cover management, urban planning, agricultural management, and etc (Thailand, 2012).

Socialist Republic of Vietnam

Capital: Hanoi
Population: 89.7 million
Area: 329,247 sq km (127,123 sq miles)
Major language: Vietnamese
Major religion: Buddhism
Life expectancy: 73 years (men), 77 years (women)
Currency: dong

3.2.15 National Spatial Data Infrastructure of Vietnam

In Vietnam, the national geospatial information system has not been built yet. Since the 1990s, ministries and agencies have been established thematic database, natural resources and environment database for planning and national development. Almost all of these systems are separated and the collected data is not standardized, therefore, the data duplicity and sharing are the major problem (Do Thu Thuy, 2011).

To resolve these problems the Prime Minister of Vietnam has approved the strategy on ICT development by 2010 and vision for 2020. The strategy emphasized that the development of ICT should be extended in every field. One of the important parts of the strategy is to develop a spatial database infrastructure system to share the information for every field.

In this context, the Vietnamese government has assigned the Department of Survey and Mapping Vietnam, to form a National Committee and prepare a plan on the establishment of Spatial Data Infrastructure. The organization's role is also to contribute some of the core geospatial data for the NSDI of Vietnam

Formation of the National Committee on Spatial Data Infrastructure

Vietnam has established the National Committee on Spatial Data Infrastructure for directing, coordinating and connecting activities to speed up the establishment of the National Spatial Data Infrastructure (NSDI) of Vietnam. The Deputy Prime Minister is the chairman of the Committee, and members are from the 12 different ministries, including the Ministry of Natural Resources and Environment, which plays a lead role on the implementation, management, and maintenance of NSDI. The main purpose of the committee is to give the solution on the government on the issues relating to NSDI and maintaining NSDI to utilizing spatial information (Do Thi Thu Thuy., 2015).

The responsibility of the committee is to advise the Government on the following issues:

(i) Policy and orientation of NSDI activities; strategies and planning for NSDI activities;

(ii) Issues including mechanisms, institutional framework, policies, programs, national investment projects, which relate to NSDI;

(iii) International cooperation activities in Vietnam's SDI; and

(iv) Legal documents promulgated under the authority of the National Assembly, Standing Committee of the National Assembly, Government and Prime Minister, regarding or relating to NSDI.

Fundamental Geographical Database

The Department of Survey and Mapping Vietnam (DOSMVN) is responsible for all survey and mapping activities in Vietnam. Vietnam Survey and Mapping Development Strategy 2020 are to recognize that DOSMVN has a duty to take part to build, develop, improve and update the geospatial database on the following data themes and datasets (Bach Giang TRAN., 2019):

(i) **Framework themes** Geodetic control, Topography, Imagery, National borders, Administrative boundary and Geographic names

(ii) **Specialized data themes** Cadaster, Land use, Water, inland, Geology, Soils, Forest, Underground work, Civil aviation, Sea charts, Natural disaster prevention, rescue, environmental incident recovery, climate change response, Transportation and Planning

Data Access

Access to data is an important factor that enables interested users to access data easily. Access to spatial data needs to be reviewed in two aspects:

(i) Create an open mechanism for access spatial data and to make it possible to access data widely in the community; and

(ii) Find reasonable architecture in accordance with a current technology level to easily access data and include clients who want to access the data for different purposes and on different platforms.

Technology

The technology component of NSDI development is always considered on the basis of four major aspects:

(i) Improvement of the national geodetic reference system and national geodetic coordinates network to form a unified framework for geospatial data;

(ii) Technological solution for geospatial data collection and update, are primarily GNSS and remote sensing in order to facilitate data collection and update;

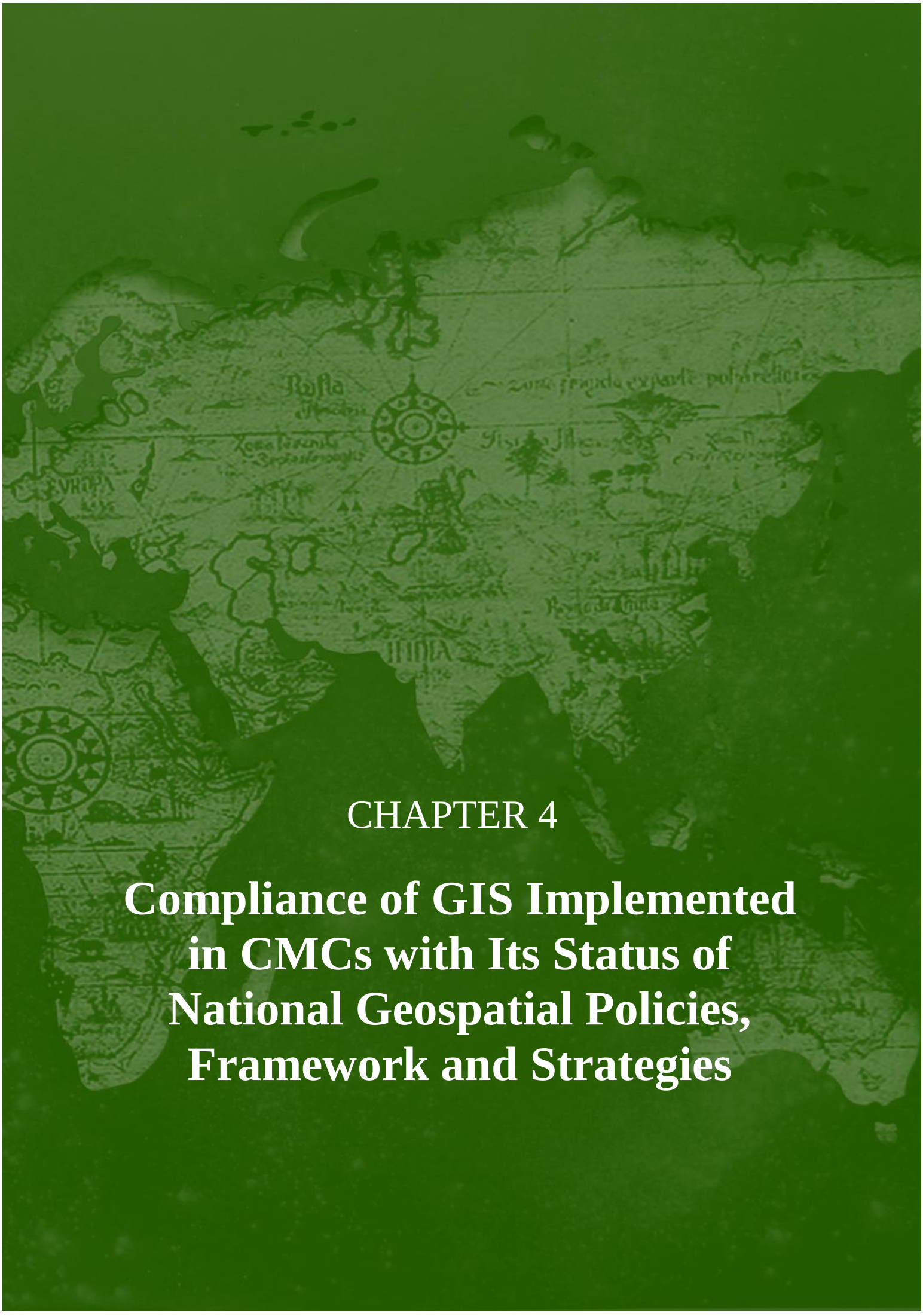
(iii) The technical solution for system architecture and networking for easy access to geo-information; and

(iv) Technical solution for spatial data processing, major in development of Web-GIS and Mobile-GIS.

Organization and Institution Component

At present, several organizations under MoNRE are responsible for storing, managing, updating and supplying spatial data, including the Department of Survey and Mapping manages national geodetic reference system, elevation, and coordinate network, aerial photos, topographic maps at different scales; The Land Administration Department manages spatial data related to land; National Centre of Remote Sensing manages satellite images of EnviSat, SPOT, and other image sources. The Spatial data related to water resources, meteorology and environment are managed by agencies of MoNRE. The forestry resources are being managed by the Ministry of Agricultural and Rural Development. Except for the above agencies, ICT Department under MoNRE is responsible for organize natural resources and environment database, developing natural resources and environment information network, and providing technical supports to all agencies in MoNRE.

Vietnam has so far focused on building and developing geospatial data components and has achieved some preliminary results. From 2019 with the implementation of the provisions of the Law on Surveying and mapping, the build, development, and management of NSDI will be implemented and make new achievements.



CHAPTER 4

Compliance of GIS Implemented in CMCs with Its Status of National Geospatial Policies, Framework and Strategies

Chapter 4

4.0 Compliance of GIS implemented in CMCs with its Status of National Geospatial Policies, Framework and Strategies

4.1 National Geospatial Policies, Framework and Strategies

Spatial data plays an important role in the development process of the country. Therefore, accessing, sharing and utilizing the geospatial data forms the essence of the geospatial infrastructure. Today, developing countries hold a considerable amount of geospatial information, including databases. Governments also establish data standards to ensure data collected by various agencies and the private sector will be interoperable, based on the same reference system (World Bank, 2019).

In the era of rapidly-changing technologies, the need for a dynamic geospatial policy and strategy has become mandatory to enable the use of data for solutions in the country. Geospatial policies should have global relevance and competent national relevance to transform a nation from a developing to a developed country.

Geographic Information Technology has developed remarkably pace over the past two decades. Thereupon, developed countries have a strong geospatial infrastructure and a strong policy framework that accelerate the growth of the geospatial industry. On the other hand, the policy framework in developing countries is at the implementation stage as the need for extensive use of geospatial is now being realized.

Underdeveloped countries are at the initial stage of setting up their spatial data infrastructure but lack the adequate legal framework. They would require considerable time to develop the geospatial infrastructure and policy framework (Narain, A., 2017). If a country does not have a framework, then naturally the growth of the geospatial industry will suffer, eventually hurting national interests (Datta, A. 2018).

4.1.1 Islamic Republic of Afghanistan

The Asian Development Bank (ADB) and the Government of Afghanistan launched two foundation policies that help in developing central information portals to increase access to accurate and comprehensive geospatial data in the country. Policy documentation is very useful in relation to lack of availability, quality, accessibility, and sharing of geospatial data in Afghanistan. Two policies are achieved in creating, maintaining and sharing

quality and accurate geospatial data. These policies help to build the government's capacity use technology improve its development plan and decision-making, which will bring better and more durable results for the country (ADB, 2017).

All Afghan government agencies and their staff have a duty to respect the confidentiality and integrity of any government geospatial information and data they have access to and are responsible for safeguarding data assets as directed by these policies. This ensures that consistent controls are implemented throughout their partners. The Afghan Government Security Classifications and data standardization came into force on 02 April 2017. Violations of these policies may result in suspension or loss of the violator's privileges with respect to Institutional Data Information Systems. Additional administrative sanctions may apply disciplinary actions up to termination of employment. Civil, criminal and equitable remedies may apply.

Afghanistan Geospatial Data Standardization Policy

The challenges regarding the lack of availability, quality, accessibility, organization, and sharing of geospatial information are common to a large number of policies and activities experienced at different levels of government and non-government organizations. In order to solve these problems, it is necessary to take measures of coordination between the users and providers of geospatial information.

Standards have always been important for cartographic. In the current digital era, standards have become important for the exchange of data between organizations at a national, regional and global level. Standardization, the process of developing and implementing technical standards, brings uniformity, compatibility, and interoperability to millions of processes, tools, and applications in all areas of a global economy. Therefore, The Asian Development Bank (ADB) and the Government of Afghanistan established a policy for the standardization of geospatial data. The purpose of this policy is to establish a framework for the standardization of geospatial data. This policy applies to all geospatial data and related information held by the Afghan government organizations. It does not cover data used by individuals for their own personal purposes.

The policy is focused on geospatial data standards, which relate to the initiatives of Afghan Government in collecting, maintaining, managing, and sharing geospatial data in order to overcome the above-highlighted issues and to improve decision making. The geospatial data standardization policy is a part of the GI standardization suite of policies, designed to enhance the integration processes of geospatial data and information into daily decision-making at all levels of society. The Afghanistan Geo-Informatics coordinated committee (AGICC) has maintained a close overview of the development of the policy and approves it for use across government with the support and backing of His Excellence the President of Islamic Republic of Afghanistan (Afghanistan Geospatial Data Standardization Policy, 2017).

Afghanistan Geospatial Data Classification Policy

The purpose of Afghanistan Geospatial Data Classification Policy is to establish a framework that helps the government classifying geospatial and related information on its level of sensitivity, confidentiality, and criticality to ensure that they are properly utilized and protected, and meet the requirements of relevant legislation and international or bilateral agreements and obligations.

Classification of data helps to determine minimum security controls for the protection of geospatial and other data, proper utilization of resources, and for compliance with regulations. This policy applies to all geospatial data held by the Afghan government organizations and also applies to all staff, partners, and third-party agencies handling government geospatial data. This policy does not cover data used by individuals for their own personal purposes. The Afghan geospatial and related information assets will be classified into one of three categories: public, for internal use or confidential. This policy is a part of the information security suite of policies, designed to ensure that the data owned by government agencies are handled in the most secure manner to satisfy business and relevant compliance requirements. Each government institution must identify and classify all geospatial data based on criticality, confidentiality, sensitivity, and availability; and must implement sufficient measures to protect data from use or disclosure that would be harmful or inappropriate in light of the classification of these datasets (Afghanistan Geospatial Data Classification Policy, 2017).
The Afghanistan Geo-Informatics coordinated committee (AGICC) has maintained a close overview of the development of the policy and approves it for use across government with the support and backing of His Excellence the President of Islamic Republic of Afghanistan.

4.1.2 People's Republic of Bangladesh

A fundamental role of any government is to provide optimized service to administration planning for economic development, law enforcement, public works, and services, etc. All these are portrayed on the map of different kinds for planning purpose, Survey of Bangladesh (SOB), being the National Mapping Organization (NMO) for Bangladesh had been facilitating Armed Forces, other Government, Non-government, autonomous organizations and even individual researchers with various data and maps of those kinds (Rehman, N., Oliullah., & Sardar, Z.H., 2014).

Institutional Framework of Surveying and Mapping in Bangladesh

Survey of Bangladesh publishes and distributes maps and data under the Rule ‘Classification, Custody and Issue of Maps/ Photographs-1972’. A new ‘Topographical Survey Act’ is under process for government approval. Projects are under implementation for the preparation of medium and large scale digital topographic maps of the whole country and its digital database which will be very much useful for the development work of the country. Bangladesh has also established a modern digital mapping center and it has further plans to establish a Survey

Institute in Bangladesh of international standard for officers/ supervisors/ technical staffs on mapping and surveying (Bangladesh Institutional Framework, 2015. UNGGIM).

Survey and land registration are the responsibility of the Department of Land Records & Survey (DLR&S) under the Ministry of Land. SOB provides geodetic control points as per their requirements. For the Registration and Certification, Survey of Bangladesh issues competency certificates to private survey companies/ farms for their survey and mapping activities.

As NMO, SOB has enough experiences in terms of geospatial data creation. But the administrative boundary data, being of other governmental organizations like DLRS, LGRD, and etc. formal legislation is missing which would have encouraged spontaneous data sharing among the SOB during changes of boundary demarcation lines. Again, from a policy viewpoint, the use of SOB's data could not be made mandatory for government and non-government organizations in order to carry out any development works' planning or research activities. SOB recommends formal legislation to propagate the use of geospatial data of SOB for planning, research works as a cost-effective tool.

The workshop on Draft Guidelines for Data Sharing Protocol and National GIS Data Policy held on LGED Headquarter, Dhaka on 22 October 2008 and the policy document was focused on "Compatibility of GIS Data and Development of Guidelines for Metadata, Data Sharing Protocol and National GIS Data Policy". In the draft, it is mentioned that "All the organizations in Bangladesh should follow a common projection system and parameters to make the GIS data compatible amongst the GIS user organizations." "All the organizations in Bangladesh should follow a common metadata standard and ISO 19115:2003 Geographic Metadata Standard has been recommended as a national metadata standard." "All the organizations in Bangladesh should follow a common GIS data sharing protocol" (CEGIS, 2009).

4.1.3 Republic of the Fiji Islands

Fiji has difficulties in managing its lands and thus achieving economic prosperity for the country as a whole. The difficulties stem to a large degree from the various organizations that have developed over the years to administer and manage its limited land resources, and from the dual land tenure system that exists in Fiji, as a result of the 94 years of British rule from 1874 to 1971. Since the colonial era, much information relating to land in Fiji has been collected, stored and maintained by various departments and agencies, in different mediums, methods, and forms in Fiji. This has made any attempt to integrate land administration activities extremely difficult. As a result, duplication of work is a common occurrence. Therefore, it became increasingly obvious to the Government of Fiji that something needed done to improve the present system of land administration. Such improvement is considered an initial but important step towards improving and utilizing Fiji's limited natural resources, and ultimately improving the quality of life for the three-quarters of a million people that co-exist on this relatively small island republic. One option is to look at establishing a Fiji Land

Information System (FLIS). In 1990, in response to the growing interest and awareness amongst the various public and private organizations, the Fiji Government initiated the implementation of a national Land Information System With the help of the New Zealand Government (NZAID). This national LIS is currently implemented; along with others that are already in place or are still being implemented (Rakai, M. E. T., & Williamson, I. P., 1995).

Governing Structure

The government of Fiji through the Fiji Geospatial Information Management Council and the FLIS Secretariat within the Ministry of Lands and Mineral Resources persisted on innovations for more cohesive efforts in the training and in the provision for appropriate funding to expand the geospatial information development in Fiji (Naicegucegu, S., 2012).

(i) Each Ministry or agency is the custodian of its own data. Sharing of data is governed by MOU/MOA

(ii) Similarly each Ministry or agency look after its infrastructure (Software/Server).

(iii) All Ministry/Agencies that have related GIS/GIM work are members of the Fiji Geospatial Information Management Council.

National Geospatial Strategy

The importance of information management in Fiji is gaining momentum through the Fiji Geospatial Information Council. The national geospatial strategy will promote and allow the sharing of centralized data from socio-economic and physical data i.e. land, sea, underground and air for decision making under five areas (The Fijian government, 2014):

(i) Strengthening of the existing government structures;

(ii) Improvement of the fundamental geospatial data;

(iii) Enabling access to fundamental geospatial data that accessible;

(iv) Enabling inter-operate ability with fundamental geospatial data; and

(v) Strengthening the human technical capacity of the industry.

4.1.4 Republic of India

National Geospatial Policy [NGP 2016] The increasing growth of the use of Geospatial Data, Products, Services and Solutions (GDPSS), the Government of India declare a comprehensive "National Geospatial Policy (NGP) – 2016" to empower people through geospatial technologies.

GDPSS is multidisciplinary in nature and important in terms of national development. It is obtained through various tools and technologies like surveying, remote sensing, aerial surveys, photogrammetry, geodesy, hydrography, Global Navigation Satellite Systems (GNSS), Geographic Information Systems (GIS), mobile phones/devices, Geospatial Web Services (GWS), Location Based Services (LBS), and Radio Frequency Identification Devices (RFID), etc. GDPSS is analyzed, classified and visualized for planning, design,

implementation, evaluation as well as for monitoring of various developmental activities. The Increasing importance of geospatial information requires proper guidelines in respect of national policy to ensure data availability, accessibility, and quality in order to fulfill the inadequacies of national development goals, in consonance with issues related to national security and intellectual property rights (IPR). It is necessary to adopt NGP for effective utilization of GDPSS for inclusive growth through efficient, informed, transparent and timely decision-making.

The policy aims to empower people through GDPSS. It will include creation, management, access, sharing and dissemination of quality assurance products, services and solutions through standards to enable more effective economic and social benefits to governmental, academic, private organizations and NGOs (National Geospatial Policy, 2016).

The availability of digital forms of map information through satellite data and the network has provided previous policies to restrict map information to citizens in many countries. The market has become a reality for the spatial information and this trend is only likely to grow. There are some internal MOD policies and guidelines that are available in open domains and related to various aspects of geospatial data such as:

(i) **The National Map Policy 2005 (NMP-2005)** The Government of India announced the National Map Policy (NMP) on May 19, 2005 (DST, 2005), and authorized the Survey of India (SOI) to issue guidelines for the implementation of NMP and in particular the use of SOI products. Keeping in view of national security, SOI has proposed two series of maps: defense series maps (DSM) to cater to defense and national security requirements, and open series maps (OSM) for civilian use. The remote sensing data policy (RSDP) was announced by the National Remote Sensing Centre (NRSC for satellite data from Indian and foreign satellites (Singh, Pramod., 2009). Other geospatial products such as aerial photography, a large set of thematic maps, geospatial models, and value-added products and services are not covered under these policies. India needs to have an integrated spatial information policy incorporating all spatial data products and services;

(ii) **The Civil Aviation Requirement (CAR)** in 2012 was giving details of the process of issuing the clearance for agencies undertaken air photography, geographic survey, geological survey, etc.;

(iii) **The Remote Sensing Data Policy (RSDP - 2001 and 2011)** defines the distribution process of satellite images to a different category of users; and

(iv) **The National Data Sharing and Accessibility Policy-2012 (NDSAP-2012)** provides a competent provision and platform for the active and open access of data generated through public funds available with various departments/organizations of the Government of India (Country Report, 2017. UN-GGIM).

Major Initiatives by Public Sector for GIS Infrastructure Development in India, Such are:

Name of Agencies	Major Projects/ Data Contents
Survey of India (SOI)	Base maps and topographical mapping on various scale
Indian Space Research Organization	NRDB (natural resource database) initiative, which is pulling data from (NRIS) natural resource information system– over 25 GIS layers for 17 states; FASAL (Forecasting Agricultural output using Space, Agro-meteorology and Land-Based Observations); Nation-wide wasteland mapping; Nation-wide wetland mapping, Nation-wide Natural Resource Census (NRC), village resource center (VRC) for remote areas, etc.
National Remote Sensing Centre	A wing of ISRO, responsible for acquisition, processing, and supply of aerial and satellite remote sensing data
National Informatics Centre	Network backbone and e-governance support to government at various levels –center, state, and district
Ministry of Urban Development	The one-stop resource for urban planning and management under two mega projects–urban spatial information system (USIS) and national urban databank and indicators (NUDB&I
Census of India	Nation-wide demographic and socio-economic data based on surveys conducted at intervals of ten years
Forest Survey of India	Biennial monitoring of forest resources in India
Geological Survey of India	Geo-scientific database developed over a period of 150 years
Central Ground Water Board	Groundwater occurrence in different terrains
National Atlas and Thematic Mapping Organization	A large number of atlases and thematic maps based on research studies on environmental and associated aspects
Ministry of Agriculture	Crop acreage and production estimation (CAPE) / FASAL
India Meteorological Department	Meteorological information for optimum operation of weather-sensitive activities
National Bureau of Soil Survey and Land Use Planning	Nation-wide soil survey and mapping
Natural Resources Data Management System	Micro-planning data on an experimental basis
State Remote Sensing Application Centers (SRSAC)	Various thematic layers state-specific data by 26 SRSACs

(Table 9: GIS Infrastructure Development in India)
Source: (Country Report, 2017. UN-GGIM)

4.1.5 Republic of Indonesia

In 2010, the Ministry of Environment and Forests produced the maps. Although these maps showed and claimed the same area and the map boundaries and forestry concessions was completely different. Only 32.6 million hectares of forests matched between the two maps, with an overall error ranging from 10 to 30 million hectares (Bretz, Kaitlyn Justine, 2017). It was later discovered that each agency had different criteria for secondary and primary forests, different forest boundaries, and different mapping methodologies. After seeing the map President Suzalo Bambang Yudhoyono offered a map policy (officially Law Number 4/2011) with three significant aspects:

(i) **"One reference",** meaning that the map will be based on a single geodetic control network (one spatial coordinate system);

(ii) "**One standard",** namely the Indonesia National Standard that would summarize the major thematic data for the nation; and

(iii) **"One database",** or the publication of an online integrated database of spatial and non-spatial data available to the public

The main purpose of one map policy was to create a map to use as a base and serves as a reference to the use of all agencies, with the aim of preventing overlapping land use claims. The Maps prepared by state agencies were merged, and spatial data was superimposed to a ratio of 1:50,000 (i.e., one centimeter on a map equals 50,000 centimeters in real space.

Spatial Informatics Group (SIG) in the United States, was one of the groups to contact by the Indonesian government to help assist *Badan Informasi Geospasial (BIG)* to meet the goals outlined in a map policy (Bretz, Kaitlyn. 2016).

The first tasked of Spatial Information Sciences Group was examining "geospatial architecture, systems, and national processes, which provided the right mix of technical alignment within the national association and geospatial database already within Indonesia.

Secondly, the Spatial Information Science group created Indonesia's first interactive mapping portal, through which any user can download or share specific data, as well as a place where a user can create a map that includes interest for them.

With the help of SIG, Indonesia's first basic geospatial maps and thematic maps (for example, national land use and land cover map, mangroves map, marine map, and shallow water map) were published after three years of data collection in 2014. This data is available on the BIG website for the public (Bretz, Kaitlyn. 2016).

4.1.6 Islamic Republic of Iran

The Islamic Republic of Iran has an effective endeavor to access ideal statue in applying GIS in-country and applying geographical information as national wealth to execute different scale projects in accord with reasonable and logical ideas. It has a very important role in

transference and technology information exchanges to the other organizations, contribution in geographical data production, standard, and work plan compilation which are the:

(i) Determination of fundamental data layer with specified quality and coverage;

(ii) Compilation of statutes and rules for different matters such as data security and owing of data and responsibility of quality and quantity of data, the way of contribution and other related issues to producer and consumer of information; and

(iii) Making importance decision with presenting useful comments and plan, presentation training course, spreading GIS culture, preparation topographical.

National Cartographic Center (NCC) of Iran has an effective role in organizing national GIS and making collaboration among Geo-Matic engineering associations and surveying societies and other organization and institute. NCC has accomplished to apply GIS and determine strategies on performing GIS. National Council of GIS Users activities (NCGISU) try to spread GIS wing and also transfer experiences and results in regional, national and international level. It was established in 1993 (for policy, planning, and coordination GIS activities, requirement analysis) to apply all scientific and technical capacity and professional ability to set up a GIS system and practical use of that, under the direction of NCC Council members are full expert and representatives of organizations, administrations and executive sections such as ministries of *Jehad.e.Keshavarsi*, Oil, Power, Industry, Roads and Transportation, Housing and Urban Development, Defense, etc (Baktash, P. (2003)..

NCC has its chairmanship and GIS department of NCC as a secretariat of this council that provides essential facilities to hold council meetings and perform its approval in order to Corporate and conduct executive organizations for applying Geo-Reference GIS.

NCC is also the coordinator organization in National GIS and activities related to NSDI. One of the necessities of its duty is to define users and their information and interaction requirements. Any information system should meet the needs of the producing organization and also the working requests of users that it supports. The interaction with users of information systems implies that the user determines the usefulness of the system. Therefore, NCC has established a National Council of GIS Users (NCGISU) to collect user needs and to interact with them. Members of NCGISU are representative of all related ministries, and the Council has provincial branches in all provinces. Each provincial committee reflects its needs to the NCGISU and soon after discussion and improvement, it will be considered by NCC to provide required changes (Baktash, P. 2012).

4.1.7 Lao People's Democratic Republic

In 1997, Laos received a new geological datum with support from the Land Titling Project. It is known as National Datum 1997 and has its origins in Vientiane, Nongteng, and Astro Pilar. NGD is recommending all land surveys in the country to use this Datum (Mishra, S. 2010).

Then, in 2003, the GIS Coordinator Committee was set up by an agreement of the Prime Minister's Office (number: 0593 / PMO). The committee held its first meeting on December

2011. It was decided in the meeting that with the support of SNGS (Strengthening of National Geographic Services), the NGD (National Geographic Department) will prepare a new list of works and work plan. The scope of the Committee's work covers the sharing and distribution of geographical information of all government institutions. The Committee supports the introduction of standards for data production and management and promotes the exchange of information to avoid overlapping work (Admin, 2012).

The current Decree on Surveying, Aerial Photography, and Mapping, Number: 330/GOL has been enacted on the date of 19-September-2014. This decree stipulates that the NGD is responsible for collecting, editing, maintaining, and developing the spatial data received from different ministries, organizations, departments, units, and international organizations related to surveying, aerial photography and mapping to become the national database. NGD has been given the power to promote the rules and monitor surveying, aerial photography and topography mapping. The decree says that all survey activities in Lao PDR should be consistent with an integrated system. The decree also emphasizes that all surveys, aerial photography and topography mapping need approval from the NGD and after completion of the survey the results will be submitted to the NGD (Decree No. 330/GOL, 2014).

On 5 June 2015, the Geographical Information System (GIS) committee organized a three-day workshop. The main objective of the workshop was to come to the agreements on joint data sharing policy and technical standards. Regarding geographical data, coordination of line ministries is necessary because there is no general regulation on geographical information, nor an authority to decide on the standards and practices of production, distribution, and sharing of geographic information. During the workshop, various departments show the techniques of data collection, stored, use and shared information. Following day, the working group discussed a draft on “Data sharing policy and technical standard” (Daosamlong, 2015).

4.1.8 Federation of Malaysia

National policy on the collection, analysis, and distribution of geospatial information is necessary for a spatially-empowered government and society. The Ministry of Natural Resources & Environment (NRE) has been mulling the National Geospatial Act since 2011, with the aim to improve governance of activities related to the application of geographically-based data.

Professor Sr. Abdul Kadir bin Talib, Director-General of the National Survey and Mapping Organization, is quite vocal about the importance of the National Geospatial Act. And said" it is necessary to pursue policies related to geospatial activities in a broad and well-planned manner by establishing basic principles and clarifying the responsibilities of federal, state and local governments, by defining policies on the dissemination of geospatial information (Singh, I., 2016).

The Ministry of Natural Resources and Environment (NRE) is developing the National Geospatial Master Plan (NGMP) to understand the capability of geospatial technology in line with the National Transformation 2050 plan of the Government.

The master plan was expected to be completed by 2018, to include the development of a clear policy, a sound legal and enforcement framework, a strategic plan for national geospatial management and national geospatial enterprise architecture (Bernama, 2017).

Through the implementation of NGMP, there are five important deliverables, such as:

(i) Draft on the geopolitical policies of Malaysia;

(ii) A draft bill on national geo-implementation;

(iii) The proposed structure of governance to manage the geospatial system;

(iv) Proposed Design of Enterprise Architecture for National Geospatial Implementation and National Geospatial Strategic Plan (2017-2027); and

(v) The master plan to strengthen the government through the fort of national geospatial efforts with effective implementation, coordination and enforcement, besides strengthening the National Geospatial Data Infrastructure program by making geospatial information more clearly and widely organized.

4.1.9 Republic of the Union of Myanmar

Food security, poverty eradication, sustainable economic development, disaster, and climate resilience are all topical government challenges that can be resolved most efficiently and effectively when governance decisions are informed by authoritative, high-quality spatial information. Modern geospatial (digital mapping) infrastructure and location services have a high potential to bring about valuable socio-economic benefits. Governments play a leading role in setting up geospatial infrastructure as a public good.

The National Land Use Policy (NLUP, 2016) of Myanmar outlines a common vision among Myanmar's government actors, civil society, businesses and academia for building the infrastructure to provide institutionally sanctioned, automated means for easy access and sharing of authoritative geospatial information and delivering land-related e-services. Nascent geospatial infrastructure and services in Myanmar should be systematically supported to underpin peace building, NLUP implementation, and e-governance advancement. The demand for better geospatial information and services can be met gradually in a systematic process of developing national spatial data infrastructure (NSDI) and ensuring overall efficiency and effectiveness. In contrast, prevailing procedures, regulations, traditional rules, and standing laws prevent easy access to sharing and dissemination of digital geospatial information

Positively, the One Map policy initiative of the Government of Myanmar, supported by the One Map Myanmar project already involves 25 land-related government agencies, civil society organizations, and academia, and paves the way for a unified digital map that is accessible on the web for government and public use.

The vision and priority of geospatial infrastructure and services in Myanmar are broadly framed in NLUP and the e-Governance Master Plan (eGMP 2016-2020). NLUP and eGMP are interrelated, complementary and consistent with Myanmar's pressing geospatial needs (Geospatial Infrastructure and Services, 2018).

4.1.10 Federal Democratic Republic of Nepal

All socio-economic developmental activities, conservation of natural resources, planning for disaster mitigation and infrastructure development require high-quality spatial data. In Nepal, The Surveying and Mapping Policy have been formulated based on the draft National Land Policy document. Survey Department is responsible for producing, maintaining and disseminating geospatial information throughout the country. The policy has been formulated based on the legislative and institutional framework for the surveying and mapping activities. The vision of the policy is defined as to produce and make available high-quality geo-information products and services for sustainable land administration and management as well as planning and various lands related development activities to achieve the national objective of poverty reduction and sustainable development.

Based on this vision, objective and issues, the policy on Surveying and Mapping in Nepal are identified on the following field (Adhikary, K R., & Paudyal, D R., 2014):

(i) **Geodetic Surveys and Space Science** Geodetic data includes horizontal and vertical ground control points distributed all over the country in their own network system;

(ii) **Topographic Survey and Geographical Information Infrastructure** Topographic survey includes the preparations of topographic base maps, derived scale topographic maps, thematic mapping, the development and maintenance of horizontal and vertical ground control networks comes in the responsibility of the national government;

(iii) **Cadastral Survey and Land Information** Cadastral survey includes the recording of location, extent, land ownership rights, area, land use and the physical characteristics of a parcel;

(iv) **Research & Development** Research and development (R&D) on surveying and mapping is necessary to look into technical developments taken place, to formulate the necessary adjustments to the working procedure of various phases and to introduce new functions in surveying mapping activities; and

(v) **Resource** Resource policy includes the human resources, equipment for the production process and technology required for surveying mapping activities.

4.1.11 Islamic Republic of Pakistan

Survey of Pakistan (SoP) prepares the policy as SoP is legally mandated to collect, maintain and disseminate geospatial information of the country. To cope up with the map mania era, SoP prepared comprehensive Surveying & Mapping Act which in principle supersedes the old map policy. The aforesaid Act has been recently promulgated by the President of Pakistan as Surveying & Mapping Ordinance 2013.

Some of the salient features of the ordinance are:

(i) Various terms related to Surveying, Mapping, Geospatial Data, GIS, Geodesy and National Spatial Data Infrastructure (NSDI), etc. have been officially defined in the history of Pakistan;

(ii) To avoid duplication of efforts in collection of the same datasets, sharing of data has been underscored;

(iii) The value of data standards and specifications has been highlighted and it has been made compulsory for all public as well as private sector organizations to produce standardized geospatial datasets for its effective and objective usage;

(iv) The need to have inter-agency coordination for acquisition, processing, and maintenance of geospatial data, has been linked; and

(v) The emerging need for the development of National Spatial Data Infrastructure (NSDI) for Pakistan with the collaboration of all major stakeholders has been briefly outlined.

Indeed, the ordinance is a good mix of technical and non-technical aspects for production, access, dissemination, and sharing of geospatial data but its implementation would be a challenge due to the prevailing organizational culture of the public sector in Pakistan (Ali, Asmat & Ahmad, Munir. 2013).

Pakistan is looking forward to Supports from International organizations in finalization of national policies on spatial data infrastructure and standardization of dataset. It's also plan to create awareness program on geospatial database, policy and importance of GI science for decision making and planning purposes (SUPARCO, 2012).

4.1.12 Republic of the Philippines

In the Philippines, A strategy for promotion and coordination of geographic information development and use was developed by Memorandum Order in 1993. The IATFGI (Inter-agency Task Force on Geographic Information), was established in 1993 by Memorandum Order to promote and coordinate geographic information development. It reviewed policies as well as coordinated activities of agencies involved in geographic information. It is formulated the Philippines NSDI framework plan in 2001 to establish a technical, operational and legal framework for the management of geographic information (Tiangco P. N. & Linda SD. P., (2006).

Afterwards, the Philippines Geospatial Data Infrastructure (PGDI) Master Plan 2011-2020 was created to achieve the vision of a spatially-enabled nation for sustainable economic, environmental and social development. It clarifies the objectives and action plans for various NSDI components across ICT infrastructure, governance structure, policies standards and change management, data, capability development and geoportal. As part of the PGDI Master Plan, the PGDI Steering Committee was formed to provide executive leadership for the coordination of activities between agencies, with NAMRIA as the technical and administrative secretariat and its reporting ministry, the Department of Environment and Natural Resources, as the chair (PGDI Master Plan 2011-2020).

In 2014, the Open Data Philippines programme was launched, to bring together existing open data initiatives, such as those of the Philippines Statistics Authority and Department of Budget & Management. It is led by an inter-agency Task Force comprised of the Office of the Presidential Spokesperson, Presidential Communications Development and Strategic Planning Office, and Department of Budget and Management.

The Task Force oversees the development of the Open Government Data portal, formulation of data disclosure policies, as well as the promotion and socialization of the Programme. The task Force is supported by the Project Management Office, which functions as an inter-agency secretariat unit that oversees the day-to-day matters of the programme (Open Data Philippines Action Plan, 2014-2016).

4.1.13 Democratic Socialist Republic of Sri Lanka

Standards for Geospatial Data

The Department of Survey has drafted a proposal for digital data standardization and distribution, ownership, copyright and liabilities, quality and accuracy, scale issues and data formats and forwarded to the map user community in the country for endorsement and approval. Afterwards, according to the proposed digital data standards, Department of Survey prepared digital maps of land use and spot heights at the scale of 1:50,000 and Digital data layers of major towns, stream network, road network, irrigation tanks and reservoirs and contours at 1:250,000 scales. (Dr Ranjith Premalal De Silva (2010).

National Data-Sharing Policy

The draft national data-sharing policy is to define a set of guidelines and principles to help create an ecosystem for the enhanced access to the sharable data to relevant stakeholders. The policy shall be applicable to all data whether electronic or in the form of manual records (National Data Sharing Policy).

The policy intends to achieve the following outcomes:

(i) To promote sharing of the data between the departments (on authorized or restricted access);

(ii) To create an integrated e-services where multi stakeholder partnership would be developed between public, private and civil societies;

(iii) To provide the data for public;

(iv) Avoid the data duplication and data integrity issue;

(v) Use the sharable data for appropriate purpose;

(vi) To create a governance framework to monitor and evaluate the implementation of data sharing framework in the government departments/ministries; and

(vii) To provide guidelines for the creation of legal, technical, operational and change management frameworks for the implementation of data sharing framework in the government departments/ministries. The benefit of this policy is in three major areas, such as:

Government:

(i) Easy access to data collected and generated by various other government departments, ministries, and agencies;

(ii) Reduce repetition of tasks associated with information management such as; collection, validation, and storage; and

(iii) Enhanced communication across government and related sectors.

Citizens:

(i) Better accountability and transparency for citizens;

(ii) Easier public access to government services; and

(iii) Citizens' contact details can be updated by one department and shared with others.

Business:

(i) Enhanced business opportunities due to access to public data;

(ii) More transparency into government functions; and

(iii) Cost Optimization as same data shall not be collected.

4.1.14 Kingdom of Thailand

The Plan to drive Thailand SDI Implementation is in National Spatial Data Infrastructure: NSDI Master Plan (2011-2017). For the efficient and effective mobilization of the Thailand SDI to take place, the implementation plan has been devised to take two consecutive phases, i.e. a 5-year period (2011-2015) and a 2-year period (2016-2017) respectively. The brief account of activities in each phases is as follows (Meeprom, P. & Nualchawee, K., (2016).

The First Phase (2011-2015)

Under the first period, all the assigned FGDS custodians collected, collated and integrated all FGDS under their responsibilities based on standardized approaches guided by the National GIS Committee.

Part of FGDS was put to service at the start and finally, from 2015 all the FGDS services are available to all sectors of the society. At the beginning of this period, the development and establishment of complete NSDI Portal/Clearinghouse were started by connecting the existing ThaiSDI clearinghouse to the Web-GIS service based on standardized protocols accepted and accessible by all stakeholders. Additionally, capacity building is effective for all concerned including data producers, data distributors, and end-users for their benefit.

The Second Phase (2016-2017)

This period has been set up to accommodate all necessary activities to ensure a fully functional Thai SDI. At the end of this period, all the FGDS developed with other relevant datasets were installed in the Thai SDI system. NSDI portal/clearinghouse included all FGDS nodes that will be functional to serve the next plan to accommodate the business, as well as high-level government administration activities.

The SDI in Thailand development and implementation was started with five action plans, namely, 1) Development of NSDI Portal, 2) Development of geospatial information standards, 3) Development and integration of base data, 4) Development and integration of FGDS and 5) Capacity building. Nowadays, a total of 25 ISO / TC211 standards developed under the GIS standard development project by the GISTDA (Silapathong, C. & Nualchawee, K. & Karnchanasutham, S., 2012).

GISTDA, has been covering the development of 13 fundamental geographic datasets and the identification of the respective custodians. GISTDA developed the geospatial metadata and clearinghouse portal for accessing, assessing, enquiring and transaction of spatial data between users and producers of spatial data that meet their needs (Hanesana, Alan & Askov, David & Nezelek, Richard., 2011).

4.1.15 Socialist Republic of Vietnam

Before the 1990s, geospatial data was considered secret documents used only in Central management agencies. The topographic maps and aerial photographs had been strictly prohibited for public use and the exchange of spatial data from other countries was complex procedures. Afterwards, Government of Vietnam realized the importance of information technology and in 1996, Vietnam launched a national program IT-2000, to promote the development and application of information technology to serve the industrialization modernization, towards three main objectives (Dr. Duc Tue NGUYEN, 2019):

(i) The widespread application of information technology in all areas;
(ii) Develop a national information network covering the whole country coverage; and
(iii) Industrial development and information technology become the spearhead economic industry.

In 2006, the Ministry of Natural Resources and Environment build national geographic information standards for all the activities related to the collect, access, and share geographic information data on the basis of the reference geographic information standards of geographic information standards Committee world ISO/TC211.

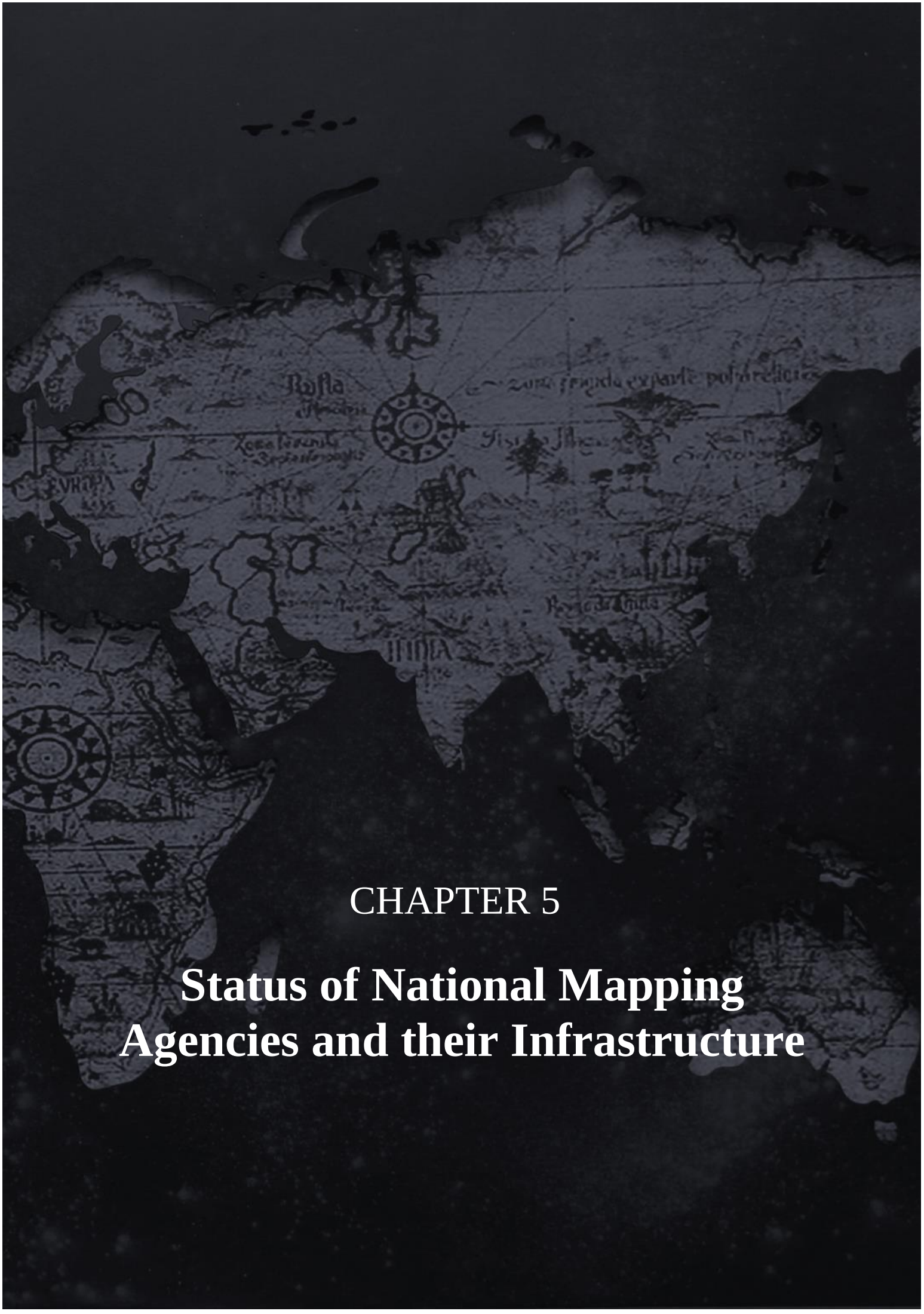
In 2013, the task of building and maintaining the infrastructure of geospatial data is officially delivered to the Department of Surveying, Mapping, and Geographic Information in Vietnam.

In 2018, Surveying and Mapping law was passed by Congress and effected from 01/01/2019 addressing the rules of construction, management of the infrastructure component of geospatial data includes policies organizations, institutions, standards, technology, data, and resources.

According to this law, the Prime Minister directly, coordinated the building of VNSDI. Ministry of Natural Resources and the Environment, in collaboration with ministries, ministerial agencies, government agencies, provincial people's Committee, building strategy development, planning implementation of NSDI and submission to Government for approval. The Ministry of Natural Resources and the Environment, built the geospatial portal of

Vietnam and integrates geospatial data from stakeholders while the Organization, individuals are involved in construction, development of geospatial data (Dr. Duc Tue NGUYEN, 2019).

A**nother Decree (12/2002/ND-CP) of Viet Nam government on survey and mapping** stipulates National Mapping Organization has a responsibility in establishing, storing and maintaining reference system, National original geodesic data, national height points system, aerial – photo, topographic maps, administrative maps, national geographical database. GDLA is responsible for the implementation of land inventory, survey, evaluation, classification, and cadastral mapping, and generalize land statistics and inventory data; establish and manage land records. The local organizations (Provinces) stores and maintains data covering in that local area, as follows: base geodesic points system, topographic maps, cadastral maps, administrative maps, geographic information, and land information system (Do Thu Thuy, 2011).



CHAPTER 5

Status of National Mapping Agencies and their Infrastructure

Chapter 5

5.0 Status of National Mapping Agencies and their Infrastructure

National mapping agencies are unique. Their role and value are changing, influenced by numerous factors including public demands, changing government priorities and initiatives as well as an ongoing business, military, environmental and other needs. In most countries, there is a national agency that has the primary responsibility for mapping. The national agencies are usually associated with geodesy, surveying and or cartographic organizations and they are often linked with the responsibility for measuring land, monitoring land and the production of products pertaining to land. National GPS grids and Transportation networks are often part of the mix as well. There is a wide variation in what each agency does and it differs by country, although it is probably safe to say each measure and describes physical land features at least.

National mapping agencies are charged with the responsibility of creating and managing digital cadaster and land management products across the entire country. This means their work is oriented toward the creation of consistent and homogenous digital databases. This enables these agencies to provide similar information across entire countries, while also enabling governments, businesses, and individuals, the ability to create policies, operations, and expectations of a countrywide nature. This value cannot be under-estimated. It is the seed for developing land use developments, managerial strategies for the environment, land use, population, and other national policy initiatives. Without such data, a country is a collection of places with no real understanding, no basis for national decision making relative to land resources and has no consistent and useful means for protecting and understanding itself. How do you put a value on that?

The role of a national mapping organization has certainly evolved significantly as we moved from paper to digital maps. Maps as abstractions of reality at a single scale are no longer acceptable, instead, we expect geospatial data at great accuracy, increasing realism and current collection (Thurston, J. & Ball, M., 2007).

New roles for National Mapping Agencies

The geospatial industry is growing rapidly worldwide and the major stakeholders in this industry are the national mapping organizations (NMOs) of various nations. NMOs are essential participants in the development of an infrastructure of any nation, but particularly for nation-building in developing countries. Changing dynamics of the geospatial industry spell changes for the NMOs as well. Here's a look at how NMOs can harness opportunities from challenges and evolve a model for nation-building (Prof. Ian Dowman & Deepali Roy. 2011).

5.1 Islamic Republic of Afghanistan

The Afghan Geodesy and Cartography Head Office (AGCHO) is a national cartographic agency of the Afghan government, and it was established in 1958 with the objective of producing, publishing and distributing of physical, topographical, political, thematic, cadastral, and natural resources maps, for the help of Afghanistan's infrastructural development, economical projects, and security organization. The AGCHO is directly reporting to the President. There are approximately 700 staff and regional offices in 16 provinces. The office is divided into five departments: geodesy, cartography and GIS, photogrammetry and remote sensing, cadaster, and metadata and client service provision (AREU, 2013).

Products of AGCHO (AGCHO Website.)

(i) Topographic maps scale 1:5,000 Kabul city based on aerial photography of April month year 2008, by a digital system that is ready for users;

(ii) City maps based on satellite imageries of the years of 2007-2009, some cities have been completed and other cities are under compilation;

(iii) The new version of administrative unites boundaries of Afghanistan using collected data from provinces and existing data in AGCHO is available on hard copy and soft copy for users.Updated 1:1,000,000 administrative and informatics map of Afghanistan, printed by the plotter;

(iv) World 1:50,000,000 maps, by the press printing system;

(v) Maps of 34 provinces of Afghanistan on the scale of 1:250,000;

(vi) Complete the topographic colored and black & white maps of Afghanistan with scales 1:5,000, 1:100,000 and 1:25,000; and

(vii) Thematic maps of Afghanistan with scale 1:4,000,000 of updating and printing of National Atlas of Afghanistan by a digital system.

5.2 People's Republic of Bangladesh

The Survey of Bangladesh (SOB) is the national mapping agency of Bangladesh, under the Ministry of Defense and is headed by the Surveyor-General of Bangladesh. The SOB started as the "Bengal Survey" on 1 January 1767 in undivided India and after the partition of the India and Pakistan on 14 August 1947, the organization established a regional office at Dhaka as Survey of East Pakistan. In the year 1971, after the partition of Pakistan and Bangladesh, this regional office was transformed into Survey of Bangladesh as a department under the Ministry of Defense.

The main objective and responsibilities of SOB are Production of Different Series of Topographical and Thematic maps and GIS Database, Establishing and Maintaining trigonometrically and primary geodetic control networks, conduct ground surveys, demarcation of international boundary of the country between Bangladesh-India (Mizoram Sector) and Bangladesh-Myanmar, Custodian of Aerial Photographs/ Images of Bangladesh (Brig Gen Md Wahidul IslamTalukder, 2014).

The SOB is also responsible for the following (Survey of Bangladesh Website):

(i) International boundary mapping (Bangladesh-Myanmar Area and Chittagong - Mizo Hill Sector);

(ii) Monitoring mean sea level;

(iii) Surveys of the cantonments;

(iv) Mapping service for various Ministries, departments and agencies;

(v) Processing and preservation of aerial photographs; and

(vi) Production of maps on various scales according to the needs of various Ministries, departments and agencies.

Geodetic Control Point's Network

SOB started the establishment of geodetic control point's network for the whole land of Bangladesh from 1990s with the technical cooperation of the Government of Japan. After completion the project with the Government of Japan, SOB continued the establishment of geodetic control point's network by themselves. The status of geodetic control points of SOB as of June 2017 as follows (JICA, 2017):

(i) Horizontal Control points which includes 260 points of 1st order, 817 points of 2nd order;

(ii) Vertical Control points which includes 662 points of 1st order, 1544 points of 2nd order; and

(iii) 3D Control points which includes 778 points.

Available GIS Datasets in SOB

SOB produces three types of database such as Topographic database, Cartographic database for production of maps and GIS basic database for external users. SOB basic GIS database contains 9 Datasets with 74 Layers for 1:25,000 scale and 92 Layers for 1:5,000 scale map.

The scale of the maps: 1:5,000 and 1:25,000 (Being implemented)	
Category	Summary Layers
Administrative Boundary	International, Division, District, Upazila along with Pillars and topographical sheet boundaries
Building and Structure	The building, Building Rooftops, Clustered Buildings, Buildup Area, Monuments, etc.
Facilities	Religious, Education, Health, Governmental facilities, etc.
Geodetic Control Points	Nationwide Vertical and Horizontal control points
Hydrography	River, Wetland, Island/Char-land, etc.
Industry	Major Industrial locations along with the type
Relief	Contour, Spot heights, etc.
Transportation	Road, Railroad, Bridges, Ports, etc.
Vegetation	Forest, Cultivation and non-cultivation area etc.

(Table 10: Available GIS Datasets in Survey of Bangladesh)
(Source: Rehman, N., Oliullah., & Sardar, Z.H., 2014)

5.3 Republic of the Fiji Islands

The Ministry of Lands & Mineral Resources (MLMR) is made up of two Departments, namely the **Department of Survey and Land Information** and the **Department of Mineral Resources**. The Department of Survey and Land Information is responsible for the effective and efficient administration, development and management of land initiatives. It is also responsible for the regulation of all land surveys conducted by registered surveyors in accordance with the Surveyor Act Cap. 260 and Surveyors Regulation to develop, provide and maintain the network of survey controls nationwide. Activities under this program include Surveying, Geo-Spatial Information, Land Valuation, Development and Maintenance of State Land, and the Land Use (Survey Division, MLMR Website).

The main objective of Survey Division is to achieving the Government's main objective i.e. "Making more land available for Productive and Social Purposes", through carrying out proper land surveys for registration of legal leases to successful applicants.

Achievements of Fiji Survey and Land Information Systems (Naicegucegu, S., 2012)

(i) Computer-based representation of all legal land parcel boundaries in Fiji. It comprises of over 90,000 land parcels, together with their legal identifiers;

(ii) A GIS of fully structured topographic data derived from 1:25,000 scale national mapping and aerial photographs;

(iii) The GIS database that contains a spatial representation of all land parcels (over 13,000 parcels) recorded on the Native Land Commission (NLC) maps;

(iv) A viewing package of all scanned approved survey plans (over 42,600 survey plans to date) and related documents;

(v) Holds records of all geodetic controls in Fiji, – first, second and third-order – 625 control points;

(vi) Contains key information for over 40,600 approved survey plans in Fiji;

(vii) Holds all valuation assessments records made by the Dept. of Lands & Survey, as well as details of property sales in Fiji;

(viii) Contains details of over 51,000 Lands Department (LD) files created to-date and including details of registered and un-registered State leases and Native leases to State, and records related actions undertaken and movement of files;

(ix) A record of all indigenous Fijians referenced to the native land-owning unit – Mataqali, Tokatoka, etc.;

(x) Contains Rental details of all registered and un-registered State Leases and Native Leases to State – 15,544 altogether; and

(xi) Holds records of National Census Boundaries – 1976, 1986 and 1996, & 2007.

5.4 Republic of India

The **Survey of India (SOI)** is the National Survey and Mapping Organization of the country under the Department of Science & Technology was established in 1767 to help consolidate the territories of the British East India Company, it is one of the oldest Engineering Departments of the Government of India completing 252 years of its existence in 2019. The SoI acts as an adviser to the Government of India on all survey matters, i.e. Geodesy, Photogrammetry, Mapping, and Map Reproduction.

The main objective of SOI plays a lead role in providing, cost-effective, standard geospatial data, information and intelligence for meeting the needs of national security, sustainable development, and Geospatial information markets.

SOI dedicates itself to the advancement of theory, practice, collection, and applications of spatial data, and promotes an active exchange of information, ideas, and technological innovations amongst the data producers and users (Survey of India, Website).

SoI Products and Services

National Ground Control Points (GCP) Library: Survey of India is the only government agency, which is responsible for Geodetic Control (Horizontal and Vertical) and Geodetic & Geophysical surveys, throughout the country and also provides data to the various governments and other national organizations including defense forces, according to their requirements. A National Ground Control Points (GCP) Library has been developed during 10th and 11th five year plan to carry out in three phases. The first phase covers 300 well spread high precision Ground Control Points (GCPs) at a spacing of 250-300 km apart. In the second phase, 2200 precision GCPs at spacing of 30 to 40 km apart; and in the third phase, 65,000 GCPs connecting all the tri-junction village boundary pillars available on the ground (DST Annual Report 2011-12).

Other Products

The SOI has been engaged in production and maintenance of various types of maps on various scales covering India, for the defense and development of the nation i.e. Open Series Maps (OSM), Political Map, Physical Map, Road Map, Railway Map, India and Adjacent Countries, World Map, State Maps, Guide Maps, Plastic Relief Maps, Tourist Maps, District Planning Map Series, Educational Map Series, Aeronautical Charts and Maps etc (Department of Science & Technology (2017).

Services

(i) To deploy its expertise in the field of environmental and disaster management, geomatics, seismicity and seism tectonics, geodetic and geophysical surveys, glaciology programmes and other projects related to digital photogrammetry and cartography etc.;

(ii) To provide standardized spatial data for scientific & technological requirements; and

(iii) To offer expert advice various Ministries in many sensitive areas such as settlement of International borders, State boundaries and in assisting planned development of hitherto under-developed areas.

Available Fundamental Geospatial Datasets

The SOI has been engaged in production and maintenance of various types of maps on various scales covering India, for the defense and development of the nation i.e. topographical map, Open Series Maps (OSM), Political Map, Physical Map, Road Map, Railway Map, India and Adjacent Countries, World Map, State Maps, Guide Maps, Plastic Relief Maps, Tourist Maps, Educational Map Series, Miscellaneous Maps, District Planning Map Series, Plastic Relief Maps, Antique Maps, Aeronautical Charts and Maps.

Topographical Base Map

SOI provides topographical base maps for the security and developmental needs of Geo-Spatial data of the country at the scale of 1:25,000, 50,000, and 250,000. To fulfill the requirements of high quality spatial data for socio- economic developmental activities, conversation of natural resources, planning for disaster mitigation, expeditious infrastructure and development works of the nation, Survey of India has proposed and executed the work of preparation of updated OSM and DSM datasets (DTDB & DCDB) with pre- field updating using High Resolution Satellite Imagery (HRSI) followed by revision survey on ground and the same is being undertaken by all Geo- spatial Data Centers.

Survey of India has completed Open Series Maps (OSMs) on 1:50,000 scale English version and are available for use by the users. To fulfill the requirements of OSM Hindi version and Regional languages version, Preparation of OSM (Hindi) and OSM (Regional Languages) is going on and is as under.

Survey of India has been providing Web Map Service (WMS) based on 1:50,000 OSMs through SOI portal “surveykshan.gov.in” for the open viewing as mandated by the NDSAP-2012. Efforts are underway to provide the data service of feature data through Web Feature Service (WFS).Progress of WMS and WFS during the year is as under. Special series maps like Guide Maps / Tourist Maps and small scale Geographical Maps like State maps (on various scales) are also prepared (Survey of India Annual report 2016-17).

5.5 Republic of Indonesia

Geospatial Information Agency (Badan Informasi Geospatial in Indonesian or BIG) is the National Mapping Agency of Indonesia as a substitute for the National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL). The Geospatial Information Agency is responsible for implementing one map policy and achieving the goal of having one standardized map mandate by President Decree No. 94 on December 27, 2011 (BIG, 2012). Its Functions are (Khafid, 2011):

(i) To assess and create national policies in surveys and Mapping;
(ii) To develop national spatial data infrastructure (NSDI);

(iii) Coordinate functional activities in conducting BAKOSURTANAL task;

(iv) To monitor, guide and maintain activities of government organizations in the field of Geomatics; and

(v) To organize, develop and serve geospatial data in the field of general planning, and management.

BIG provides the basic geospatial information including national geodetic control networks and base maps. The geodetic control networks include the vertical, horizontal, gravity control networks, and Tide Gauge Station Network, while the base maps include topographic maps (up to scale 1:1,000), coastal maps (up to scale 1:10,000) and marine maps (up to scale 1:50,000).

BIG is also responsible to provide infrastructures for geospatial information to other related government institutions. The infrastructures include policies, institutional aspect, technologies, standards, and human resources.

BIG provides Wall-to-wall base map of Indonesia at the scale of 1:50,000 as 'one reference' which will be freely downloaded from BIG website and also provide Administrative Boundary ,Geology, Land cover Hydrography, Hypsography, Buildings, Transportation and Utilities, cadaster, Spatial references, toponyms on a scale of 1: 250,000, 1: 50,000, 1: 25,000, and 1: 10,000.

Status of Basic Geospatial Information

Horizontal Control Networks (HCN)	700 planned station
Vertical Control Network (VCN)	5.911 point
Gravity Control Network (GCN)	• 5780 points of First, Second and Third Order • 110 points of Absolute Gravity Control Network
Tide Gauge Station Network	400 tide gauge station
GNSS Stations Network (Ina-CORS)	118 GPS permanent stations with online system
Topographic Maps	• 306 map sheets of scale 1:250,000 • 2536 map sheets of scale 1:50,000. • 2119 map sheets of scale 1:25,000, • 790 map sheets of scale 1:10,000

(Table 11: Status of Basic Geospatial Information in Indonesia)

Source: (BIG, 2012).

5.6 Islamic Republic of Iran

The National Cartographic Center of Iran (NCC) is the national mapping and spatial information authority under the Supervision of President Deputy of Planning and Strategic. It has more than half a century of experience in production of mapping and spatial information product. The latest technologies of geomatics are utilized by NCC experts. NCC undertakes supervision and technical control of geomatics projects based on the ISO 9001-2000 quality management system. These projects are carried out by NCC and other public and private mapping sectors. NCC produce base maps at 1:25,000, 1:50,000, 1:100,000 and 1:250,000 scale, marine charts at both 1:25,000 and 1:100,000 scales, National Atlases, design and

establishment of National Geodetic Control Points as well as Geodynamical Networks, establishment of national, regional, and urban spatial information databases (Baktash, P., 2012).

Organization goals are to (National Cartographic Center, Website. Retrieved):

(i) Extend and improve database data, reference frameworks and spatial data infrastructure for effective participation in the country's sustainable development and planning;

(ii) Strengthen the authority of the organization in developing and developing standards and technical requirements to ensure quality, interoperability, and reliability;

(iii) Enhance of interaction outside the organization at the national, regional and international levels to effectiveness of the organization;

(iv) Increase the level of social interaction Organization in recognition of the mutual organization and community;

(v) Expand of research organization with an emphasis on applied research and development;

(vi) Propose and track the adoption of laws and regulations to strengthen the role of the sovereign organization;

(vii) Play a key role in prognosis and crisis management;

(viii) Promote the role of the mapping organization in the country's technical and executive system;

(ix) Facilitate and expedite public access to the various products and services of the organization;

(x) Develop and update new technologies and products;

(xi) Develop sustainable revenue sources; and

(xii) Promote an organise an agile, learner and productive organization.

The main objective and tasks of NCC are centralizing all surveying and geographic activities, map preparation, standardization of all surveying and geographic processes, implementation of fundamental surveying operations, preparation of base maps, and determination of sea level for surveying activities, aerial photography, and a lot of other activities in Geomatics field for the nation of Iran.

The main products of NCC are related to their key activities. NCC prepares base maps at different scales (of the country at the scale of 1:25000 and also at other required scales needed for economic, social and cultural development projects of the nation), thematic maps, and planning and implementation national atlases. It is also in the process of designing and establishing GIS, LIS and National Topographic Databases (NTDB) for Iran. Aerial photographs (films, digital images, etc.) and Hydrographic operations including preparation of basic hydrographical charts and in other cases, collecting and processing of tidal data and predicting and preparing the tide tables also form prime activities. Quality control of all surveying activities in Iran and supervision and technical control of all mapping activities of both governmental and private sector institutions according to international standards

also falls under the purview of this Center. The products of NCC are available through the Sales Section of NCC and also its agents throughout the country (Dr Alireza Gharagozlu, 2010).

5.7 Lao People's Democratic Republic

National Geographic Department (NGD) is the Surveying, Aerial Photography, and Mapping Authority of Lao PDR. The NGD is responsible to research and establish policies regarding survey and mapping, aerial photography for submission to the government for consideration and approval.

There are 8 divisions in the division, namely: Planning-Finance and Cooperation, Survey, Science and Technology, Cartography, National Borders and Joining Zone, Photogrammetry, and Technical Equipment and Data Supply Management (Khachonesack DOUANGPHOUTHA, 2016).

Legislations

The main policy document that exists in the geospatial domain is the Decree on Surveying, Aerial Photography and Mapping Activities in the Territory of Lao PDR, No. 255 / PM. By another policy, Decree No 73/PM, dated 14th July 1994, NGD is given the power to promulgate regulations and supervise surveying, aerial photography and topographic mapping. The Decree emphasizes that all surveying, aerial photography and topographic mapping needs approval from the NGD and after completion of survey projects the results shall be submitted to NGD. In 1997, Laos got a new geodetic datum with recourses from the Land Titling Project. It is referred to as Lao National Datum 1997 and has the origin in Vientiane, Nongteng, and Astro Pillar. NGD is recommending all land surveys in the country to use this datum (Mishra, S., 2010).

Products and Services

(i) **Geo-Portal**

Geoportal is available to the public with water-marks but professional users can request access to private Geoportal services without watermarks.

(ii) **Aerial Photography**

The NGD has created digital orthophotos in Lao PDR since 2010. With a grant provided by the Finnish Government, 2/3 of the country (central and southern parts) were covered with aerial photographs. Customers can order aerial photographs of predefined area or make a request for a customized aerial photograph for an area of your choice by contacting NGD (NGD Website).

(iii) **Topographic maps**

Topographic maps having the scale of 1:50,000 were used as base maps covering the whole country. Apart from that, various purpose maps were produced namely:

administration, tourism, social-economics, world maps, atlases and among others. In addition larger scale maps (1:25,000 and 1:10,000 and 1:5,000) of the agricultural plains and areas of high importance. NGD is now working on updating the country-wide topographic map in digital form (Khachonesack DOUANGPHOUTHA, 2016).

5.8 Federation of Malaysia

Department of Survey and Mapping Malaysia (Jabatan Ukur dan Pemetaan Malaysia, JUPEM) was established during the occupation of the British Colonial in 1885(Sr Azlim Khan, Abd.Raof Khan., (2011). JUPEM has planned various reforms and modernization to improve the quality of services and products offered. Starting from the use of conventional equipment to satellite applications, JUPEM has always taken steps to keep track of the latest technology in the field of measurement and mapping.

The vision of JUPEM's is to providing outstanding survey and mapping services as well as geospatial data management towards fulfilling the nation's vision. JUPEM is directly involved in assisting the government to provide necessary advice on resolving various international boundary issues with neighboring countries. JUPEM is also responsible for the country's survey and mapping activities that accelerate the socio-economic development of the country. The main JUPEM activities is to provide survey infrastructure for the country, such as:

Defense Geospatial Activities (JUPEM Website)

(i) Advise the government in the cadastral survey, mapping and geospatial surveys and state and international delineations; and

(ii) Provides comprehensive and integrated geospatial defense services for defense and security purposes.

Mapping Survey Activities

(i) Publish topographic maps, cadastral, thematic and underground utilities for planning, natural resource management, environmental conservation, development, monitoring, and security;

(ii) Provides geodetic infrastructure for cadastral measurements, mapping, engineering, and scientific studies;

(iii) Topographic and Cartographic National Databases for production of topographical and thematic maps throughout the country with the scale 1:25,000 and 1:50,000 for the public and military uses; and

(iv) Publish astronomical and astronomical products including the direction of the Qibla direction, prayer time, hilal rukyah data, the calendar of hijriah and the eclipse information as well as the falak syariah.

Cadaster Survey Activities

(i) Provide complete and permanent cadastral survey information for land ownership, strata, and statutory purposes;

(ii) Manage efficient cadastral and mapping databases efficiently; and

(iii) Create and maintain the National Digital Cadastral Database (NDCDB).

Products & Services

GPS Control Stations.	• 238 Stations in Peninsular Malaysia • 171 Stations in Sabah and Sarawak
Benchmark.	• Standard Benchmark (SBM): 40 kilometers intervals. • Benchmark (BM): at every half (0.5) kilometer in developed area and at every one (1) kilometer for the rest.
Gravity Data	• The accuracy of First Order Gravity Network is 0.03 mGal. • The accuracy of Second Order Gravity Network is 0.05 mGal • he accuracy of Third Order Gravity Network is 0.1 mGal
Geoidal Map	• Separate Geoid Map in the size of Peninsular Malaysia, Sabah and Sarawak, Sabah or Sarawak. • Geoid Map in the size of topography map (30km X 30km) L7030 0r T736
Cadastral	• Digital Cadastral Database (PDUK) • National Digital Cadastral Survey Database (NDCDB)
Topographic Mapping	• Topographic Map 1:50 000 Peninsular Malaysia • Topographic Map 1: 3000 - 12 500 Town Map in Peninsular Malaysia • Topographic Map 1: 50,000 whole of Peninsular Malaysia • Topographic Map 1:10 000 Klang Valley • Topographic Map 1:50 000 Sabah & Sarawak • Topographic Map 1:3000 – 12 500 Town Map in Sabah & Sarawak

(Table 12: Product and Services of Department of Survey and Mapping Malaysia)

(Source: JUPEM Website)

5.9 Republic of the Union of Myanmar

The national mapping agency of Myanmar (Burma Survey Department) was formed on 1st November 1946, under the Ministry of Finance and Revenue by the British Government. On 1st March 1990, during the reign of the State Law and Order Restoration Council, Survey Department was formed with a new set-up consisting of six divisions (Survey Department of Myanmar, Website):

(i) Office of the Director-General;

(ii) Aerial Survey and Photography Division;

(iii) Map Reproduction Division;

(iv) Geodetic and No.(2) Survey Division;

(v) International Boundary and Civil Construction Survey Division; and

(vi) Training and No. (1) Survey Division.

The following are the main functions of the Myanmar Survey Department:

(i) Production of topographic maps;

(ii) Joint boundary demarcation with neighboring countries;

(iii) Taking the photographs throughout the whole country;

(iv) Establishment and maintenance of GPS Control Stations and leveling Benchmarks (BMs);

(v) Conducting the survey training; and

(vi) Producing the maps for certain projects on demand.

Products

Topographical map (nationwide coverage)	1134 map sheets at 1: 50,000 scale 322 map sheets at 1: 100,000 scale 93 map sheets at 1:250,000
Lambert Map	1 inch = 1 mile Scale/ 2 mile Scale/ 4 mile Scale
Map of Myanmar	1 inch = 20 mile Scale/ 45 mile Scale
Map of State/Region	at various scale
Nay Pyi Taw /Yangon Guide Map	Not specified

(Table 13: Products of National Mapping Agency of Myanmar)
(Source: Survey Department of Myanmar, Website)

Map Distribution

All the topographic maps are restricted and can only be available with the permission of Ministry of Defense. However, Maps of Myanmar and maps of State/Region are publicly available.

5.10 Federal Democratic Republic of Nepal

The Survey Department under the Ministry of Land Reform and Management is the National Mapping Agency of Nepal. It was established in 1957. Topographical Survey, Geodetic Survey, Cadastral Survey, and 83 Survey offices are the main branches of the department. Survey Department has been involving in many segments of surveying and mapping such as topographic mapping, geodetic surveys, Ortho-photo map production, cadastral surveys, land resources mapping, etc. It applies modern technologies including Geographical information system, remote sensing, Global Navigation Satellite System, Photogrammetry Digital Cadaster, etc (Survey Department of Nepal., 2012).

Topographical Survey Branch

It is responsible for producing and disseminating various kinds of maps such as national topographic map series, land property map and administrative maps. A new series of topographic base-maps were produced in two basic scales, 1:25,000 for the plains and the middle mountain region, and 1:50,000 for the high mountain and Himalayas during 1992-2001. The topographic maps series has been converted to the National Topographic Database (NTDB).

Geodetic Survey Branch (Trigonometrical Survey Branch)

It is responsible for carrying out geodetic surveys, such as horizontal control points, leveling survey, gravity survey, magnetic surveys, among others. GSB has established a geodetic control network throughout the country. Gravity observation, geodetic leveling, and measurements of previously established geodetic control points with the Global Positioning System are its present activities. Recently, airborne gravity surveys have been conducted to determine the national geoid of the country.

Cadastral Survey Branch

The Agency is responsible for supervising the activities related to cadastral surveys such as land property mapping, identifying land types as well as scientifically maintaining the land records for Land Information System uses. Cadastral mapping work of 37 districts of Nepal was completed using the National Geodetic Network in the year of 2000. Out of which 38 districts were mapped without the National Coordinate System Network.

The Survey Department has 83 Survey offices in the 75 districts of the country, with some districts having more than one such office. The main objective is to serve the public, in the form of facilitating land transfers and registrations, land measurements, updating and safekeeping of land records and cadastral plans, etc (Survey Department Website).

5.11 Islamic Republic of Pakistan

Survey of Pakistan (SOP) under the ministry of defense is a National Surveying and Mapping Organization of the country. It is primarily responsible for all sorts of topographical land surveys of cis-frontier areas of the entire country. The core products include map sheets on scale 1:50,000 and 1:250,000 are prepared to meet the requirements of the Defense Forces as well as the General Public. The department is actively participating in the various kinds of national development projects and thus fulfilling demands of various government / semi-government and autonomous bodies (Survey of Pakistan. Website).

Functions

The following are core functions of the Survey of Pakistan:

(i) To survey, print and publish topographical maps;

(ii) To establish and maintain a geodetic network in the entire country;

(iii) To delineate and demarcate international borders of Pakistan;

(iv) To carry out cantonment surveys and other surveys; and

(v) Provide the desired information for national development projects and the general public.

Over the years, the department has gradually switched over to digital production line by adopting modern surveying and mapping techniques, methods and equipment. As a result, now the department is able to produce quality products and services, and deliver it more efficiently and effectively.

Product and Services

Topographic maps with the scale of 1:50,000 and 1:250,000 were used as base maps covering the whole Pakistan. Apart from that, various purpose maps were produced namely: Guide Map, administrative map, physical map, social-economics, world maps, scales sheets, atlases and among others on a different scale.

Survey of Pakistan offers diverse nature of different services such as Geospatial Data Development, Capacity Building Services, Mapping Services, Remote Sensing Services, Site Coordinates Services, Coordinates Conversion Services and Qibla Direction Services (Free) to various government/semi-government and autonomous bodies.

5.12 Republic of the Philippines

In the Philippines two government organizations manage the country's base mapping and Surveying activities. These two are:

(i) **National Mapping and Resource Information Authority (NAMRIA)** is the central mapping agency of the government under the Department of Environment and Natural Resources (DENR) responsible for mapmaking services. It also acts as the central mapping agency, depository, and distribution facility of natural resources data in the form of base maps, nautical charts, statistics and other resource data. Its core functions are topographic base mapping, development of the national geodetic network, land classification, hydrographic surveys, and nautical charting, delineation of maritime boundaries, and geographic information management (NAMRIA, 2012).

Products

The map products of NAMRIA are available in analog and digital forms. The topographic maps with the scale of 1:250,000; 1:50,000; 1:10,000 and 1:5,000), were produced with information from the Philippine Coast and Geodetic Survey, Army Map Service, US Coast and Geodetic Survey, Bureau of Public Highways, and other agencies. NAMRIA is currently maintaining 178 nautical charts in various scales covering the whole country. These charts are classified according to their usage as follows:

(i) 81 harbor charts at 1:50,000 scale and larger;

(ii) 66 coastal charts at 1:50,000 to 1:100,000 scale;

(iii) 26 general charts at 1:100,00 to 1:600,000 scale; and

(iv) 5 sailing charts at 1:60,000 scale and smaller.

NAMRIA has in its holdings several types of satellite imageries such as Landsat Thematic Mapper, Landsat 7 enhanced thematic mapper, SPOT XS and SPOT Panchromatic. NAMRIA was producing another kind of base maps such as different thematic maps such as land condition, land cover, land use, plan metric, and administrative maps, etc (Product, NAMRIA Website).

NAMRIA has established 30 geodetic stations nationwide. These stations provide real-time high precision geographic position data via the internet to the surveying community in the country (Philippine Active Geodetic Network, NAMRIA Website).

NAMRIA is also in the process of updating the country's geographic features database consisting of key elements namely: total number of islands, total land area, total coastline length, and geographic feature names.

Services

NAMRIA provides surveying and mapping services, training on Geographic Information System or GIS, technical assistance on GIS development and certifications to various data and technical equipment such as Global Positioning Systems or GPS.

The NAMRIA Information and Client Service Unit (ICSU) serves as the frontline service center that provides assistance to clients. They assist clients in determining the type of product that can be used, where it is located and then to request a copy by fax or telephone. Technical staffs of ICSU are also trained to teach how to use the information obtained (Services, NAMRIA Website).

(ii) **The Land Management Bureau (LMB)** under the Department of Environment and Natural Resources (DENR) is in charge of managing the cadastral survey projects and the digital cadastral mapping in the country. A priority program of the bureau is the fast-tracking of the cadastral survey projects. The program is instrumental in patent distribution and accelerating countryside development.

The DENR has completed the cadastral survey of 1,634 cities and municipalities nationwide. This includes the 118 cities and municipalities of the Autonomous Region in Muslim Mindanao (ARMM) and the 1,516 non ARMM cities and municipalities (NAMRIA, 2012).

5.13 Democratic Socialist Republic of Sri Lanka

The Department of Survey of Sri Lanka (also known as the Department of the Surveyor-General) under the Ministry of Land and Development was established on 2nd August 1800. The Department is the National Surveying & Mapping agency pioneering the fields such as Land Surveying, Mapping, Satellite Remote Sensing (RS), Global Positioning System (GPS),

Geographical Information Systems (GIS), Land Information Systems (LIS), and Airborne Remote Sensing and Photogrammetric activities in Sri Lanka (The department, Survey of Sri Lanka). The main objective of the department is to provide high-quality land information products and services through a professionally qualified and dedicated person. Survey Department engaged in a wider range of surveying functions including Block Surveys for land settlement, Topographic Surveys for Mapping, Application / Miscellaneous Surveys including Irrigation Surveys, Road / Railway Surveys, Forest Surveys, etc. and the increase of field cadre was very much significant.

The department has established two branches, namely Geo Names (Geographical names) and NSDI (National Spatial Data Infrastructure) which plays a significant role to share the land related information's (The department, Survey of Sri Lanka).

Products

Sri Lanka was completely aerial photographed at the scale of 1: 40,000 in 1956 by a foreign company. Subsequently using departmental aircraft, the country has photographed again at the scale of:

(i) 1:10,000 (coverage 5%);
(ii) 1: 20,000 (coverage 100%); and
(iii) 1: 40,000 (coverage 70%).

A topographic map series was prepared on the scale 1 : 50,000, 1 : 10,000 for 80% of the country, 1 : 2,000 City Maps of Colombo and suburbs, and establishment of Topographic Vector Databases at the scales of 1 : 250,000, 1 : 50,000 and 1 : 10,000 using photogrammetric methods and high resolution satellite images.

The geodetic network for the entire country was established in 1999 to work with Global Positioning Systems. According to the adjustment, the statistical accuracy of the network was around 1: 750,000.

The department introduced digital Land Information System (LIS) in 2003. LIS is having information around 1100,000 land parcels and it is published on the website under the "GEO Sri Lanka" web services for the public. In 2015 under the assistance of the JICA, the department introduced the Lidar technology and LIDAR data available in Western, Sabaragamuwa & Central provinces (History, Survey of Sri Lanka).

The major contributions of the survey department are; Surveys for Land Settlement, Land Development, Land Reform, Central Highway, Galoya Irrigation Project, Southern Highway Project, Southern Habour development project, mapping of the Tsunami affected coastal areas, Southern Airport establishment project, Mahaweli Development Project, Power generation projects, establishment of Geodetic Control Network and upgrading the same to a higher level of accuracy with the introduction of Global Positioning System (GPS), publishing the National Atlas in all three languages (Sinhala, Tamil and English).

5.14 Kingdom of Thailand

The Royal Thai Survey Department (RTSD) is the national mapping organization under the Royal Thai Armed Forces Headquarters, Ministry of Defense for surveying and producing maps of Thailand in support of national security, spatial data infrastructure and other country development projects carrying out geodetic and geophysics surveys and also providing academic courses and trainings in the field of survey corps.

The Royal Thai Survey Department (RTSD) is responsible for the establishment of Geodetic Network using the Global Positioning System (GPS). The GPS observation has been performed since 1991 and its networks are continuously developed and adjusted in 2002. RTSD has regularly conducted a survey on geodesy and monitored the incidences on the earth which has changed over time. The movement of tectonic plates due to the disaster of the earthquake in 2004, these had directly affected the stations of the national geodetic network. Therefore, RTSD had conducted the new GPS network to replace the previous one since 2005 and completed in 2007. The development and improvement of the horizontal network included 8 stations of Reference Network, 19 stations of Primary Network, 94 stations of Secondary Network and 381 stations of Auxiliary Network.

RTSD has set up vertical control network since 1912 using mean sea level at Ko Lak, Prachaup Kirikhan province as a vertical reference point and using vertical point of Bench Mark with the height of 1.4477 meters as a reference point in order to tie with the first-order leveling. In 1982, the Primary vertical control network was firstly adjusted. The network throughout the country was divided into two parts, northern and southern part of Ko Lak. In 2014, RTSD has surveyed the vertical control network in the northern part of Ko Lak amount 2,058 stations with total distance 3,983 kilometers. The spacing of vertical station was in accordance with the standard of national vertical control network which specified spacing of first-order leveling class 1 not exceeding 100 – 300 kilometers. Therefore, the density of stations was sufficient to support the mapping and development of the country. Moreover, RTSD still has endeavored to develop the quality of vertical control network in order to reach the FGCC standard by using geopotential data for network adjustment. In 2014, the observation of gravity on the junction of the vertical control network was taken for network adjustment. In the present, RTSD is going to carry on the network adjustment (THE ROYAL THAI SURVEY DEPARTMENT, 2015).

Geo-spatial database collection and implementation

In 1881, RTDS's produced topographic maps at the scale of 1:2,000,000 and 1:100,000 over the central area of Thailand were completed. During 1901 to 1971, new datum, WGS84, has been used in L7018 map series at the scale of 1:50,000 covering entire country subsequently, in 2008, map series 1501 at the scale of 1:250,000 covering the whole country was completely produced.

RTSD continues updating both L7018 and 1501 map series in according with a fiscal plan as the Second Edition of L7018 (830 sheets) and 1501 (54 sheets) be completed in 2012. The topographic map features separate into 11 layers consist of the following (**Next page**):

RTSD proposing concerned to reform data from conventional map to the hierarchical and spatial database which used as a fundamental geographic data set (FGDS) of Thailand. To produce 1:50,000 L7018 GIS data, RTSD launch operational project called "Geospatial database collection and implementation project" for multi-scale and multipurpose usage. The project campaign is five-year period starting from 2012 – 2016 and collects a database of 166 map sheets per year. Many attributes of the digital line map are classified by field survey using mobile technologies and geo-tagging photo are used to validate the completeness and accuracy.

RTSD believes that this L7018 digital line map development to geospatial database will support GIS applications and enhance Thai spatial data infrastructure (SDI) development in the future (RTSD, 2015).

Layer 01	The industry consists of Mine, Industrial factory, Power plant, Oilwell
Layer 02	Culture consists of Stadium, Building, (Dense) community, Tomb, Church, Hospital, Lighthouse, Monument, School, Railway station, Tank, Zoo, Ruins, Health station, Mosque, High-Tension power line, Wind-sock, Sanitation, Monastery, Temple, Chinese shrine, Stupa, Pagoda, Admin Office
Layer 03	Transportation consists of Road, Bridge, Track, Trail, Railroad, Route marker, Tunnel
Layer 04	Hydrography Drainage consists of Water pipe, dam, Open water, Coral-line, Canal, Ditch, Lake, Port, Islet, Reservoir Salt farm, Sea-shore, Spring, Water-fall, Water-course, Stream, Well, Land subject to inundation, Swamp, Aquaculture area
Layer 05	Elevation consists of Contour interval, Deep interval, Number and Spot of elevation and Spot height.
Layer 06	Physiography consists of Cave sign, Bluff, Cliff escarpment, Avenue (between hills), Sand and Gravel
Layer 07	Vegetation consists of Grassland, Grass, Tree, Thick and Perforated forest, Agricultural area, Bracken, Bamboo, Cultivated land, Orchard land, Scrub, Mangrove, and Nipa.
Layer 08	The boundary consists of the International border, First and Second-order administrative boundaries.
Layer 09	Aeronautical consists of Airport sign, Airport border, Heliport, Runway, and Airbase.
Layer 12	General consists of Vertical and Horizontal datum pin
Layer 14	Margin consists of the detail in the bottom of the map to describe all of the things in the map.

(Table 14: Products of Royal Thai Survey Department)

(Source: Thailand, 2012).

5.15 Socialist Republic of Vietnam

Surveying and mapping of Vietnam have a rather long history and tradition. There are several agencies for surveying and mapping but the National Mapping Organization of Vietnam is the Department of **Survey and Mapping Vietnam (DOSMVN)** which is under the Ministry of Natural Resources and Environment (MONRE). The Department's main functions are (Le Minh Tam., 2009):

(i) To submit to MONRE bills, ordinances and other legal instruments on survey and mapping;

(ii) To disseminate, give guideline to different branches, localities, organizations and citizen and control them for keeping surveying-mapping activities in compliance with the legislation;

(iii) To master plans of development; main important programs and projects in the field of survey and mapping;

(iv) To organize and conduct implementation of survey and mapping projects after their seal of approval;

(v) To manage maintenance and protection of benchmarks and other specific survey-mapping constructions; and

(vi) To establish Survey Mapping Database for GIS (Geographical Information System) and thematic information.

Activities and Products of the DOSMVN

The DOSMVN creates, gathers and stores a large amount of survey and mapping data such as geodetic framework, satellite images, aerial photos, topographic maps of different scales and indifference map projections made by French, an army of USA and Vietnam Survey and Mapping agencies (Le Minh Tam., 2009).

The basic geodetic framework has been created by the DOSMVN consisted of the following networks:

(i) National Coordinate Control Network which includes 71 points of 0 order, 328 points of I order, 1.177 points of II order and 12.658 points of III order covered the whole country;

(ii) National High Control Network consisted of 18 original points, 1.181 points of I order 1.100 points of II order and 4.640 points of III order;

(iii) The first Vietnam Gravimetric network of I, II, III, IV orders were created from 1975 to 1980, adjusted in 1982 and completed in 1988; and

(iv) There are 6 GPS base stations in Vietnam located along the coast-line and along the Vietnam China border, they are mainly used for sea survey and border demarcation.

Vietnam topographic maps are making in the Vietnam National Reference system VN-2000, which is based on the international system WGS -84 allocated for Vietnam. All the topographic maps are mapped in digital form. The scales of the maps as:

(i) Establishment of the geographic database at the scale of 1:2,000, 1:5,000 are taken for all of the cities and towns, (Implemented within 2008-2011);

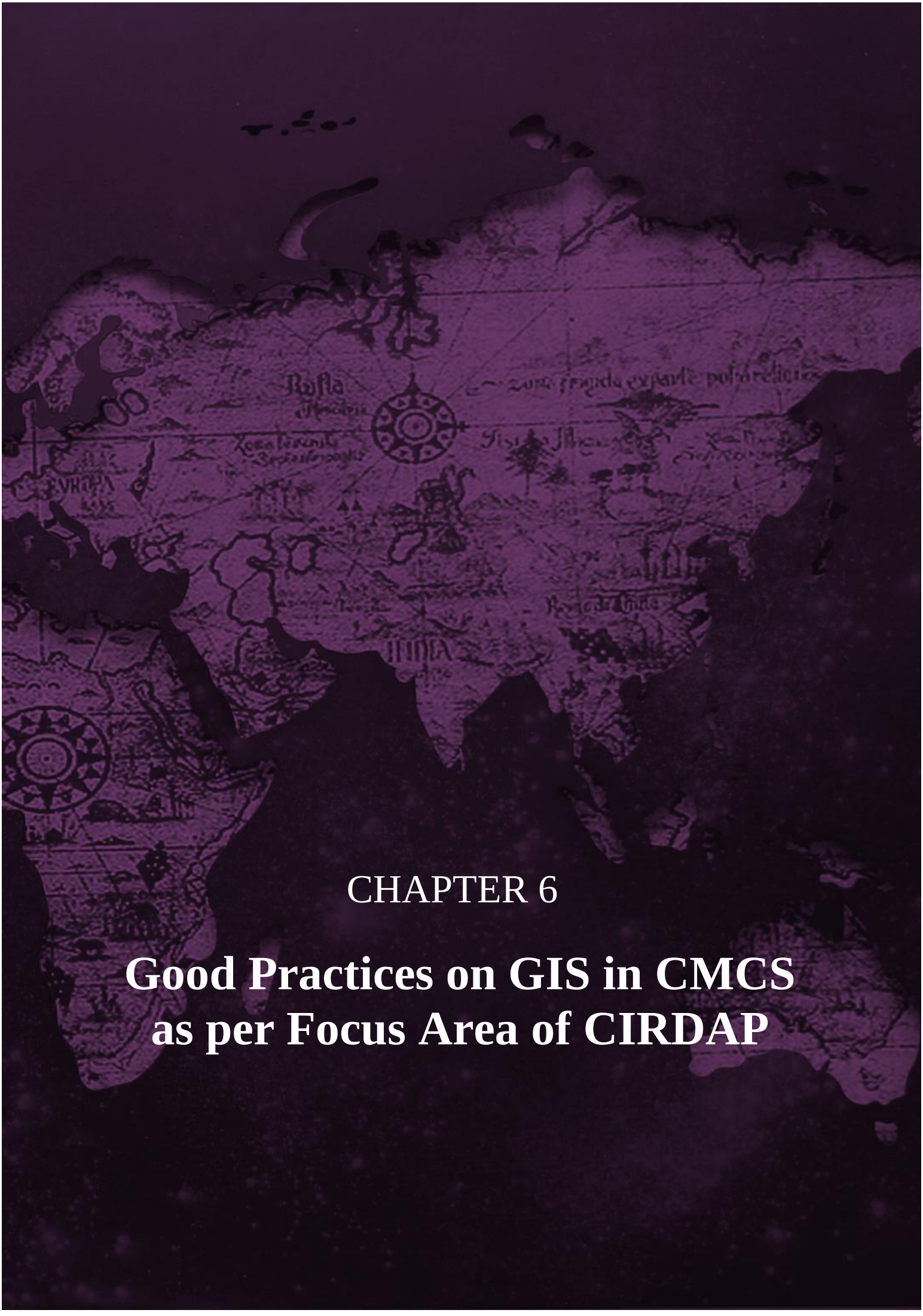
(ii) Establishment of the geographic database at the scale of 1:10,000 with the DEM for whole Vietnam. (Implemented within 4 years from 2008-2011);

(iii) Establishment of the geographic database at the scale of 1:25,000 is taken mainly for the midland and economic development areas or where it is needed;

(iv) Establishment of the geographic database at the scale of 1:50,000, 1:100,000, 1:250,000, 1:500,000, 1:1,000,000 are taken for the topographic features of the whole country and these scales have been already covered the whole country from 2004; and

(v) Establishment sea bed topographic mapping at scales 1:10,000 and 1:50,000 are taken for the whole territorial water, river mouths and seaports from 2015.

Besides topographic mapping, DOSMVN also produces other kinds of maps such as Vietnam national atlas, Provincial atlases; administrative maps and atlases, etc.



CHAPTER 6

Good Practices on GIS in CMCS as per Focus Area of CIRDAP

Chapter 6

6.0 Good Practices on GIS in CMCs as per Focus Area of CIRDAP

Contributions of space technology, digital innovations and geospatial information applications in addressing sustainable development in the CMCs, and the potential for further development of these innovative technologies can help to further sustainable development efforts.

The Asia-Pacific region is rapidly evolving into a hub of innovation as advances in digital technologies are transforming the way in which people live, work and relate to one another (ESCAP, 2018). CIRDAP decided to promote regional cooperation in geospatial information applications and to foster the sharing of good practices and lessons learned to ensure coherence with global, regional and national frameworks and commitments.

Some of good practices on CIRDAP Focus area mentioned below:

(i) Sustainable Development and Efficient use of Natural Resources;
(ii) Livelihoods;
(iii) Access to basic Services;
(iv) Governance; and
(v) Climate Change and Impact.

It also highlights emerging trends in geospatial technology and information applications for Sustainable Development in CMCs.

6.1 Focus Area 1: Sustainable Development and Efficient use of Natural Resources

❖ GIS in Land Administration and Management

Republic of the Fiji Islands

Computerized Cadastral Mapping System (CCMS): This was the conversion of all old and manual land record sheets to be converted to digital (Computer based representation) in metric scales. It comprises over 90,000 land parcels, together with their legal identifiers.

The primary functions are to store the current shape, position, identity and relationship of Fiji's cadastral land parcels and to display the land parcels at appropriate scales (Naicegucegu, S., 2012).

(i) Fiji Topographical Database – Digital Maps in six themes (Transport, Hydro, Terrain, Survey (Places), Structure and Vegetation at 1:25,000 scale. This is the base of all published maps;
(ii) Native Land Commission (NLC) Maps – Conversion on Historical Native Land Units Maps to Digital;
(iii) Qoliqoli Maps – Digital Mapping of all Native Fishing Rights Boundaries;
(iv) Native and Crown Grant Maps;

(v) State Land Maps – maps of original transfers to State; and
(vi) Vanua view – A Spatial Data Viewer".

Fiji Land Information System

The purpose of FLIS Stage 1 was to provide the spatial framework for the legal/fiscal LIS and record all survey land parcels and their relationships to the land ownership and tenure systems in Fiji (Rakai, Mele & Williamson, Ian.,1995). It included the following systems:

(i) Titles Index;
(ii) Titles Journal;
(iii) Native Lands and Fisheries Commission Final Reports System;
(iv) Road Index;
(v) Survey Plan Journal;
(vi) Valuation Records System;
(vii) State Lease Administration;
(viii) State Land Register;
(ix) Native Reserves Register;
(x) Vola-ni-Kawa-Bula (VKB) Link Town Planning Application System; and
(xi) LIS Central Index.

Federation of Malaysia

e-Kadastre Project

e-Kadastre is a system that optimized current ICT, GIS, and survey technologies, implicating modification in cadastral survey manner from the traditional Bowditch and Transit methods to a Survey Accurate Coordinate system using Least Square Adjustment. A dense network of global positioning system (GPS) Real Time Kinetic (RTK) permanent stations has been established to provide on-the-fly precise geocentric positioning. Upon the successful implementation of e-Kadastre, Department of Survey and Mapping Malaysia (DSMM) has envisaged a significant reduction of time taken in any cadastral survey process from the existing average of 2 years to within 2 months (Dr. Abdul Kadir Bin Taib, 2011).

The new environment allows various cadastral survey processes such as planning, design layout submission, field data capturing, completed job submission, quality control, and approval to be carried out remotely via the mobile telecommunication network. The global positioning system provides real-time positioning at centimeter resolution homogenously to the entire country. Additional features such as building footprint and space images will be incorporated into the new database in a move towards a multi-purpose cadastral (TAN Liat Choon, Khadijah Binti HUSSIN., 2012).

Republic of the Philippines

Participatory three-dimensional mapping (P3DM)

Philippine Association for Intercultural Development (PAFID) has been adopting the use of (P3DM) as a tool for community development in the Philippines as it relates to indigenous

peoples' land rights claim, and to facilitate Ancestral Domain Management Planning (ADMP).

The rights of indigenous people/communities addressed are:

(i) The right to ancestral domains and lands;
(ii) The right to self-governance and empowerment;
(iii) The right to cultural integrity; and
(iv) Social justice and human rights.

The law defines ancestral domains to cover "forests, pastures, residential and agricultural lands, hunting grounds, worship and burial areas, including lands no longer occupied exclusively by indigenous cultural communities, but to which they had traditional access"(IFAD, 2014).

Kingdom of Thailand

Participatory land use planning (PLUP)

Technique to involve community members in exploring and contributing to local and regional land use planning issues. It begins with series of participatory mapping processes to classify natural resources at the village level. The aim of the project is to improve sustainable use of land, water and forest resources, rehabilitation of water catchment areas, and intensify agriculture on suitable land. Three dimensional topographic model were used for demarcating highland areas under shifting cultivation, area of permanent cultivation, community forest available for use and conservation watershed forests. These models were used to generate discussions among community member and to develop local management strategies.

❖ GIS in Natural Resource Management

Republic of the Fiji Islands

Bio-Regional Mapping of Viti Levu

The degree to which bioregional mapping can be useful depends largely on bringing these biophysical parameters together with the ecologically and biologically significant as well as environmentally social and in part economic considerations. The concept of bioregionalism offers light into a potentially effective approach that could help in the direction of effective conservation. The measure of its applicability in the real world however may be a rather complex matter to comprehend given our land tenure and resource use situation and such. In the larger scope of things though, Bioregionalism can collectively communicate a holistic image of place that would allow decision makers to make out what actions could be adopted relatively to achieve sustainable prosperity and better resource management (Leba Gaunavinaka, 2007).

Mapping Important Bird Areas (IBA) in Fiji and the Region

This project is funded by the David & Lucile Packard Foundation and leads to a major improvement in understanding of seabird breeding colonies in two of the most significant island groups for seabirds in the Pacific, French Polynesia and Fiji. The project analyses the

historical information, gather new ethno-biological information from local people – fisher folk in particular – and investigate the use of remote imagery to identify existing and historically important islands for breeding seabirds in both countries. The up-to-date information is made available mapped showing distributions and numbers of breeding seabirds. An action plan will be produced identifying islands to be restored for breeding seabirds. The culmination of this work, alongside the ongoing advocacy, education and provision of information to national and local governments and people, will be a significant first step for the development of a coherent regional seabird conservation initiative (Amit Sukal, 2007).

Republic of India

POWERGRID programme

It has managed to link a country as vast and diverse as India through a transmission network of sub-continental magnitude.

One of the POWERGRID's most successful achievements have been in managing and protecting the environment. It has undertaken several technological innovations aimed at minimizing damage to natural resources and human habitat. POWERGRID used Geographical Information System (GIS) and satellite imagery to determine transmission line routes, and sites for substations. Impact was that there were times when towers as tall as 140 m were erected to avoid damage to forests and water bodies.

The larger impact of all these measures was that in the last 10 years use of precious national resources like forests have been reduced to a bare 2 percent from 6 percent (World Bank, 2008).

Lao People's Democratic Republic

Sustainable Natural Resource Management and Productivity Enhancement

Asia Development Bank has recently decided to support a project called “Sustainable Natural Resource Management and Productivity Enhancement” with the total cost estimated at US$35 million.

The project aims at capacity building in land suitability assessment, land-use classification and zoning, and digital mapping in participating provincial agriculture and forestry offices (PAFO) and requires (Anders Wellving, 2010):

(i) Provision of geographic information system (GIS) equipment;

(ii) Training of PAFO and district staff in land suitability and participatory land-use mapping and social analysis of land rights and GIS and information management techniques;

(iii) Procurement of digital data sets to facilitate the preparation of land suitability and land-use maps at a district level, i.e. kumbans and villages; and

(iv) Funds to operate a resource mapping facility including “ground truth” of interpreted data sets. This will provide the basic information and equipment to enable staff to present technical recommendations prior to the award of land concessions.

Kingdom of Thailand

The SEMIS II (Sub regional Environmental Monitoring and Information System Phase2) project

Project carried out by the Asian Development Bank. This Project was to make environmental and natural resources use data available in a user friendly and timely manner to support integrated economic and environmental planning. The five major objectives of the project are included (Sengja Jangmaw, 2015):

(i) To increase the capacity of national governments to make informed decisions regarding development investments relating to sustainable utilization of natural resources;

(ii) To enhance the ability of GMS national governments to conduct integrated economic and environmental planning with relevant data;

(iii) To assess the availability of useful and relevant data for planning purposes;

(iv) To increase and strengthen the capacity of national governments to collect data; and

(v) To conduct, store, manipulate, and share actual integrated planning information using the data collected in pilot projects for some "hot spot" areas.

6.2 Focus Area 2: Livelihoods

❖ Economic Productivity through Technological Innovation, Upgrading and Diversification and Related Policies

Republic of the Fiji Islands

Utilizing GIS to Determine the Value of Navovo Agriculture Subdivision

The main purpose of the project is to use GIS to extract the Unimproved Capital Value (UCV) per lot identified for agriculture leases. Information on land use at Navovo Agricultural S/D was produced by the Land Resource Planning and Development Department (Buliruarua Lesuma & George Tami, 2007).

(i) Land Use Class (LUC) data was transferred to MapInfo formats and used as layers to overlay with the original Scheme Plan of the Agricultural Subdivision;

(ii) LUC area for each lot was extracted after overlaying the layer to determine the UCV for each lot Benefits;

(iii) The Project is to engineer ways for iTaukei Land Trust Board (iTLTB) to move forward using modern technology;

(iv) This process is to ensure quick assessment of UCV using Land use Data, Satellite Imagery and GIS through MapInfo; and

(v) This approach will have the following impact on iTLTB Operational Cost will include the following: Reduction in fuel cost as one is able to visualize the area of inspection (Location, Feature, etc.) saves time and money in trying to locate the area.

Republic of India

Tamil Nadu Precision Farming Project

The objective of this platform is:

(i) to direct On-line sensor, image processing, remote sensing (RS), yield monitoring system, VRT, GPS, etc.

(ii) to develop farm database to enable access to information on weather, moisture condition, organic content, farm area and inputs required along with estimation of pesticide and fertilizer requirements and scientific farm practices, crop disease forecasting system and expert crop advice system.

It is been developed by National Agricultural Innovation Project (NAIP) for organized farming sector (Pinaki Mondal & Manish Basu. 2009).

Islamic Republic of Iran

Improve Agricultural Monitoring Systems through Satellite Imagery

The project funded by FAO's Technical Cooperation Programme, is being implemented by the Ministry of Jihad-e-Agriculture (MJA) and FAO.

The objective of this project is to enhance the national agricultural monitoring system that improve the quality of agriculture information and reporting based on geospatial technologies. This was achieved through the development of sustainable methods and tools based on the integral use of geospatial technology and capacity development. The transfer of skills and good practices and the use of learning materials help to ensure accurate crop production estimates and integrate the use of remotely sensed data in reporting.

This operational and innovative system improves the quality of agricultural information and reporting, crop status monitoring, area estimates and yield forecasting. By gathering precise and up-to-date agricultural statistics, the project supports the development of a more efficient and transparent Agricultural Market System, and encourages the coordination of policy action in response to market uncertainty (FAO's Project).

6.3 Focus Area 3: Access to Basic Services

❖ Affordable reliable and modern renewable energy

Islamic Republic of Afghanistan

Open Source Spatial Electrification Tool (OnSSET)

It aims at building a database of geospatial information, and helping planners create a modifiable least-cost electrification model. Benefiting Rural Population-73 percent of total population in Afghanistan. GIS fits into this by (Alexandros Korkovelos, et. al):

(i) Extract trivial characteristics for the electrification analysis from GIS layers and combine them together in a format easy to read by the Python code (a comma separated-value file with all the attributes per population point); and

(ii) Visualize the final results in maps.

❖ Access and use of ICT for IRD

Islamic Republic of Afghanistan

GPS cameras track progress on irrigation infrastructure in hard-to-reach areas of Afghanistan. Cheap and relatively low-tech global positioning system (GPS) cameras are being used to record the date, time, longitude, latitude, and to some extent altitude, in photos of irrigation structures under repair or construction. This effort in building capacity within government agencies and ministries to sustainably monitor projects to improve development outcomes (World Bank, 2010).

People's Republic of Bangladesh

The Avian Influenza alert system, developed by FAO and piloted in Bangladesh, extensively used mobile technology to track the outbreak of the deadly avian (H5N1) virus. Short message services (SMS) were used to collect and manage information from a large number of grassroots level volunteers, thereby enabling a coordinated and real-time response to contain the outbreak. Remote Sensing and ICTs are crucial in assessing and providing information to tackle it (FAO, 2017).

Republic of the Fiji Islands

Telecom Fiji Limited (TFL) is a private company providing terrestrial telecommunications services to Fiji. The GIS within TFL is primarily designed to assist in the mapping and location aspects of the company's operations. The GIS is set up around the mapping of the network infrastructure. Cables, junctions, distribution points, exchanges and other external plant were all captured from plan sheets and linked to attributes from the company's asset database. This increased the efficiency of mapping and location finding operations. Before the implementation of a GIS, the network infrastructure was manually stored and updated on plan sheets (Conway Pene, 2006).

Republic of India

e-choupals

To develop village internet kiosks that enable access to information on weather, market prices and scientific farm practices, crop disease forecasting system and expert crop advice system. 1200 'e-choupals' have already been developed across four states of India (Singh M, Singh G., 2006).

e-Choupal, provide matching services, commodity exchanges, virtual trading floors and trading services that help the typically larger upstream and downstream firms, such as processors or exporters, to manage their operations and the quality of their produce better. Often, these platforms are based on specific contractual arrangements that define online negotiations conditions, the procedure to assess quality, the payment and delivery/withdrawal conditions – such standardized contracts can enhance transparency and efficiency (FAO, 2017).

Application of GIS in Modeling of Dengue Risk Based on Sociocultural Data

Its objective was to determine the applicability of GIS as a tool to identify varying degrees of spatial social risks in *Jalore* related to dengue incidence and transmission. The GIS approach has assisted in focusing and implementing precautionary and preventive strategies to monitor and control the incidence of dengue more effectively. The spatial (point data) with their attributes were input into GIS and a spatial point-wise risk-level map was developed. This was achieved by digitizing spatial locations of houses of Dengue affected and unaffected households sample located in the Jalore administrative map and thus specifying the location and categorizing the threat zones along the map projection for future administration (Bohra, Alpana & Andrianasolo, Dr., 2000).

Republic of Indonesia

ESDM One Map Indonesia

ESDM One Map Indonesia is a web-based information system capable of displaying various thematic geospatial information (maps) in the field of energy and mineral resource online (web GIS). This application presents a variety of thematic geospatial information obtained from different sectors of Ministry of Energy and Mineral Resources (MEMR), namely Oil and Gas, Mineral and Coal, Electricity, Geology etc. The information includes, for instance, the maps of Oil and Gas Working Area, Mining Business License Area, Geothermal Working Area, Electricity Infrastructure, Oil and Gas Infrastructure, and Potentials (Resources and Reserves) of New Renewable Energy and Geology. This system also provides thematic geospatial information from other sectors in different ministries or institutions (Setyowati, Heratania, et. al., 2018).

Republic of the Philippines

Participatory GIS (PGIS) Application a community-based resource valuation research was designed by the CSOs, together with the community, aimed at identifying the affected communities and computing the value of local investments which will be affected by the mining operations. A series of community workshops were conducted to facilitate the construction of the 3D models at the village level. Basically, the process involved the merging of traditional spatial information with modern technologies called Participatory Geographic Information System. Using push pins, the location of various important geographical features, such as houses, ritual areas, graveyards, resource gathering areas, and trap setting areas, were identified. The agricultural areas used for farming were color-coded according to crops planted. Thereafter, the data were transposed into a formal GIS via digitizing software. At this point, the local communities directly traced the information from the 3D model using transparent thin plastic sheets. All the information represented by lines, points, and polygons were traced using color-coded permanent marker pens (ANGOC, PAFID. 2018).

❖ Rural transportation access

Republic of the Fiji Islands

GIS by PWD

Within the PWD, only the roads section has been able to implement any kind of lasting GIS solution. This has taken the form of an automated road mapping system, using a combination of GIS software, GPS receivers and digital video cameras. This system is fitted in a customized PWD vehicle, which is then driven down the road to be surveyed. The location data is captured by the GPS receiver, and later differentially corrected for greater accuracy. Attribute data of the road, including road surface type and condition, verge and pavement condition, line markings and road signs are entered using the data captured on the digital video system (2001) (Geospatial World, 2008).

6.4 Focus Area 4: Governance

❖ Strengthening local governance and CBO/CSOs

People's Republic of Bangladesh

PPGIS (People Participatory GIS)

PGIS practice is about empowering ordinary people in adding value and authority to their spatial knowledge through the use of GIT and maps as a media to effectively communicate by increasingly using Web 2.0 applications and related multimedia. PGIS practice is the result of the merging of Participatory Learning and Action (PLA) and Geospatial Information Technologies (GIT). As defined, PGIS is embracing low and high tech GIT, from ground mapping (drawing in the sand) to participatory interpretation of remote sensing images, modeling, networking, communication and alliance building. The process that leads towards the production of maps is more important than the output itself. The highly motivating process frequently reinforces the identity and the cohesion of the community members. Moreover, maps add power and authority to communication and are quite effective in raising awareness among policy and decision makers concerning people's concerns and aspirations (Orban-Ferauge, et. al., 2011).

BRIS (Birth Registration Information System)

Birth registration or provision of Birth certificates is an essential document for obtaining admission in schools, health facilities and other welfare services. The E-Governance tool developed the Birth Registration Information System (BRIS) - is a good example of how the municipality and health department can cooperate to provide incentives to citizens for performing birth registration, as well as providing them a means for doing so efficiently. Through this tool, the process of awarding birth certificates is computerized. Here, citizens can visit designated centers located within the city to get birth certificates via computers. Particulars of the child, such as his name, address, Date of birth, etc. get stored in the municipality's database and automatically transferred to the city's health and education departments (Relhan et al., 2012).

Republic of India

BHUVAN Platform use by Panchayat for Decentralized Planning

The objective of Space based Information Support for Decentralized Planning (SIS-DP) is to build up a spatial and non-spatial database at Gram Panchayat level for the entire country. The data sets utilized at various levels to enable an environment for Panchayati Raj Institutions. In detail the four major objectives are (gisresources, 2014):

(i) To generate and provide 'Satellite Image Maps' for the entire country as base for decentralized planning. (High resolution, true color, Ortho-rectified, merged satellite data products);

(ii) To build Capacity of PRIs & stakeholders for the use of Space Based Information in Decentralized planning and governance;

(iii) To prepare thematic & base layers on 1:10,000 scale using 'Satellite Image Maps', slope classes maps and Cadastral maps vectorization & geo-referencing; and

(iv) To develop comprehensive web portal as per PRIs & stakeholders needs for decentralized planning, governance, outreach to the citizens and data dissemination. Here 38 Academic institutions in 9 States & 35 Organizations (SRSACs, NGO & NIRD) are involved.

By geotagging 12+ lakh assets covering about 38019 GPs. It helps in Natural resource identification and its produce estimation, Watershed Management by Hydrological unit identification and climate data and thematic data generation which could be used for Land use and fallow land related development planning along with drainage and water bodies (NRSC, 2017).

Satellite Communication Model (SATCOM)

The 'Satellite Communication Model' (SATCOM) of Gujarat, India is a good example of the e-learning approach to capacity development that has had an extensive reach and wide coverage area. Under 'satellite communication model' a training programme was designed using Satellite Communication (SATCOM) whereby all 25 districts of Gujarat were covered through 38 SATCOM centers. A district level training facilitating team was engaged with the participants promoting horizontal learning and transmitting the knowledge base into practical learning. The complete programme was designed in a participatory manner to meet the participant's learning needs. Around 850 gram panchayat elected representatives, primarily sarpanches, were covered in each of the six rounds of SATCOM training on different themes of local governance. The participants of the first round were repeated in all the six rounds. The training rounds were spaced in such a way that after each round of training the participants could go back to their respective panchayats and try to implement their learning. This would give them the opportunity to clear their doubts or hindrances in the implementation at the field level in the following round of SATCOM training. Sessions transmitted through the studio also used various mediums like lectures, pictorial slide presentations and short films developed on particular themes to hold the attention of the

participants and motivate them to think about issues, their repercussions and also what could be done to address them.

'e-SEVA' Online Water & Sewage Billing, Hyderabad Metro Water Works, India

Then: The Hyderabad municipality had to keep track of thousands upon thousands of customer billing accounts manually. The system was so inefficient, that the Corporation struggled to make ends meet and invest further in infrastructure development due to poor revenue collection and monitoring mechanisms. Citizens themselves were unmotivated to pay bills on time as it involved physical transportation to the billing department, waiting in long queues, etc. Besides, the repercussions of not paying bills on time or not paying at all were seldom severe as middlemen could be bought out using bribes.

In addition, people in slum clusters enjoyed political patronage for free water. Importantly, since the system was not based on digital metering, it was almost impossible to assess water consumption on a per household basis. Water charges per community were divided up by the number of households, leading to scarce financial incentives to conserve water for households per se.

Now: But by virtue of e-SEVA, all the above problems are resolved. By digitally monitoring (as shown in the figure below) who has paid bills, it is now possible to impose repercussion measures on defaulters. As a result, the Corporation is able to recover its revenues and invest in new project (Relhan et al., 2012).

Republic of Indonesia

Web Application — Blue Raster

Global Forest Watch Fires Online Platform is the result of a partnership between Blue Raster, World Resources Institute, ESRI, Digital Globe, and others. It was built using ESRI's ArcGIS for Server 10.2.2 with Image Extension and the ArcGIS API for JavaScript. The platform contains comprehensive information on the location of fires, land use, land cover, and conservation areas in Indonesia (ESRI, 2015).

6.5 Focus Area 5: Climate Change and Impacts

❖ Strengthen resilience and adaptive capacity to climate change/Disaster

People's Republic of Bangladesh

Digital Elevation Model (DEM) data from Shuttle Radar Topography Mission (SRTM)

It assess the national capacity and evaluate disaster and risk reduction activities, policies and plans with regard to the use of space-based technology, it facilitates the national institutions' access to space-based information to support disaster risk reduction and emergency response activities and it identifies the possible risk reduction and emergency response activities using space based technology (United Nations General Assembly, 2013).

Republic of the Fiji Islands

Fiji DRM Geoportal

This is geospatial data sharing platform for Disaster Risk Reduction and Sustainable Development. Presenting information to assist with planning and coordination for disaster preparedness and response. The Data available on this portal is being provided by Fiji's data repository agencies and managed from National Disaster Management Office (NDMO). Various types data including geospatial data, documents, etc. can be easily accessed, visualized, downloaded using this platform (Fiji DRM Geoportal Website).

Vanua GIS

Government is able to map coastal communities that are most vulnerable to rising sea levels and assist in the relocation of these communities. All information can be assembled digitally in one web portal and accessed by authorized users with the click of a button. The Ministry of Lands & Mineral Resources gets the assistance rendered by various stakeholders who provided their respective data to their Geospatial Information Management Division, which formed the basis of Vanua GIS portal. These stakeholders included; Fiji Elections Office, Ministry of Sugar, Ministry of Infrastructure, Ministry of Agriculture, iTaukei Lands Trust Board, Water Authority, Fiji Electricity Authority, Fiji Roads Authority & Telecom Fiji Limited (Ministry of Lands & Mineral Resources, 2016).

Republic of Indonesia

InaSAFE

This is a free software tool that produces realistic natural hazard impact scenarios for better planning, preparedness and response. The software allows users to combine data from many sources and explore the impacts a single hazard would have on specific sectors, e.g., location of primary schools and estimated number of students affected by a possible flood. This open source tool enables users to download a free Geographical Information System editor (QGIS), install the InaSAFE plugin, and pull in hazards and exposure data layers either with manual offline sources or via Internet web services. Afterwards, users can run a risk impact analysis to show the vulnerability of certain infrastructure or populations to a specific hazard. The software was developed in a partnership with the World Bank/GFDRR, the Australia-Indonesia Facility for Disaster Reduction and the Government of Indonesia (InaSAFE, Website).

Republic of the Union of Myanmar

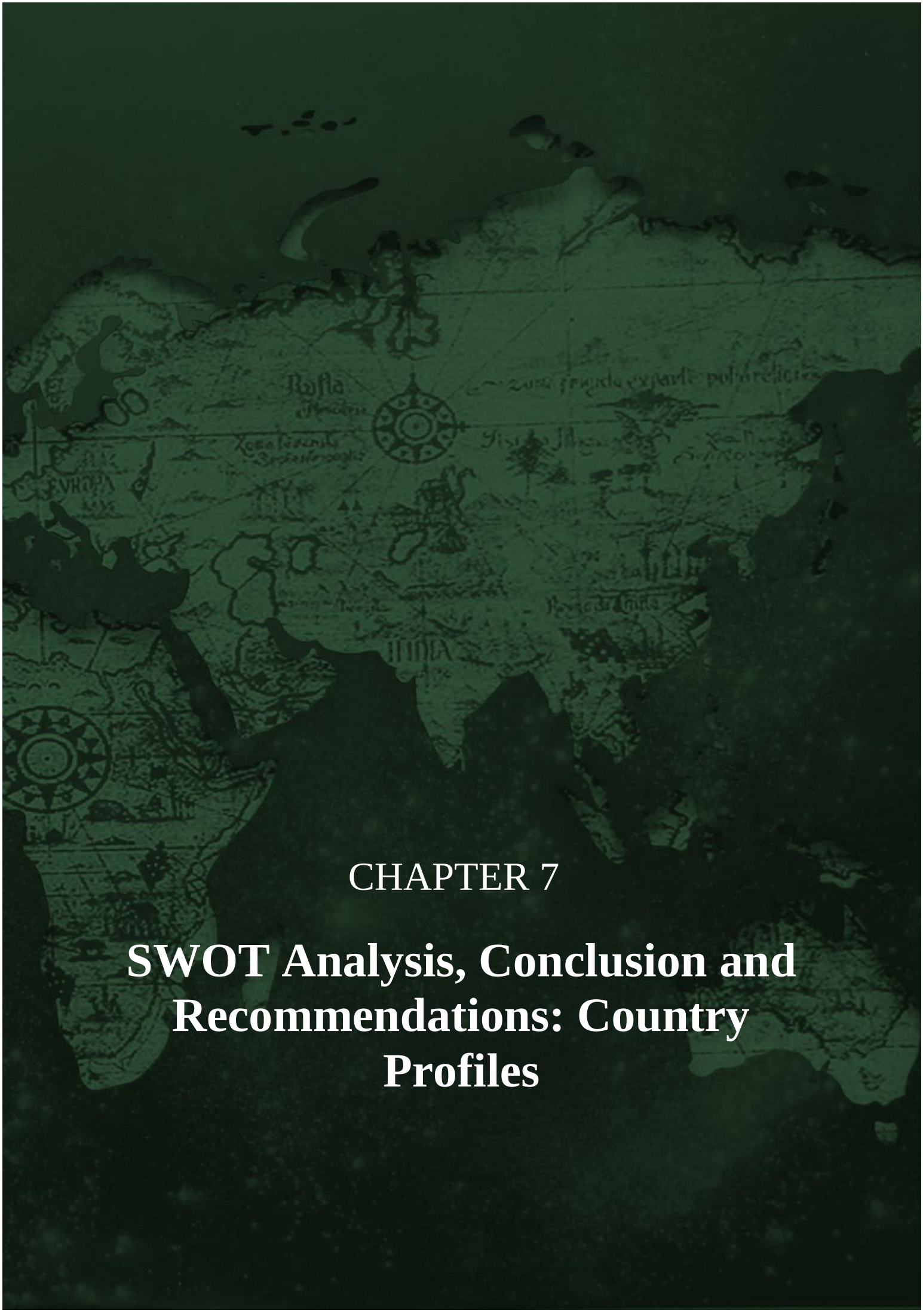
Drought Monitoring System

A Drought Monitoring System in Myanmar has been operationalized recently at the Department of Meteorology and Hydrology with technical support from India. This has improved the drought monitoring capability of Myanmar, focusing initially on its central dry zone region. The system provides agricultural drought information pertaining to prevalence, severity and persistence using moderate resolution data and multiple indices for drought assessment, and augments the ground databases (ESCAP, 2018).

Republic of the Philippines

PREDICT

Philippine Rice Research Institute (PhilRice) collaborated with the Advanced Science Technology Institute of the Department of Science and Technology to automate the collection and retrieval of weather data. PhilRice has been collecting weather data since 1985. Retrieval of data was difficult since you have to personally go to the field and regularly record one-by-one the numerous climate parameters using various instruments. Once missed, the weather condition that has passed at a particular time is also gone. PREDICT now automates the collection of data and stores them in a computer database 24/7 in real-time, downloadable whenever needed, the data are useful for researchers, especially for those doing crop yield projection and other process-based production modelling. Most of our field experiments heavily rely on climatic data. The new system makes it easier for us to access the specific data they need (AGRIMAG, 2018).



CHAPTER 7

SWOT Analysis, Conclusion and Recommendations: Country Profiles

Chapter 7

7.0 SWOT Analysis, Conclusion and Recommendations: Country Profiles

From the 90's decade, the level of geographic information systems (GIS) implementation is increasing in developing countries, despite this, the developing countries are faced with a lot of problems in the operation and maintenance of GIS projects. The lack of an adequate GIS plan can be considered one of the main reasons for difficulties and problems at various stages of GIS development and operations (Mennecke, Brian & Jr, Lawrence. 2001).

Evaluation of the current status related to spatial database infrastructure, geographical database, policies, framework, and best practices of GIS applications can be used as a base to prepare a GIS strategic plan in an organization. Different techniques and approaches can be used for this evaluation; among them, SWOT (strengths, weaknesses, opportunities, and threats) analysis is the most common. The SWOT analysis identifies the strengths, weaknesses, opportunities, and threats that a country faces while the implementation of GIS projects. The strengths and weaknesses are identified by an internal environment appraisal. On the other hand, opportunities and threats are identified by an external environment appraisal. SWOT-analysis helps to determine the current situation and to identify major prospects and challenges that could significantly impact GIS implementation.

Based on the information obtained from previous chapters, this chapter provides the Strengths, Weaknesses, Opportunities, and Threats of the CMC's geographic information situation using the Asia-Pacific scenario. The analysis findings are now presented:

Conclusion

Afghanistan is developing an ASDI which is at initial stages of resolving the data duplicity, improve quality reduce costs, promotion of standards, and the encouragement of transparency related to geographic information, to make geographic data more accessible to the public; but it has worked in increasing the benefits of using available data, by establishing key partnerships with Central and state government, academia and mostly by depending on the external private sector like UGIS.

The Asian Development Bank (ADB) and the Government of Afghanistan launched two Geospatial data policies (Standardization and Classification Policy-) that help in developing central information portals to increase access to accurate and comprehensive geospatial data in the country. Policy documentation is very useful to face challenges in relation to lack of

availability, quality, accessibility, and sharing of geospatial data in Afghanistan.

7.1 Islamic Republic of Afghanistan

Strengths	Weaknesses
(i) New ASDI has strengthened the government and private sector involvement; (ii) Availability of Afghanistan Geospatial Data Standardization and Classification Policy; (iii) Availability of a large base of skilled manpower in cartographic agency which will give an edge to the organizations dealing with spatial information; (iv) Cheap and relatively low-tech global positioning system camera are being used to utilize the existing monetary support to the GIS program; and (v) Open Source spatial electrification tool (OnSSET) is working in inter-disciplinary departments of GoA.	(i) Insufficient budgets; (ii) Weak national IT infrastructure; (iii) Lack of GIS experts; (iv) Lack of market orientation for GI products and services; and (v) Up-to date digital topographic base map series is not available.
Opportunities	**Threats**
(i) Once fundamental dataset (FDS) is created, the custodian agencies will be continuously undertaking data updating; (ii) policies will help to build the government's capacity to use technology to improve its development plan and decision-making; (iii) opportunity for agencies that do not currently maintain standardized metadata to engage in compliant practice; and (iv) highly skilled IT-oriented employees increases that would be expected to handle the GIS functionalities, the number of jobs that the GIS system would create also increases.	(i) High seismic area for earth quick; (ii) More Dependence on External sourcing of Data and infrastructure support and innovation; (iii) Rapid changes of GIS technology; and (iv) Limited Funding/ Resources for Geospatial Initiatives.

Recommendations

(i) Afghanistan has to direct more funds for GIS technology development and has to scientifically diversify the implement ability of the technology in multidimensional aspects of Local governance by GIS, Web-GIS model, Land resource management and interoperability of it in precision agriculture, in order to generate more income and to promote sustainable integrated rural development;

(ii) Some agencies are already developing their own systems within existing projects and programs and these efforts should be combined with the objectives and intended outcomes of ASDI. Agency-specific efforts can be easily aligned with the broader, cross-sector objectives of the ASDI through additional coordination, use of international

standards, and other measures. The strength of ASDI will depend on the agency "building blocks" that make it up, thus strengthening individual agencies helps to strengthen the whole structure; and

(iii) Develop an organizational structure of the GIS Unit that includes a sufficient number of specialists and coordinators, and carefully identify and distribute roles, as well as identify and organize relationships with the municipal departments/branches and government agencies.

7.2 People's Republic of Bangladesh

Strengths	**Weaknesses**
(i) GeoDash has strengthened the government and private sector involvement along with the technical institutions; (ii) Sophisticated and high end-tech GIS platform is developed for information storing & public use for operations at various fields; (iii) Availability of long experience with survey departments (Bengal Survey is 242 years old) and rich base of spatial data; and (iv) Digital elevation model tool & GeoDASH is working in inter-disciplinary departments for disaster management.	(i) Up-to date digital base map series; (ii) Economic productivity through technological innovation, Upgrading and diversification and related policies is not yet developed; (iii) Lack of GIS experts; (iv) Less awareness of an organization about the activities of other organizations in GIS field; and (v) Insufficient capability and funds to tackle problem concerning GIS technology transfer and its rapid evolution.
Opportunity	**Threats**
(i) NSDI platform will provide the valuable geospatial information layers by various agencies for potential user in order to help them develop their own GIS project; (ii) After implementation of national GIS Data policy, all organizations should follow common projection, common sharing protocol and a common metadata standard; and (iii) Important role of GIS and related services to decrease unemployment rate.	(i) High financial input and low GDPI leads to inefficient implementation of high-end SDI technology; (ii) Less finance channelization for GIS Technology development and research; (iii) More Dependence on External sourcing of Data and infrastructure support and innovation; and (iv) Rapid changes of GIS technology.

Conclusion

Bangladesh is developing a common GIS platform GeoDASH which is at initial stages of resolving the data duplicity and improve quality and reduce costs related to geographic information, to make geographic data more accessible to the public by working in increasing the benefits of using available data, by establishing key partnerships with Central and state government & academia.

The rapid changes and development of hardware and software pose a serious problem in its up gradation when necessary. Most of the GIS installation in the country is donor assisted and still operated by foreign expert with limited home personnel.

There are insufficient human resources with skills in the GIS field. GIS departments in local governments hardly exist, and staff members who were not part of any particular department executed GIS tasks repeatedly. Lack of GIS employees was also recognized by the other stakeholders.

Incomplete large-scale basic geospatial data are available. Because the obtainable data are mostly in medium scale (1:25,000), local governments have difficulties in conducting urban planning and land management.

Recommendations

(i) Bangladesh has to direct more funds for GIS technology development and has to scientifically diversify the implement ability of the technology in multidimensional aspects of resource management and interoperability of it in precision agriculture, in order to generate more income and to promote sustainable integrated rural development; and

(ii) Develop an organizational structure of the GIS Unit that includes a sufficient number of specialists and coordinators, and carefully identify and distribute roles, as well as identify and organize relationships with the departments/branches and government agencies.

7.3 Republic of the Fiji Islands

Strengths	**Weaknesses**
(i) GIS database platform (Venua-GIS, Road, DRM, Crime) are developed for information storing & government/ public use for operations at various fields; (ii) Increasing public awareness regarding the role of geo-spatial information for decision making and planning process; and (iii) Fiji Land Information System provides the information of land parcels and their relationships to the land ownership and tenure systems.	(i) Up-to date digital base map series; (ii) National geospatial policies related to data creation, classification and sharing are not yet developed; (iii) Insufficient capability to tackle problem concerning GIS technology transfer and its rapid evolution; and (iv) Lack of market orientation for GI products and services.
Opportunities	**Threats**
(i) Through Geoportals, valuable geospatial information will be stored by various agencies so that the user can access the information for the socio-economic development of Fiji; (ii) FLIS provide the primary and very basic data for the potential users in order to help them develop their own GIS; and (iii) Value of data will increase, if the 'create once, share and use several times' approach is followed.	(i) Less finance channelization for GIS Technology development and research; (ii) More Dependence on External sourcing of Data and infrastructure support and innovation; and (iii) Rapid changes of GIS technology.

Conclusion

Fiji developed its multi-GIS database platform (Venua-GIS, Road, DRM, Crime) for resolving the data duplicity and improve quality and reduce costs related to geographic information, to make geographic data more accessible to the public by working in increasing the benefits of using available data.

There is growing awareness of geospatial information in society. People are now starting to use geo-spatial information for decision making and planning process.

Incomplete large-scale basic geospatial data are available. Because the obtainable data are mostly in medium scale (1:25,000), local governments have difficulties in conducting land management process.

Recommendations

(i) Fiji has to direct more funds for GIS technology development and has to scientifically diversify the implement ability of the technology in multidimensional aspects of Local governance by GIS, Web-GIS model, Land resource management;

(ii) Some agencies are already developing their own database systems (Venua-GIS, Road, DRM, Crime), these efforts should be combined with the objectives and intended outcomes of NSDI; and

(iii) Need more practical "how to" training in GIS. Most relevant officials are not yet familiar with the technology and how it is applied. There is a need for more focused training and workshops to address specific areas of interest, such as database development, performing spatial analysis with GIS, cartographic production, and other practical issues and skills.

7.4 Republic of India

Strengths	**Weaknesses**
(i) NSDI & GIS policies has strengthened the government and private sector involvement along with the technical institutions; (ii) High end-tech GIS platform is developed for information storing and public use for operations at various fields; (iii) BHUVAN is working in inter-disciplinary departments for strengthening local governance and CBO/CSOs; (iv) Availability of long experience with survey departments–for instance, SOI is 242 years old department; and (v) Indian enterprises are developing innovative geospatial products and services by harnessing various geospatial technologies.	(i) Still the private players are not completely under the common platform of data sharing for inter-department operations; (ii) Only a small part of metadata is available from the vast store-house of spatial data available in India; (iii) Long response time for data access from other institutions; and (iv) Both the policy and guidelines of NMP of India are silent about partnership process with major stakeholders.
Opportunities	**Threats**
(i) SOI GIS product will provide the primary and very basic data for the potential users in order to	(i) Geospatial programme in India is top-down, data centric and supply

help them develop their own GIS; (ii) In build precision, better DEM generated 3D view resolution, dependability and usability-blended with digital map making experiences; (iii) Making technical updates for SDI and training professional in other developed countries as well as contributing in Global GIS policy reform; (iv) Opportunities for all stakeholders for access to spatial information could be possible if the new geospatial policy incorporating all the geospatial products and services is formulated by the organization; and (v) Convergence of technologies such as GIS, remote sensing, GPS, broadband internet, and satellite and mobile communication will help in diversifying the products and services.	oriented, and adopts the 'one size fits all' kind of approach; (ii) Non-availability of right resolution data at the grassroots level; and (iii) Increasing pressure for change management at organizational level for adopting the fast changing geospatial technologies.

Conclusion

India is been playing a crucial role in Technological advancement and recreational approaches in GIS sector as well as Phasing up by imparting the training and inter operations among the Asia-pacific and other regional countries in capacity building and imparting techno-support. Private Player stake is still less and to be dealt for reaching optimization of the system output.

India has a very long tradition of collecting spatial data through various organizations at national, state, and district levels, which forms a broad and powerful base. But still the private players are not completely under the common platform of data sharing for inter-department operations.

The purpose of the NSDI is to develop and maintain a standard digital collection of spatial data, general solutions for the exploration, access and use of spatial data in response to the needs of diverse user groups and awareness and understanding of vision, concept and benefits of NSDI.

Bhuvan, as an open platform, being used by diverse users as per their requirements, enabling specific applications of their choice. Bhuvan provide 'Satellite Image Maps' for the entire country as base for decentralized planning and to build Capacity of PRIs & stakeholders for the use of Space Based Information in Decentralized planning and governance.

The Survey of India (SOI) was established in 1767 and completing 252 years of its existence in 2019 and the objective of SOI plays a leadership role in providing user-focused, cost-effective, reliable and quality geospatial data, information and intelligence for meeting the needs of national security, sustainable national development, and new information markets.

Recommendations

(i) The private sector players and the NGOs (Regional as well as Global) need to be brought under on stop solution for Data duplicity and quality rendering mitigation so as to minimize the fund investment for same area or data sector by multilateral organizational

inputs and thus saving time and will initiate the triangulation of the data. Policy reform is needed with regard to this at Global level;

(ii) There is a need for more focused training and workshops to address specific areas of interest, such as database development, performing spatial analysis with GIS, cartographic production, and other practical issues and skills; and

(iii) Need to coordinate with local partners to develop means to share knowledge/expertise either through partnerships or collaborating on common projects and technical issues.

7.5 Republic of Indonesia

Strengths	**Weaknesses**
(i) NSDI & GIS policies has strengthened the government and private sector involvement along with the technical institutions; (ii) The national Geoportal is available as the key product of NSDI development. It provides geospatial data to users and facilitates sharing and the exchange of geographic services among the stakeholders.; (iii) Most of the fundamental datasets, as well as the thematic datasets, are available in digital format; and (iv) InSAFE is free software tool that produce realistic natural hazard impact scenarios for better planning, preparedness and response. The software allows users to combine data from many sources and explore the impacts.	(i) Still private organizations are not completely under the common platform of data sharing; (ii) Lack of GIS experts; (iii) Up-to date digital base map series; and (iv) Lack of market orientation for GI products and services.
Opportunities	**Threats**
(i) Issues such as the implementation of local clearing houses and the maintenance of spatial fundamental data, and standard have been taken into considerations; (ii) Making technical updates for SDI and training professional in other developed countries as well as contributing in Global GIS policy reform; (iii) The demand for geospatial-related applications can be an opportunity to leverage NSDI data and services; (iv) Growing awareness of geospatial information in society. People are now starting to use maps in their daily lives; (v) Open data initiative encourages interactions between public authorities and private companies and may help generate value-added products); and (vi) Adopting state-of-the-art technologies will provide the innovation for geospatial applications to support public services).	(i) Less private and external organization data sharing common platform requirement in GIS to remove data duplicity and extra financial resource utilization technology development and research; (ii) More Dependence on External sourcing of Data and infrastructure support and innovation; and (iii) Lack of finance.

Conclusion

The government was facing the problem of data duplication and data sharing. To solve these problems, the government took initiative to established NSDI with the vision to make the national fundamental datasets available, accessible and integrated into one national data standard.

In order to database, BAKOSURTANAL builds the geodetic network and Fundamental geographical datasets at 1:1,000 to 1:50,000 scale, topographical map sheets to meet the requirements of the government organizations as well as the General Public.

Towards this, NGD formed a one map policy with three significant aspects, one reference, one standard, and one database. The main purpose of one map policy is to create a reference map for all users and preventing overlapping land use claims.

Recommendations

(i) The Regional technology development and investment on high end technology is utmost needed and can be achieved in GIS policy reform with particular standards to be listed out for it by Govt. The external sourcing should be lowered by funding regional technical institutes for research and pilot projecting. Private players to be included in decision making;

(ii) Develop an organizational structure of the GIS Unit that includes a sufficient number of specialists and coordinators, and carefully identify and distribute roles, as well as identify and organize relationships with the municipal departments/branches and government agencies; and

(iii) Need to provide marketable spatial services such as GIS Marketing, Retail, Network analysis etc.

7.6 Islamic Republic of Iran

Strengths	**Weaknesses**
(i) New Geoportal has strengthened the government and private sector involvement; (ii) Existing of ICT departments in Ministries/ Organizations (as a basis for Geo-Information Technology); and (iii) Increasing public awareness regarding the role of SDI for search, retrieve, access and share of spatial data.	(i) Lack or unavailability of required digital geo-spatial data; (ii) Lack of required standards and policy for producing and sharing geo-spatial data; and (iii) Inadequate funds and high costs of producing geo-spatial data.
Opportunities	**Threats**
(i) NCC GIS product will provide the primary and very basic data for the potential users in order to help them develop their own GIS; (ii) National investment to produce geo-spatial data framework; and	(i) More Dependence on External sourcing of Data and infrastructure support and innovation; (ii) Less private and external organization data sharing common platform requirement in

(iii) Increasing general awareness of governmental policy/decision makers about the important role of GI science for decision-making and planning purposes.	GIS to remove data duplicity and extra financial resource utilization technology development and research; and (iii) Rapid changes of GIS technology.

Conclusion

Like many other developing countries, the main goal of Iran is to achieve sustainable development (development in economic, social and environment sectors).NCC has established the National SDI Cooperative Committee to provide a way for government organizations to participate, collaborate and also facilitate inter-organization cooperation to implement NSDI. NCC has established a National Council of GIS Users (NCGISU) to collect user needs and to interact with them and also designed and implemented a National Geoportal to enable all agencies and organizations to share their information services and spatial data layers. In addition, the NCC produces coverage maps across the country on 1:25000, 1:50000, 1:100000, 1:250000 and 1:1000000 scales. Towards this, NCC undertakes supervision and technical control of geomatics projects based on the ISO 9001-2000 quality management system.

Recommendations

(i) Need for proper national strategies to improve the quality of geo-spatial data produced by all private and governmental organizations, specifically national mapping agencies;

(ii) IRAN has to channelize more funds for GIS technology development and has to scientifically diversify the implement ability of the technology in multidimensional aspects, in order to generate more income and to promote GIS development; and

(iii) Need to establish a national organization or forum with the mandate and responsibility for national standards and geospatial data policy.

7.7 Lao People's Democratic Republic

Strengths	**Weaknesses**
(i) Strengthening National Geographic Services (SNGS) funded to establish a sustainable NSDI; (ii) NGD provided the Ortho-photographs free-of-charge to all government organizations; (iii) Increasing public awareness regarding the role of geo-spatial information for decision making and planning process; (iv) The law is reinforced by the issuance of several government regulations such as Decree No. 330/GOL. This regulations act as an umbrella for the Surveying, Aerial Photography, and Mapping; and (v) New Geoportal has strengthened the government and private sector involvement and use the information for operations at various fields.	(i) Unplanned use of resources; (ii) lack of accurate and up-to-date data; (iii) Insufficient capability and funds to tackle problem concerning GIS technology transfer and its rapid evolution; and (iv) Lack of market orientation for GI products and services.

Opportunities	Threats
(i) Through NSDI platform, valuable geospatial information will be stored by various agencies so that the user can access the information for the socio-economic development of Lao PDR; (ii) Through NSDI platform, the co-operation between NGD and different organizations enabling data and information sharing will be improve; (iii) NMA will provide the basic data layer for the potential users in order to help them develop their own GIS projects; and (iv) Increase awareness of standards for data production and management and promotes the exchange of information to avoid duplicate work.	(i) High financial input and low GDPI leads to inefficient implementation of high-end SDI technology; (ii) Less finance channelization for GIS Technology development and research; (iii) More Dependence on External sourcing of Data and infrastructure support and innovation; (iv) Uncertainty of the future continuous resources; and (v) Rapid changes of GIS technology.

Conclusion

The major issue in the Lao PDR is the unplanned use of natural resources and environmental degradation. The GIS technology has become an important tool in many sectors and industries. NSDI is still underway of construction and in order improve geospatial cooperation and coordination between inter-ministerial in the country to prevent duplication of work, NGD formed a GIS Coordinating Committee. In order to database, NGD build the Fundamental geographical datasets at 1:5,000 scale, topographical map sheets to meet the requirements of the government organizations as well as the General Public. Towards this, NGD formed a distinctive policy and legal framework to improve geospatial data management in the country. This decree stipulates that The NGD is responsible for collecting, editing, maintaining, and developing the spatial data received from different ministries, organizations, departments, units, and international organizations related to surveying, aerial photography and mapping to become the national database. The decree also emphasizes that all surveys, aerial photography and topography mapping need approval from the NGD and after completion of the survey the results will be submitted to the NGD.

Recommendations

(i) Identify needed resources, such as software, analytical tools, data, and staff training to meet required strategic plan needs. Incorporate these needs to appropriate strategies (e.g., Data Acquisition Strategy);

(ii) Develop an organizational structure of the GIS Unit that includes a sufficient number of specialists and coordinators and they can get more funds for GIS technology development; and

(iii) Identify which business process needs geospatial applications. Prioritize and implement solutions to meet those needs.

7.8 Federation of Malaysia

Strengths	Weaknesses
(i) MyGDI & National Land Use Policy has strengthened the government and private sector involvement along with the technical institutions; (ii) National Geospatial Data Center serves standardized geospatial data; (iii) The law is reinforced by the issuance of several government regulations such as National Geospatial act with the aim of improve governance of activities related to the application of geographically-based data; (iv) Developed the National Geospatial Master Plan (NGMP) to understand the capability of geospatial technology; (v) Availability of long experience with survey departments–for instance, JUPEM is 134 years old department; and (vi) Developed eKadaster, in order to transform current regiment cadastral system to a coordinated cadastral system.	(i) Still the private players are not completely under the common platform of data sharing for inter-department operations; (ii) increasing complexity in land planning and management; and (iii) Lack of proper attitudinal orientation to data usage especially in public sector organizations.
Opportunities	**Threats**
(i) JUPEM GIS product will provide the primary and very basic data for the potential users in order to help them develop their own GIS; (ii) Opportunities for all stakeholders for access to spatial information could be possible if the new National Geospatial act incorporating all the geospatial products and services is formulated by the organization; (iii) MyGDI is taking shape, which could provide scope for collaborative efforts in creation of geospatial products and services; and (iv) Convergence of technologies such as GIS, remote sensing, GPS, broadband internet, and satellite and mobile communication will help in diversifying the products and services.	(i) Non-availability of right resolution data at the grassroots level; (ii) Increasing pressure for change management at organizational level for adopting the fast-changing geospatial technologies; (iii) Uncertainty of the future continuous resources; and (iv) Rapid changes of GIS technology.

Conclusion

With its rapid rate of development, Malaysia faces an increasing complexity in land planning and management. These rapid development activities are fueling high demand for geospatial information. A high quality geospatial information with an effective GIS system able to play strategic role for a country sustainable development and can contribute significantly to overcome bigger challenges that the world is facing today such as environmental conservation, climate change and global warming.

The GIS technology has become an important tool in many sectors and industries. In order to streamline and further enhance the development of GIS in this country, JUPEM and MaCGDI have formulated strategies to ensure better coordination and effective use of geospatial data. Geodetic network, Cadastral and topographic activities of Malaysia in have focused and participated in the high accuracy survey work whether it is horizontal or vertical surveying, in order to monitor the situation of the earth which is being changed over the years. Towards this, they are working on a distinctive policy and legal framework to improve geospatial data management in the country. A separate Act is being formulated to improve governance and control of geospatial activities undertaken by government agencies and private sector in the country. The proposed Act will provide multiple benefits to the citizen and the country towards digital environment.

Recommendations

(i) The private sector players and the NGOs (Regional as well as Global) need to be brought under on stop solution for Data duplicity and quality rendering mitigation so as to minimize the fund investment for same area or data sector by multilateral organizational inputs and thus saving time and will initiate the triangulation of the data. Policy reform is needed with regard to this at Global level;

(ii) Make an objective to target user requests related to improving intuitiveness of Database, field applications, editing capabilities, searching for layers, and the external web page; and

(iii) There is a need for more focused training and workshops to address specific areas of interest, such as database development, performing spatial analysis with GIS, cartographic production, and other practical issues and skills.

7.9 Republic of the Union of Myanmar

Strengths	**Weaknesses**
(i) OneMap Myanmar portal and one map policy has strengthened the government and private sector involvement along with the technical institutions; (ii) Increasing public awareness regarding the role of geo-spatial information for decision making and planning process; (iii) Sophisticated and high end-tech GIS platform is developed for information storing & public use for operations at various fields; and (iv) Availability of long experience with survey departments–for instance, national mapping agency of Myanmar is 73 years old department.	(i) Less awareness of an organization about the activities of other organizations in GIS field; (ii) Insufficient capability and funds to tackle problem concerning GIS technology transfer and its rapid evolution; (iii) lack of skilled and trained personnel in GIS usage; and (iv) Lack of market orientation for GI products and services.
Opportunities	**Threats**
(i) Through NSDI platform, valuable geospatial information will be stored by various agencies so	(i) Less finance channelization for GIS Technology development and

that the user can access the information for the socio-economic development of Myanmar; (ii) One map Myanmar initiative will generate experience and knowledge aiming to outline and recommended relevant reforms in the geospatial sector; (iii) Survey department of Myanmar will provide the primary and secondary geodetic network for the potential users in order to help them develop their own Geospatial data; and (iv) Important role of GIS and related services to decrease unemployment rate.	research; (ii) More Dependence on External sourcing of Data and infrastructure support and innovation; (iii) Uncertainty of the future continuous resources; and (iv) Rapid changes of GIS technology.

Conclusion

Facing reality is the key to success and to improve the existing situation and the reality is that Myanmar is relatively still weak in the implementation of GIS applications. One Map Myanmar is still underway of construction, and the initiative benefits from the financial support of the Swiss government. In one map Myanmar, Incomplete large-scale basic geospatial data are available. Because the obtainable data are mostly in medium-scale (1:25,000), local governments have difficulties in conducting urban planning and management.

Myanmar has National Land Use Policy related to the building of infrastructure, easy access and sharing of authoritative geospatial information and delivering land-related e-services. Towards this, Modern geospatial (digital mapping) infrastructure and location services have a high potential to bring about valuable socio-economic benefits. One Map policy initiative of the Government of Myanmar, supported by the One Map Myanmar project already involves 25 stakeholders, and paves the way for a unified digital map that is accessible on the web for government and public use.

There are insufficient human resources with skills in the GIS field. GIS departments in local governments hardly exist, and staff members who were not part of any particular department executed GIS tasks repeatedly. Lack of GIS employees was also recognized by the other stakeholders.

There is an urgent need to establish a National level GIS committee for standardization to reduce Lack of consistency (data storage, documentation, format) and to set standards in GIS implementation, cooperation and information interchange for speed up the process with the active participation of stakeholders.

Recommendations

(i) National level GIS committee for standardization to reduce Lack of consistency (data storage, documentation, format) and to set standards in GIS implementation, cooperation and information interchange should be established to speed up the process;

(ii) GIS is essential tool give up-to-date information to take the appropriate and timely action;

(iii) Human resource development in all area is the key to success to reduce technology gap for GIS applications for agricultural & rural development and natural resource management in sustainable manner; and

(iv) Identify needed resources, such as software, analytical tools, data, and staff training to meet required strategic plan needs. Incorporate these needs to appropriate strategies (e.g., Data Acquisition Strategy).

7.10 Federal Democratic Republic of Nepal

Strengths	**Weaknesses**
(i) National Geographic information Infrastructure Programme has strengthened the government and private sector involvement along with the technical institutions; (ii) Metadata Services and Clearinghouse Services help the users to access and retrieve data of their interest; (iii) Increasing public awareness regarding the role of geo-spatial information for decision making and planning process; and (iv) The Surveying and Mapping Policy has strengthen to stakeholders for access high-quality geo-information products and services for sustainable land administration and management.	(i) Lacking sufficient resources that would be required to meet the national need in the sector of geospatial information; (ii) Lack of financial support at different level such as data acquisition, data processing and data dissemination; (iii) Lack of market orientation for GI products and services; and (iv) Lack of the policy on Data security, Data quality and data standard.
Opportunities	**Threats**
(i) Through NSDI platform, valuable geospatial information will be stored by various agencies so that the user can access the information for the socio-economic development of Nepal; (ii) Survey department of Nepal provide the National Topographic Database (NTDB) for the potential users in order to help them develop their own GIS; and (iii) Important role of GIS and related services to decrease unemployment rate.	(i) Less finance channelization for GIS Technology development and research; (ii) Uncertainty of the future continuous resources; and (iii) Rapid changes of GIS technology.

Conclusion

From the SWOT analysis, NGIIP is still underway of construction, notwithstanding the thorough understandings of NGIIP and approaches not in sync among agencies. The success of NGIIP implementation is based on the government vision, commitments of state organizations and current implementation of spatially related policies.

Nepal has quite a large investment to build the multiple geospatial databases at 1:25,000 to 1:1Million scale, topographical map sheets to meet the requirements of the government organizations as well as the General Public. In relation to policy, Nepal has a Surveying and Mapping Policy related to the legislative and institutional framework for the surveying and mapping activities. The vision of the policy is to produce and make available high-quality

geo-information products and services for sustainable land administration and management as well as planning and various lands related development activities to achieve the national objective of poverty reduction and sustainable development.

National Mapping Organization of the country is lacking sufficient resources that would be required to meet the national need in the sector of geospatial information. There is a lack of sufficient and adequately trained human resources to work with modern technology, and the information-sharing mechanism is not sufficiently adequate and the willingness of the stakeholders in participating in the NGIIP initiatives is not optimistic.

There is an urgent need to establish a national organization or forum with the mandate and responsibility for geospatial data policy, geospatial education, dissemination of knowledge & information related to geospatial issues. This organization or forum could also serve as the national affiliation towards the regional cooperation for geospatial data sharing and integration process.

In the future, Nepal has to make a great effort itself as well as with the support of developed and other GIS-successful developing countries to improve their works.

Recommendations

(i) Identify needed resources, such as software, analytical tools, data, and staff training to meet required strategic plan needs. Incorporate these needs to appropriate strategies (e.g., Data Acquisition Strategy);

(ii) The establishment and development of a professional GIS unit at a high level of efficiency and quality to provide spatial services require good and sustainable funding; and

(iii) Need to establish a national organization or forum with the mandate and responsibility for national standards and geospatial data policy on data security.

7.11 Islamic Republic of Pakistan

Strengths	**Weaknesses**
(i) E-government and PNSDI has strengthened the government and private sector involvement along with the technical institutions; (ii) Increasing public awareness regarding the role of geo-spatial information for decision making and planning process; (iii) Data catalog portal developed for search database and available on Local Area Network (LAN); (iv) Surveying & Mapping Ordinance 2013; and (v) Availability of 1:50,000 and 1:250,000 map sheets to meet the requirements of the Defense Forces as well as the General	(i) Redundancies in the collection and maintenance of spatial data; (ii) E-government program ignoring the spatial part of the information; (iii) Lack of GIS experts; (iv) Lack of collaborative efforts and strategies for spatial data sharing among different organizations; (v) Unavailability of metadata; and (vi) Lack of market orientation for GI products and services.

Public.	
Opportunities (i) Through NSDI platform, valuable geospatial information will be stored by various agencies so that the user can access the information for the socio-economic development of Pakistan; (ii) Huge public funds and effort can be saved by controlling duplication of efforts in spatial data production through the establishment of NSDI in the country; and (iii) Surveying & Mapping Ordinance promote inter agency coordination and all organizations should produce standardized geospatial datasets for its effective and objective usage.	**Threates** (i) High financial input and low GDPI leads to inefficient implementation of high-end SDI technology; (ii) Less finance channelization for GIS Technology development and research; (iii) More Dependence on External sourcing of Data and infrastructure support and innovation; (iv) Uncertainty of the future continuous resources; and (v) Rapid changes of GIS technology.

Conclusion

Pakistan is developing an NSDI platform in that SOP which is at initial stages of resolving the data duplicity, improves quality, reduce costs, promotion of standards, and the encouragement of transparency related to geographic information, to make geographic data more accessible to the public. But it has worked in increasing the benefits of using available data, by establishing key partnerships with Central and state government, academia. Pakistan developed a geoportal that is currently available on Local Area Network (LAN) only.

Pakistan has a survey and mapping ordinance that is a good mix of technical and non-technical aspects for production, access, dissemination, and sharing of geospatial data but its implementation would be a challenge due to the prevailing organizational culture of the public sector. In SOP, Incomplete large-scale basic geospatial data are available. Because the obtainable data are mostly in medium-scale (1:25,000), local governments have difficulties in conducting urban planning and land management

There are insufficient human resources with skills in the GIS field. GIS departments in local governments hardly exist, and staff members who were not part of any particular department executed GIS tasks repeatedly. Lack of GIS employees was also recognized by the other stakeholders. Towards this, Pakistan is looking forward to Supports from International organizations in the finalization of national policies on spatial data infrastructure and standardization of dataset. It's also planned to create an awareness program on the geospatial database, policy and importance of GI science for decision making and planning purposes.

Recommendations

(i) There is a lack of awareness of the advantages of the use of spatial information in operation, maintenance and decision support. More effort is needed as part of a strategic plan to raise awareness and increase the uses of GIS in order to advance GIS into the top priority of departmental managers and upper management;

(ii) Develop an organizational structure of the GIS Unit that includes a sufficient number of specialists and coordinators, and carefully identify and distribute roles, as well as identify and organize relationships with the municipal departments/branches and government agencies

(iii) Need to coordinate with local partners to develop means to share knowledge/expertise either through partnerships or collaborating on common projects and technical issues; and

(iv) Identify which business process needs geospatial applications. Prioritize and implement solutions to meet those needs.

7.12 Republic of the Philippines

Strengths	**Weaknesses**
(i) PNSDI Framework: it envisages "a spatially enabled nation with a comprehensive and consistent geospatial dataset widely available and shared for sustainable economic, environment and social environment and management"; (ii) One Nation One Map Project intends to provide an ICT platform for collaboration, data and resource sharing, integration, transparency and resource optimization; (iii) Availability of 1:250,000; 1:50,000; 1:10,000 and 1:5,000 map sheets to meet the requirements of the General Public; and (iv) Geodetic network database provide real-time high precision geographic position data via the internet to the surveying community in the country.	(i) Still the private players are not completely under the common platform of data sharing for inter-department operations; (ii) Lack of policies and procedure on data access, sharing, standard, security and pricing; (iii) Lack of local manpower and misplacement of expertise; and (iv) Low level of appreciation about the Philippine Geoportal among stakeholder agencies.
Opportunities	**Threats**
(i) Map products of NAMRIA will provide the primary and very basic data for the potential users in order to help them develop their own GIS; (ii) Opportunities for all stakeholders for access to spatial information could be possible if the new policy framework incorporating all the geospatial products and services is formulated by the organization; (iii) Philippine Geoportal is taking shape, which could provide scope for collaborative efforts in creation of geospatial products and services; and (iv) Lot of public money and effort can be saved by controlling duplication of efforts in spatial data production through the	(i) Less private and external organizational data sharing perceived nations about data ownership, privacy and public access, unclear policies on sharing agreements and liability among other; (ii) Less finance channelization for GIS Technology development; (iii) Uncertainty of the future continuous resources; and (iv) Rapid changes of GIS technology.

establishment of NSDI in the country.	

Conclusion

Philippines has recognized the importance of NSDI to reduce the data duplicity and promotion of data sharing and transparency in access to the information. They have visualized the importance of Data sharing and the Global Common platform for GIS expansion. Through this integrated platform, NAMRIA has stored the available topographic base maps namely at various scale (1:250k, 1:50k and 1:10K), LiDAR and orthophotos, geodetic control points, gravity stations, declination, bathymetry, lighthouses, tide stations, forest cover, and land classification. Geodetic network activities of NAMRIA have focused and participated in the high accuracy survey work.

They have set up strict Standards to follow up on and controls Data security & operational costs. The Philippines is in the process of formulating the policy framework and it's implementing rules and regulations on the protocols and standards for the sharing and exchange of geospatial data.

The Land Management Bureau (LMB) is on the fast-tracking of the cadastral survey projects. It has completed the cadastral survey of 1,634 cities and municipalities nationwide. The program is instrumental in patent distribution and accelerating countryside development.

Still in Philippines have some issues and concern on data sharing and coordination because of perceived notions about data ownership, privacy and public access, unclear policies on sharing agreements, and liability, among others. These issues have been clarified and addressed in various consultations, roundtable discussions, and high-level meetings with the stakeholder agencies.

Recommendations

(i) The private sector players and the NGOs (Regional as well as Global) need to be brought under on stop solution for Data duplicity and quality rendering mitigation so as to minimize the fund investment for same area or data sector by multilateral organizational inputs and thus saving time and will initiate the triangulation of the data. Policy reform is needed with regard to this at Global level;

(ii) Need to establish a national organization or forum with the mandate and responsibility for national standards, geospatial data policy and procedure on data access, sharing, standard, security and pricing;

(iii) Human resource development in all area is the key to success to reduce technology gap for GIS applications for agricultural & rural development and natural resource management in sustainable manner; and

(iv) There is a need to promote the activities and datasets of organizations in the GIS sector.

7.13 Democratic Socialist Republic of Sri Lanka

Strengths	Weaknesses
(i) SLNSDI has strengthened the government and private sector involvement along with the technical institutions; (ii) Metadata catalog and a Geoportal facilitate accessing geospatial information for decision-makers; (iii) Availability of long experience with survey departments–for instance, Department of the Surveyor-General is 219 years old department; (iv) Surveying & Mapping act promote inter agency coordination and all organizations should produce standardized geospatial datasets for its effective and objective usage; (v) Availability of Multiple geospatial databases at 1:10,000, 1:50,000 and 1:250,000 scale, topographical map sheets to meet the requirements of the government organizations as well as the General Public; (vi) adopting modern surveying and mapping techniques, methods and equipment; and (vii) Land Information System (LIS) published around 1100,000 land parcels information on "GEO Sri Lanka" portal for the public.	(i) Redundancies in the collection and maintenance of spatial data; (ii) Lack of awareness of the benefits at a higher decision-making level; and (iii) Lack of Geospatial data policy.
Opportunities	**Threats**
(i) NSDI creates an ecosystem where government and private sector organizations can collaborate to manage, improve and exchange spatial data and information; (ii) Survey and mapping of Sri Lanka products will provide the primary and very basic data for the potential users in order to help them develop their own GIS; and (iii) Opportunities for all stakeholders for access to spatial information could be possible if the new geospatial policy incorporating all the geospatial products and services is formulated by the organization.	(i) More Dependence on External sourcing of Data and infrastructure support and innovation; (ii) Problem regarding protection of private information; and (iii) Multiple agencies creating the same data i.e. improper use of financial resources by duplication of data.

Conclusion

Sri Lanka has recognized the importance of NSDI to reduce the data duplicity and promotion of data sharing and transparency in access to the information by departments and for the community to generate their own GIS. While despite the threats Sri Lanka is working forward data protection and privacy.

Sri Lanka has quite a large investment to build the Multiple geospatial databases at 1:10,000, 1:50,000 and 1:250,000 scale, topographical map sheets to meet the requirements of the government organizations as well as the General Public.

The review of the past developments and present status of GIS and Geo-Informatics reflects bright prospects and great expectations of the industry in Sri Lanka. There is an urgent need

to establish a national organization or forum with the mandate and responsibility for geospatial data policy, geospatial education, dissemination of knowledge & information related to geospatial issues. This organization or forum could also serve as the national affiliation towards the regional cooperation for geospatial data sharing and integration process.

Recommendations

(i) There is an urgent need to establish a national organization or forum with the mandate and responsibility for geospatial data policy, geospatial education, dissemination of knowledge & information related to geospatial issues;

(ii) Set an objective to improve accessibility and awareness of the GIS data contained. This can extend to improving applications for finding data, searching capabilities, training, etc.; and

(iii) There is a need to promote the activities and datasets of organizations in the GIS sector.

7.14 Kingdom of Thailand

Strengths	**Weaknesses**
(i) National geographic Information committee (NGIC) marked policies for reducing repetition, promoting, sharing and coordinating effectively on geospatial information development; (ii) Natural disaster information such as map and spatial damage assessment through web application; (iii) Established common standard for remote sensing and Geo-Informatics system, and GISTDA have been formally announced 23 standards; (iv) establishment of Geodetic Network (8 stations of Reference Network, 19 stations of Primary Network, 94 stations of Secondary Network and 381 stations of Auxiliary Network); and (v) Rich base of spatial data with RTSD.	(i) Still the private players are not completely under the common platform of data sharing for inter-department operations; and (ii) Only a small part of metadata is available from the vast store-house of spatial data available in Thailand.
Opportunities	**Threats**
(i) GIS CHANGWAT: it provide the geospatial database as multiscale base map which was used by central government and local government; (ii) GIS AGRO system provide the agricultural information on five subsystems: crop monitoring system, pest and plant diseases monitoring system, agricultural technology transfer system, weather forecast system, and productivity estimation system; (iii) RTSD will provide the geospatial data for the potential users in order to help them develop their own GIS; and (iv) Convergence of technologies such as GIS, remote sensing, GPS, broadband internet, and satellite and mobile communication will help in diversifying the products and services.	(i) Less private and external organization data sharing perceived notions about data ownership, privacy and public access, unclear policies on sharing agreements, and liability, among others; and (ii) Sustainability (cost recovery, revenue generation) of the Thailand Geoportal.

Conclusion

Thailand has recognized the importance of Policy reform and acted upon it to regulate the data duplicity and promotion of data sharing and transparency in access of the information by departments and for community to generate their own GIS. Despite of the threats Thailand is working forward to bring all stakeholder under one roof.

Geodesy and Geophysics activities of RTSD in have focused and participated in the high accuracy survey work whether it is horizontal or vertical surveying, in order to monitor the situation of the earth, which is being changed over the years. The disasters caused are earth quaked and the movement of tectonic plates will results directly to the reference coordinates on the map. The results of the GPS measurements have been conducted to improve the control network to be more accurate and reliable.

In the future, RTSD will continue to focus on participating in scientific research and educational institutions to track the threat posed by the global environment. Moreover, RTSD will support the establishment of permanent stations or GPS base station project covering the entire country to monitor the movement of tectonic plates in this region more accurate and reliable, also prepared to cope with other natural disasters that may occur in the future.

Recommendations

(i) There is an urgent need to establish a national organization or forum with the mandate and responsibility for geospatial data policy, geospatial education, dissemination of knowledge & information related to geospatial issues;

(ii) Only a small fraction of the metadata is available from the vast repository of spatial data available in Thailand. There is a need to make it fully available; and

(iii) Set an objective to improve accessibility and awareness of the GIS data contained. This can extend to improving applications for finding data, searching capabilities, training, etc.

7.15 Vietnam: SWOT Analysis

Strengths	**Weaknesses**
(i) Spatial databases are simultaneously updated at all level of administrative entities; (ii) Spatial data database is centrally stored and managed by Ministry of Natural Resources and Environment; (iii) Supports from International organizations via projects and funds; (iv) Techniques for data acquisitions are improved very fast, making data retrieval in a short time with high degree of accuracy; (v) National standards in geographic information have been finished for the first phase with nine standards which will be a base for the creation of framework data and data sharing; and (vi) Large amount of survey and mapping data such as geodetic framework, satellite images, aerial photos, topographic maps of different scales.	(i) Weak information and communication infrastructures throughout nation; (ii) Technical standards are still under construction - Limited awareness of all stakeholders on NSDI development; (iii) Lack of experts in both GIS and IT fields; (iv) As yet there exists no policy for multi-field cooperation; (v) Less finance channelization for GIS Technology development; and (vi) Lack of market orientation for GI products and services.
Opportunities	**Threats**
(i) National standards will be a base for the creation	(i) To some extent, spatial data are

of framework data and data sharing; (ii) Increasing supports and funds from international organizations - Globalization that promote spatial data interoperability; (iii) State awareness of spatial data rises, and the Government starts allocating budget for NSDI; (iv) The Government is pushing administrative reforms to facilitate spatially related services and improve transparency in public sectors; and (v) In the era of globalization, experiences in strategies and technologies from developed countries could be learned.	subject to social stability and security that are not fully available to all user access; (ii) Limited budget for database updating and Policy regulating the access and sharing of spatial data; (iii) In the situation that technologies in the world develop very fast, Vietnam might be in risk of lagging behind if does not have rapid leap as well as continuously self-motivated and creative efforts; and (iv) Limited investment for research works.

Conclusion

With numerous applications in societal and environmental problems, Geo-Informatics is highly appreciated. Being far behind in knowledge, technology and budget in comparison with most developed countries, it is also a challenge for developing countries to efficiently apply Geo-Informatics to support development of the country. Vietnam also has to face this problem.

From the reflective analysis of the weaknesses and opportunities, it assessed that SDI is still underway of construction, notwithstanding the thorough understandings of a SDI and approaches are not in sync among agencies. The success of SDI implementation is based on the government vision, commitments of state organizations and current implementation of spatially related policies.

Vietnam has a number of policies related to the development and application of geospatial data, but these policies have yet to truly sync, unity towards a spatial data infrastructure of the country.

Vietnam has quite a large investment to build the spatial data at various scales in the form of a topographic map, cadastral, land records, satellite images, GIS information systems. In the future, Vietnam has to have to make a great effort itself as well as with the support of developed and other GIS-successful developing countries to improve this work.

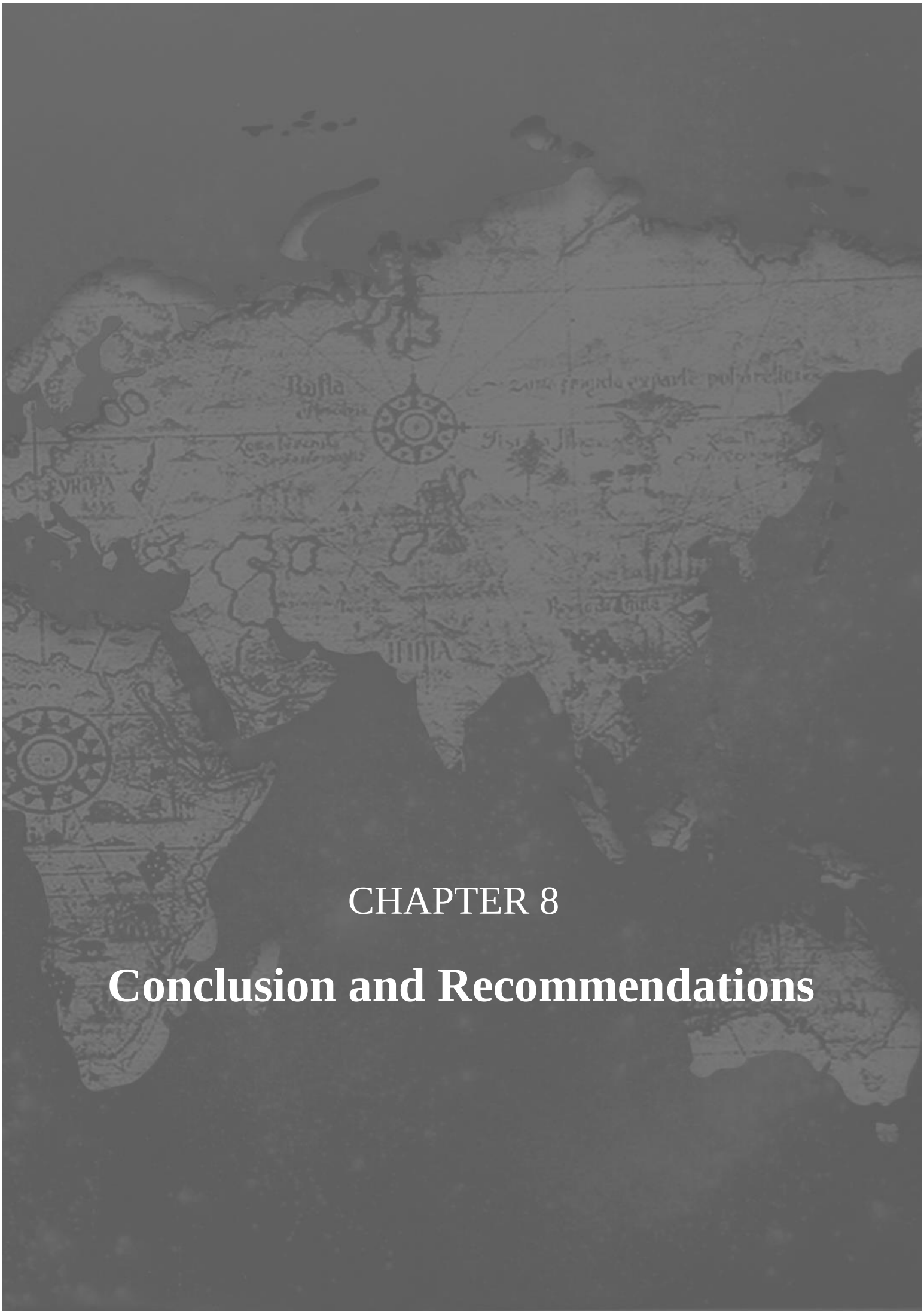
Recommendations

(i) The private sector players and the NGOs (Regional as well as Global) need to be brought under on stop solution for Data duplicity and quality rendering mitigation so as to minimize the fund investment for same area or data sector by multilateral organizational inputs and thus saving time and will initiate the triangulation of the data. Policy reform is needed with regard to this at Global level;

(ii) The promotion of NSDI platform should be replicated with the aim of future expansion at Global Common platform. Vietnam should work with research institute and NGOs to develop GIS models for various other sectors like Agriculture, livelihood stratification and diversification, rural electrification so as to attain sustainable IRD;

(iii) The GIS professional services budget in non-existent currently. It is important to keep in mind that specialized professional GIS services are still likely to be needed in the future; and

(iv) Set an objective to improve accessibility and awareness of the GIS data contained. This can extend to improving applications for finding data, searching capabilities, training, etc.



CHAPTER 8

Conclusion and Recommendations

Chapter 8

8.0 Conclusion and Recommendations

The use of geospatial information is increasing rapidly. There is growing recognition between the government and the private sector that understanding of location and place is an important component of making effective decisions. It is believed that various CMCs are in very different stages in respective of country development, geospatial-data infrastructure and sophistication analysis of the data to generate valuable information. It is inevitable truth that all CMCs will not be in position to invest and realize the full capacity of Geo information for county government, business and citizens.

The aim of the research is to contribute evidence and analysis that will improve understanding of spatial database infrastructure, Geospatial policies, institutional advancement and GIS Best practices for Geospatial technology implementation in CMCs in the context of CIRDAP's Focus areas.

The research presented an SDG index and dashboards for 14 CMCs on their attainment of the SDGs. According to SDG index, Malaysia, Vietnam, and Thailand rank first, second, and third on the attainment of the SDGs. whereas Afghanistan rank last among 14 CMCs, and Fiji not included in the 2018 SDG Index due to insufficient data availability.

The dashboard also shows that progress has been made towards some SDGs in CMCs, but the rate of progress is insufficient and need to accelerate progress towards all SDGs of the United Nations 2030. In particular, CMCs have made relatively more progress on SDG 1 (No Poverty), SDG 5, SDG 8, SDG 13 and SDG 14 although there is still progress to be made but the major progress is needed in fighting Zero Hunger (SDG 2), Good Health and Well-Being (Goal 3), Industry, Innovation and Infrastructure (Goal 9), Inequalities (Goal 10), Life below water (Goal 14), injustice (Goal 16) and strengthening partnerships (Goal 17).

The lack of reliable data to effectively measure progress towards the SDGs remains one of the biggest challenges in CMCs. There is also a wide gap in data availability and sharing across CMCs. There is a lack of data preventing a comprehensive analysis of issues ranging from social protection, violence against women and girls, child and forced labor, food waste and loss, marine pollution, national and local planning of forest management, justice for all and more (Asia and the Pacific SDG Progress Report, 2019).

The research finds that the Contributions of space technology, digital innovations and geospatial information applications in addressing sustainable development in the CMCs, and further development of these innovative technologies can help to further sustainable development efforts.

The research also presented the status of NSDI and brief about geospatial data, metadata, clearinghouse, standards, framework and partnerships in CMCs. The main focus was on institutional arrangements, technological, social and economic dimensions which affect the NSDI growth nationally and regionally in CMCs. The research highlighted that the development of NSDI is a long-term process that require a long-term vision and strategy. The success of an SDI is not dependent on its legal or technical sophistication, but whether it provides an effective communication channel to all stakeholders and allows easy access to spatial data adequately, simply, quickly, safely, and minimally at the cost. However, if the resources are not available to keep the SDI up-to-date then there is little justification for its development. Therefore, funding and resources to secure the implementation of SDI is always an important issue (Rajabifard, Abbas & Williamson, Ian., 2003).

As per the findings, Research highlighted that Geospatial data infrastructure in India, Thailand, Philippines, Indonesia, and Malaysia is at an advanced level with a functional and effective National Spatial Data Infrastructure, and National Mapping Agency. All of these countries have a well-defined framework of spatial data management policies incorporating geo-processing, mobile applications, and customized web applications for leveraging geospatial data available from all distributed source agencies. The thematic layers such as topography, cadastral, transport network, utility network, soil and land cover are available at higher scales ranging from 1:5,000 to 1:10,000 with half-yearly frequency of update. In these countries, Geospatial data and information is largely open and freely available to its public and governments. If data is available on a paid basis, it is of the highest scale or high resolution.

On the other hand, Iran, Myanmar, Sri Lanka, Fiji and Vietnam, their geospatial data infrastructure is growing and has established their NSDI, which provides access to the collection and aggregation of spatial data. These are accessible over the web for online use, and downloadable for offline use for distributed maintenance and use. The spatial data available through geoportals and it is partially open and free for citizens and government. Datasets based on license or payment are also available while many are restricted. The technology architecture is well-developed. They have an integrated data center in place and are in the process of developing a functional clearing house. The thematic layers such as topography, cadastral, soil, land cover, utility network, and transport network are available at scales of 1:5,000 to 1:25,000 with frequency of updates at yearly.

While, In Afghanistan, Bangladesh, Nepal, Pakistan and Lao, the geospatial data infrastructure is at an initial stage, while some countries have a basic level of NSDI, and in the planning, design and implementation phase. The thematic layers available in the country are not of high scales, and range from 1: 40,000 to 1: 250,000 or above. The frequency of updates occurs with most layers updating after three-five years. Geospatial data architecture including platforms and portals is in development stages. Some countries have view-only web portals, with an integrated data center to be enabled soon. There can be no effective development without geospatial information. The time has come for developing countries to recognize the fact that geospatial information is part of national development, underpinning

its development programs. This information must be transformed into knowledge, using GIS and other geospatial technologies for the betterment of the country.

Furthermore, based on the results and outcomes of research on CMCs fundamental datasets, the report has highlighted that there are large amounts of spatial data with many common data layers that are available at different scales in the CMCs and could be useful for the creation and facilitation of the Regional SDI. However, from the identified issues and challenges, the major challenges that give the most impact to the implementation of NDSI, are namely the availability of quality digital data, lack of awareness on GIS and NSDI, and institutional arrangements (Arshad, Noor & Hanifah, Fuziah., 2010). Most of the issues and challenges identified can be considered common to many countries. The report suggested that data is a national capital asset and should be collected once to reduce duplication, improve the quality and reduce costs and shared through NSDI at all level to make spatial data more accessible to the public, to increase the benefits of using available data, and to establish key partnerships with Central/State/tribal government, academia and the private sector.

The research also examined the relevant Geospatial policies existing in CMCs to face challenges in relation to lack of availability, quality, accessibility, and sharing of geospatial data and highlighted that Policy are critical to advance a nation's vision for the advancement of technology capabilities, capacity development, and innovation and user adoption (Asia and the Pacific SDG Progress Report, 2019). A conducive, facilitative and aspirational policy framework provides the necessary environment and reference guidelines for holistic development and adoption of geospatial information and technologies, as well as the development of geospatial data infrastructure in a country.

As per the finding, research highlighted that in the era of rapidly-changing technologies, the need for a dynamic geospatial policy and strategy has become mandatory to enable the use of data for solutions in the country. Thereupon in India, Malaysia, Indonesia, Philippines and Thailand are moving forward on the development of a national level Geospatial policy and legislation framework that accelerates the growth of the geospatial industry.

On the other hand, the geospatial policy framework in Afghanistan, Myanmar, Sri Lanka, Iran and Pakistan are at the implementation stage as the need for extensive use of geospatial is now being realized. While, in Bangladesh, Fiji, Lao, Nepal, and Vietnam are at the initial stage and understand the importance of an enabling geospatial policy framework. It would require considerable time to develop the geospatial infrastructure and policy framework. If a country doesn't have a framework, then naturally the growth of the geospatial industry will suffer, eventually hurting national interests (Datta, A., 2018).

The research also gives a brief about the Status of National Mapping Agencies and their infrastructure, database and government's recent initiative in geospatial development and highlighted that the National mapping agencies are unique. Their roles and values are changing, influenced by many factors, including public demands, changing government priorities and initiatives, as well as ongoing business, military, environmental, and other needs. In every CMCs, there is a national agency that has primary responsibility for mapping.

There is a wide variation in what each NMO does and it differs by country. This report presents NMO's role, products and services in CMCs as well as it has been described to have opportunities to create a model for nation-building.

The research highlighted that sharing best practices can help organizations fill knowledge gaps, improve efficiency, encourage leadership, and more. The report also contained best practices on CIRDAP Focus area and it will be useful for the policy makers, researchers, development practitioners and other stakeholders to improve the performance and productivity.

The CMCs are faced with a lot of problems in the operation and maintenance of GIS implementation. The lack of an adequate GIS plan can be considered one of the main reasons for difficulties and problems at various stages of GIS development and operations. Based on the findings of the study, the following key recommendations are suggested for the policy makers, researchers, development practitioners and other stakeholders:

1	There are large amounts of spatial data with many common spatial data layers that are available at multiple scales in the Asia and Pacific region and can be useful for the creation and facilitation of the Regional SDI. However, the most anticipated political barriers regarding the establishment of a regional SDI include access to datasets for security reasons, lack of resources, national administrative boundaries as a data layer, and copyright issues;
2	Policy makers should keep in mind that advances in technology have change organizational structures, and workflows. Today's SDI is different from yesterday's SDI. SDI allows a distributed or centralized approach to meet the needs of users. It is built on web services and online catalogs. It is more suited for location-based decision making. The pace of change requires new thinking about the national SDI role and investment, and a commitment to differentiation based on open standards is required to deal with this transition;
3	The promotion of NSDI platform should be replicated here with the purpose of future expansion at Global Common platform. Countries should work with research institute and NGOs to develop GIS models for various other sectors like Sustainable Development and Efficient use of Natural Resources, Livelihoods, Access to basic Services, Climate Change and Impact, and Governance so as to attain sustainable IRD;
4	Countries have to channelize more funds for GIS technology development and scientifically diversify the implement ability of the technology in order to generate more income and to promote sustainable integrated rural development;

5	The government, private sector players and the NGOs (Regional as well as Global) need to be brought under on stop solution for Data duplicity and quality rendering mitigation so as to minimize the fund investment for same area or data sector by multilateral organizational inputs and thus saving time and will initiate the triangulation of the data. Policy reform is needed with regard to this at Global level;
6	Human resource development in all area is the key to success to reduce technology gap for GIS applications for agricultural & rural development and natural resource management in sustainable manner;
7	There is a need to establish a national organization or forum with the mandate and responsibility for national standards, geospatial data policy and procedure on data access, sharing, standard, security and pricing;
8	There is a lack of awareness of the advantages of the use of spatial information in operation, maintenance and decision support. More effort is needed as part of a strategic plan to raise awareness and increase the uses of GIS in order to advance GIS into the top priority of departmental managers and upper management;
9	Develop an organizational structure of the GIS Unit that includes a sufficient number of specialists and coordinators, and carefully identify and distribute roles, as well as identify and organize relationships with the municipal departments/branches and government agencies;
10	There is a need for more focused training and workshops to address specific areas of interest, such as database development, performing spatial analysis with GIS, cartographic production, and other practical issues and skills. As well as there is also a need for exchange of views and sharing of lessons learnt among CMCs. It will help in integration of statistics with geospatial information.

Bibliography

A. Mansourian and M. J. Valadan Zoej.(2008). IRAN SDI INITIATIVE: STUDY PHASE OF NSDI. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B4. Beijing 2008.

About CIRDAP (2018, April 10). Retrieved from https://cirdap.org/about-cirdap/

ADB, Afghanistan Launch GeoPortal to Improve Data Access, Sharing, (2018, March 26). Retrieved from https://www.adb.org/news/adb-afghanistan-launch-geoportal-improve-data-access-sharing.

ADB, Afghanistan Launch New GIS Policies to Improve Geospatial Data. (2017, September 14). Retrieved from: https://www.adb.org/news/adb-afghanistan-launch-new-gis-policies-improve-geospatial-data.

Adhikary, K R., & Paudyal, D R. (2014). A Proposed National Surveying and Mapping Policy In Nepal. Nepalese journal of Geoinformatics. Number 6. P 1-7.

Admin. (2012). GIS Committee. National Geographic Department [Website]. Lao's People Democratic Republic. Retrieved from: http://www.ngd.la/?page_id=549&lang=en.

Admin. (2015). Geoportal (Professionals). [Website] National Geographic department. Retrieved from: http://www.ngd.la/?page_id=3521&lang=en.

Admin. (2015, June 14). 67 Important GIS Applications and Uses. Retrieved from https://grindgis.com/blog/gis-applications-uses.

Afghanistan central statistics office. (May, 2007). Afghanistan spatial data infrastructure (ASDI). Afghanistan Spatial Data Infrastructure Workshop. Retrieved from http://ggim.un.org/knowledgebase/attachment1364.aspx?attachmenttype=1.

Afghanistan Geospatial Data Classification Policy, (March 2017). Version 1.0.

Afghanistan Geospatial Data Standardization Policy, (March 2017). Version 1.0.

Afghanistan SDI Initiation Program (2006), GCP Group. At Kabul, Afghanistan. Retrieved from https://thegpcgroup.com/projects/afghanistan-sdi-initiation-program/.

AGCHO Website. Retrieved from: https://agcho.gov.af/8027

AGRIMAG. (2018). [Story] SMART WAY TO MONITOR WEATHER CONDITIONS DEVELOPED. Agriculture Monthly magazine. Retrieved from: https://www.agriculture.com.ph/2018/01/25/smart-way-to-monitor-weather-conditions-developed/

Ahmad, Munir & Ali, Asmat. (Nov, 2015). Is GIS a small talk in the era of SDIs? The Case of Pakistan. Conference: FIG - ISPRS Workshop, 2015: International Workshop on Strengthening Opportunity for Professional Development & Spatial Data Infrastructure Development. At Kathmandu, Nepal.

Alexandros Korkovelos, et. al. A GIS Approach to Planning Electrification in Afghanistan. Afghanistan Energy Study. P 5. Retrieved from: https://energypedia.info/ images/d/d6/A_GIS_approach_to_electrification_planning_in_Afghanistan.pdf

Ali, Asmat & Ahmad, Munir. (2013). Geospatial Data Sharing in Pakistan: Possibilities and Problems. Global Geospatial Conference 2013 UNECA Conference Center, At Addis Ababa, Ethiopia.

Ali, Asmat. (2010). How Does NSDI Development Fit into Pakistan's E-Government Programme?. GSDI 12 World Conference-Realizing Spatially Enabled Societies held at Singapore from 19-22 October 2010 At: Singapore.

Amit Sukal. (2007). Mapping Important Bird Areas (IBA) in Fiji and the Region. Pacific GIS&RS NEWS. The Newsletter of the GIS&Remote Sensing Users in the Pacific Issue 2/2007 August, 2007. P 10.

Anders Wellving. (2010). Information systems for monitoring, assessment and reporting of forest resources - a case study in Cambodia and Lao PDR. MAR Working Paper 38. Strengthening Monitoring, Assessment, and Reporting on Sustainable Forest Management in Asia (GCP/INT/988/JPN).

AREU. (2013). The A to Z Guide to Afghanistan Assistance. Eleventh Edition.

Arshad, Noor & Hanifah, Fuziah. (2010). Issues and challenges in NSDI implementation. International conference on System Science and Simulation in Engineering - Proceedings. 65-70.

Asia and the Pacific SDG Progress Report 2019, United Nations (July 26, 2019), United Nations Publications, 70 p. ISBN-10: 9211207908, ISBN-13: 978-9211207903.

Asian NGO Coalition for Agrarian Reform and Rural Development (ANGOC) and Philippine Association for Intercultural Development (PAFID) (2018). A resource book on participatory geographic information system (PGIS) for land rights advocates. Vol. 1. P 47.

Bach Giang TRAN. (2019). Building, Developing and Managing the National Geospatial Data Infrastructure in Vietnam. FIG Working Week 2019. Geospatial information for a smarter life and environmental resilience. Hanoi, Vietnam, April 22–26, 2019.

Baktash, P. (2003). National and Regional Spatial Data Infrastructure (NSDI & RSDI) and National Cartographic Center of Iran's Activities about it. 2nd FIG Regional Conference. Marrakech, Morocco.

Baktash, P. (2012). National Report of Geomatics in Islamic Republic of IRAN. Nineteenth United Nations Regional Cartographic Conference for Asia and the Pacific. Bangkok, 29 October – 1 November 2012

Bangladesh Institutional Framework (2015). [Knowledge base article] The United Nations Committee of Experts on Global Geospatial Information Management.

Bastide, Joan & Heinimann, Dr. (2017). OneMap Myanmar - Enabling a multi-stakeholder environment for the co-production of data, information and knowledge on land. World Bank Annual Conferance on Land and Poverty, At Washington.

Bernama. (August, 2017). National geospatial master plan to be ready by May 2018. [News] The Sunday Daily. Retrieved from: https://www.thesundaily.my/archive/national-geospatial-master-plan-be-ready-may-2018-DTARCH473724

Bhuvan portal of NRSC/ISRO. India. Retrieved from: www.bhuvan.nrsc.gov.in

Bohra, Alpana & Andrianasolo, Dr. (2000). Application of GIS in modeling of dengue risk based on sociocultural data: Case of Jalore, Rajasthan, India. Dengue Bulletin- Vol 25.

Boila, Sainiani. (November 25, 2016). Vanua GIS launched. FBC News, Fiji. Retrieved from: http://www.fbc.com.fj/fiji/45964/vanuagis-launched

Bretz, Kaitlyn Justine. (2017). "Indonesia's One Map Policy: A Critical Look at the Social Implications of a 'Mess'". Senior Theses. 134.

Bretz, Kaitlyn. (2016). "Geospasial Indonesia: The Utilization of Spatial Data Through Geographic Information Systems Across Indonesia in Various Environmental Contexts". Independent Study Project (ISP) Collection. 2588.

Brig Gen Md Wahidul IslamTalukder. (2014). Survey of Bangladesh Ushers in an Era of Geospatial Data Management and Digital Mapping in Bangladesh. [Online article] The Guardian.

Buliruarua Lesuma & George Tami. (2007). Utilising GIS to Determine the Value of Navovo Agriculture Subdivision. Pacific GIS&RS NEWS. The Newsletter of the GIS&Remote Sensing Users in the Pacific Issue 2/2007 August, 2007. P 9.

Cadastral Survey Division. [Website] Survey Department. Government of Nepal. Retrieved from: http://dos.gov.np/cadastral-survey-division

CEGIS, (2009). Compatibility of GIS Data, Metadata, Data Sharing Protocol and National GIS Data Policy: a complimentary approach towards "Digital Bangladesh".

Centre for Development and Environment (CDE), Research. OneMap Myanmar. Retrieved from: https://www.cde.unibe.ch/research/projects/onemap_myanmar/index_eng.html

Clean Water and Sanitation, Global Partnership for Sustainable Development Goals. Retrieved from: http://www.data4sdgs.org/SDG6

Conway Pene. (2006). [thesis] Integrating urban spatial data using Geographic Information Systems: A case study of Suva. School of Geography, Faculty of Islands and Oceans, University of the South Pacific. P 70.

Daily News. (2018). [News] ICTA launches National Spatial Data Infrastructure in Sri Lanka. Retrieved from: https://www.dailynews.lk/2019/01/04/business/173200/icta-launches-national-spatial-data-infrastructure-sri-lanka

Daosamlong. (2015). GIS Committee workshop discusses coordinated collection and use of geographic data [Website]. Lao's People Democratic Republic.

Data Inventory. Geoportal Philippines. Retrieved from http://www.geoportal.gov.ph/resources/PGPDataInventorywithSW&Trng.pdf

Datta, A. (2018). Geospatial World. [Article] Why India needs a geospatial strategy?. Retrieved from https://www.geospatialworld.net/article/why-india-needs-a-geospatial-strategy/

Decree on Surveying, Aerial Photography and Mapping No. 330/GOL September 18, 2014.

Department of Science & Technology (2017). India Country Report. The United Nations Committee of Experts on Global Geospatial Information Management.

Department of Science and Technology. Annual Report 2011-12. Government of India. P 204

Diaz, L., et al. (2012). Future SDI—Impulses from geoinformatics research and IT trends. Int. J. Spat. Data Inf. Res. 2012, 7, 378–410

Do Thi Thu Thuy. (2015). Plan on establishment of National Committee on Geographical Names and Spatial Data Infrastructure in Viet Nam. UNITED NATIONS ECONOMIC AND SOCIAL COUNCIL. Twentieth United Nations Regional Cartographic Conference for Asia and the Pacific Jeju, 6 - 9 October 2015.

Do Thu Thuy. (2011). Country Report of Viet Nam. High Level Forum on Global Geospatial Management Information. First Forum Seoul, Republic of Korea, 24-26 October 2011.

Dr Alireza Gharagozlu. (2010). [Article] Role of NCC Iran. Geospatial World. Retrieved from: https://www.geospatialworld.net/article/role-of-ncc-iran/

Dr Ranjith Premalal De Silva (2010). Geospatial world. [Article] GIS and Geoinformatics in Sri Lanka. Retrieved from: https://www.geospatialworld.net/article/gis-and-geoinformatics-in-sri-lanka/

Dr. Abdul Kadir Bin Taib. (October 2011). The Current Status of GIS Implementation in Malaysia. High Level Forum on Global Geospatial Management Information. First Forum. Seoul, Republic of Korea, 24-26 October 2011.

Dr. Duc Tue NGUYEN. (2019). DEMAND AND DEVELOPMENT OF GEOSPATIAL DATA IN VIETNAM. FIG Working Week 2019. Geospatial information for a smarter life and environmental resilience, Hanoi, Vietnam. April 22–26, 2019

ESCAP. (2018). Good practices and emerging trends on geospatial technology and information applications for the Sustainable Development Goal's in Asia and the Pacific. ESCAP Technical Paper. Final draft.

ESRI. (2015). Esri Partners Acknowledged for Best Practices in GIS. Retrieved from: https://www.esri.com/esri-news/releases/15-1qtr/esri-partners-acknowledged-for-best-practices-in-gis?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+Esri-News+%28ESRI.com+-+News%29

FAO, (2017). Information and Communication Technology (ICT) in Agriculture: A Report to the G20 Agricultural Deputies. Food and Agriculture Organization of the United Nations. P 4-5

FAO's Project. Improve Agricultural Monitoring Systems through Satellite Imagery for Iran. Retrieved from: http://www.fao.org/in-action/improve-agriculture-monitoring-systems-for-iran/en/

Fiji DRM Geoportal. [Website] Geospatial data sharing platform for Disaster Risk Reduction. National Disaster Management Office (NDMO), Fiji. Retrieved from: http://www.fijigeoportal.gov.fj/

FUJITSU. Case study: Badan Informasi Geospasial (BIG). Retrieved from: https://www.fujitsu.com/downloads/STRSYS/cs/case_study_BIG.pdf

GENDER EQUALITY, Sustainable Development Goals. Retrieved from: https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-5-gender-equality.html

Geospatial Infrastructure and Services, (2018). Towards a Sustainable Land Administration and Management System in Myanmar. Land Sector Needs Assessment; Thematic Policy Notes, P 22-29.

Geospatial World. (2008). [News] Eye in sky will monitor leaks in Fiji. Retrieved from: https://www.geospatialworld.net/news/eye-in-sky-will-monitor-leaks-in-fiji/

Gisresources. (2014). ISRO Empowering Panchayati Raj Institutions using Bhuvan Panchayats. Retrieved from: http://www.gisresources.com/isro-empowering-panchayati-raj-institutions-using-bhuvan-panchayats/

Global Partnership for Sustainable Development Data. Retrieved from http://www.data4sdgs.org/

Good health and well-being, Sustainable Development Goals. Retrieved from: https://www.undp.org/content/seoul_policy_center/en/home/sustainable-development-goals/goal-3-good-health-and-well-being.html

GSDI Newsletter. (2015). Pakistan: Finally, PAK-NSDI initiated. GSDI Regional Newsletter – Vol. 2 No. 6. P 10. Retrieved from: http://gsdiassociation.org/images/Regional_Newsletters/GSDI_Regional_Newsletter-July2015.pdf

Hanesana, Alan & Askov, David & Nezelek, Richard. (2011). Geographic Information System (GIS) Metadata Portal Website Migration. 2011 Society for Advancement of Hispanics/Chicanos and Native Americans in Science National Conference.

History, Survey of Sri Lanka. Retrieved from: https://www.survey.gov.lk/sdweb/page_content_about_us.php?id=56409db7884ae2cee43caa68ac150b555ec3af42

InaSAFE, Website. Retrieved from: http://inasafe.org/

Infrastructures, D.S.D. (2004). The SDI Cookbook. GSDI/Nebert. Retrieved from: http://gsdiassociation.org/images/publications/cookbooks/SDI_Cookbook_GSDI_2004_ver2.pdf

International Fund for Agricultural Development (IFAD). 2014. Moving Up Innovations to Scale: Lessons from IFAD-Supported Development Interventions in the Philippines. IFAD, Manila, Philippines. P 83.

JICA, (2016). International seminar on National Spatial Data Infrastructure (NSDI) for Bangladesh. Retrieved from https://www.jica.go.jp/bangladesh/english/office/topics/160602.html

JICA. (2017). Present Status of Continuously Operating Reference Stations and Future Development Policy. Project for strengthen the capacity on Advance Mapping of SOB for building Digital Bangladesh. Final Report.

John Carpenter and Jevon Snell, (2013), Future trends in geospatial information management: the five to ten year vision. United Nations Initiative on Global Geospatial Information Management. ISBN: 978-0-319-08792-31.

John SF Fabic. (2012). Data integration and sharing for disaster management. Coordinates.

JUPEM Website. Retrieved from: https://www.jupem.gov.my/

Kalantari Oskouei, Ali & Modiri, Mahdi & Alesheikh, Ali & Hosnavi, R. & Nekooie, Mohammad Ali. (2018). An analysis of the national spatial data infrastructure of Iran. Survey Review.

Kebijakan Satu Peta Website. Retrieved from: https://portalksp.ina-sdi.or.id/

Khachonesack DOUANGPHOUTHA. (2016). LaoPDR Country Report. A glimpse of the organization and its activities in brief. The United Nations Committee of Experts on Global Geospatial Information Management.

Khafid. (2011). Geodetic Activities in the National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL). Indonesia Country Report. IUGG General Assembly. Melbourne, Australia. June 28 – July 7, 2011.

KL. (2012). GIS Committee. [Website] National Geographic department. Retrieved from: http://www.ngd.la/?p=626&lang=en

Kumar, n. (2015). Geospatial world. [blog] My reflection on Indian NSDI. Retrived from: https://www.geospatialworld.net/blogs/my-reflection-on-indian-nsdi/

Le Minh Tam. (2009). Survey and Mapping Activities in Vietnam. UNITED NATIONS ECONOMIC AND SOCIAL COUNCIL. Eighteenth United Nations Regional CartographicConference for Asia and the Pacific. Bangkok, 26-29 October 2009.

Leba Gaunavinaka. (2007). Bio-Regional Mapping of Viti Levu. Pacific GIS&RS NEWS. The Newsletter of the GIS&Remote Sensing Users in the Pacific Issue 2/2007 August, 2007. P 7.

MacGDI. [Website] Malaysia Geoportal. Retrieved from: https://www.mygeoportal.gov.my/ ms/node/192

Meeprom, P. & Nualchawee, K. (2016). The Web Map Server Interface: Standardization and Application Development in Thailand and Its Trends toward National Spatial Data Infrastructure Policy. Global Spatial Data Infrastructure Association, GSDI 15 Conference Proceedings, November 2016.

Mennecke, Brian & Jr, Lawrence. (2001). Geographic Information Systems in Developing Countries: Issues in Data Collection, Implementation and Management. JGIM. 9. 44-54.

Ministry of Lands & Mineral Resources. (2016). [News] Ministry Launch Vanua GIS. Retrieved from:http://www.lands.gov.fj/images/news%20article/Design%20Articles/MINISTRY% 20LAUNCH%20VANUAGIS.pdf

Mishra, S. (2010). Geospatial World. [Article] Perspectives Status of Surveying and Mapping in Laos, Philippines: Gathering Momentum. Retrieved from: https://www.geospatialworld.net/ article/perspectivesstatus-of-surveying-and-mapping-in-laosphilippinesgathering-momentum/

MITV. (2015) [News] NSDI project easy accessible data among ministries. Retrieved from: https://www.myanmaritv.com/news/nsdi-project-easy-accessible-data-among-ministries

MyGDI Data Services Application. Online Service Delivery. [Website] MyGoverent. Retrieved from: https://www.malaysia.gov.my/portal/content/30688

MyGDI Governance. [Website] Malaysia Geoportal. Retrieved from: https://www.mygeoportal.gov.my/ mygdi-governance

Naicegucegu, S. (29 October – 1 November 2012). Geospatial information in Fiji. Nineteenth United Nations regional cartographic conference for Asia and the pacific Bangkok.

NAMRIA. (2012). COUNTRY REPORT OF THE PHILIPPINES. UN COMMITTEE OF EXPERTSON GLOBAL GEOSPATIAL INFORMATION MANAGEMEN. August 13-15.

Narain, A. (2017). Geospatial World. [Blog] Developed Countries lead the Geospatial Infrastructure Readiness. Retrieved from https://www.geospatialworld.net/blogs/geospatial-infrastructure-policy-readiness/

Narain, A. (2017). What is the strategic importance of geospatial for SDGs (Geo4SDGs or GEO-for-SDGs)? Geospatial World. Retrieved from https://www.geospatialworld.net/ blogs/importance-geospatial-for-sdgs-geo4sdgs/

National Cartographic Center (NCC) website. Retrieved from: https://www.ncc.ir/en-US/ NCCPortal/1/page/HomePage

National Cartographic Center, Website. Retrieved from: https://www.ncc.ir/en-US/NCCPortal/ 3611/page/The-Goals-and-Tasks-of-NCC--

National Data Sharing Policy. Retrieved from: http://data.gov.lk/national-data-sharing-policy-draft

National Database for Emergency Management (NDEM) website. Retrieved from: https://ndem.nrsc.gov.in/

National Geospatial Policy, (2016). Version 1.0.

Nebert, Doug & Reed, Carl & And, Roland & Wagner, (2007). Proposal for a Spatial Data Infrastructure Standards Suite: SDI 1.0. Research and Theory in Advancing Spatial Data Infrastructure Concepts.

News. November 10. 2017. Minister Koya opens Fiji Geospatial Information Council meeting. cop23. Environment and climate change. Retrieved from https://fijifirst.com/minister-koya-opens-fiji-geospatial-information-council-meeting/

NGD Website. Retrieved from: http://www.ngd.la/

NRSC. (2017). [presentation] Space Based Information Support for Decentralised Planning (SIS-DP). National Workshop Enhancing Effectiveness of Gram Panchayat development Plan (GPDP). NIRD&PR, Hyderabad.

NSDI Meeting (23-25 January, 2017), Geospatial World Forum 2017. At Hyderabad International Convention Centre, Hyderabad, India.

NSDI Portal Website. India. Retrieved from: https://nsdiindia.gov.in/nsdi/

NSDI portal. AN OPEN SOURCE GEOSPATIAL DATA MANAGEMENT & VISUALIZATION PLATFORM. Retrieved from https://nsdi.gov.bd/

NSDI Sri Lanka Website. Retrieved from: https://www.nsdi.gov.lk/nsdi

Nurwadjedi. (2013). One Map Policy: Integrating local data into national database. In Proceedings of the Disaster Risk Management in East Asia and the Pacific Distance Learning Seminar, Jakarta, Indonesia, 18 June 2013.

OneMap Myanamar portal, Website. Retrieved from: https://portal.onemapmyanmar.info/ omm/home/

OPEN DATA PHILIPPINES ACTION PLAN 2014-2016.

Orban-Ferauge, F & Aguilar, V & Carmona, A & Daix, N & Nil, B & Ignacio, J & Alarcon, E & Martin, Javier & McCall, Michael & Miscione, Gianluca & others,. (2011). PGIS: Participatory geographic information systems and land planning: life experiences for people empowerment and community transformation.

P. Michael, GIS for Ocean Conservation, GIS Best Practices, ESRI. Reprinted from the April–June 2006 issue of ArcUser magazine.

Partnerships for the goals, Sustainable Development Goals. Retrieved from: https://www.undp.org/ content/undp/en/home/sustainable-development-goals/goal-17-partnerships-for-the-goals.html

Peace, justice and strong institutions, Sustainable Development Goals. Retrieved from: https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-16-peace-justice-and-strong-institutions.html

Peyman Baktashm. (2012). Iran Activities on SDI and Data Sharing for Disaster Management Case Study : Recent Earthquake on August 11, 2012. GPS-Based Analysis of the Crustal Deformation in NW Iran. UNITED NATIONS ECONOMIC AND SOCIAL COUNCIL. Nineteenth United Nations Regional Cartographic Conference for Asia and the Pacific. Bangkok, 29 October – 1 November 2012.

Phurith Meeprom, Kaew Nualchawee. (2012). THE WEB MAP SERVER INTERFACE: STANDARDIZATION AND APPLICATION DEVELOPMENT IN THAILAND AND ITS TRENDS TOWARD NATIONAL SPATIAL DATA INFRASTRUCTURE POLICY. Retrieved from: http://gsdiassociation.org/images/gsdi15/nonrefereed/198.pdf

Pinaki Mondal & Manish Basu. (2009). Adoption of precision agriculture technologies in India and in some developing countries: Scope, present status and strategies. Progress in Natural Science. Volume 19, Issue 6, 10 June 2009, Pages 659-666.

Poniman, A.; Nurwadjedi; Lumban-Tobing, P. (2004). Developing the National Land Resource Database for Supporting Spatial Land Use Planning. In Proceedings of the 3rd FIG Regional Conference, Jakarta, Indonesia, 3–7 October 2004.

Prof. Ian Dowman & Deepali Roy. (2011). [Article] National mapping organisations: A model for nation building. Geospatial world.

Quality education, Sustainable Development Goals. Retrieved from: https://www.undp.org/ content/ undp/en/home/sustainable-development-goals/goal-4-quality-education.html

R, Siva kumar & PS Acharya, (2013). NSDI in India: Status and the road ahead. Coordinate. Retrieved from: https://mycoordinates.org/nsdi-in-india-status-and-the-road-ahead/

R.R. Chhatkuli. (2004). National Geographic Information Infrastructure in Nepal for Strengthening Planning and Resource Management. NEPALESE JOURNAL ON GEO-INFORMATICS NUMBER 3.

Rabin K. SHARMA and Babu Ram ACHARYA. (2004). Spatial Data Infrastructure for Prosperous Nepal. Spatial Information Management Promoting Sustainable Development. 3rd FIG Regional Conference Jakarta, Indonesia, October 3-7, 2004.

Raja Ram CHHATKULI and Durgendra Man KAYASTHA. (2005). Towards a National Geographic Information Infrastructure: Overcoming Impediments to the Development of SDI in Nepal. Pharaohs to Geoinformatics. FIG Working Week 2005 and GSDI-8, Cairo, Egypt. April 16-21, 2005.

Rajabifard Abbas, Escobar Francisco and Williamson Ian P. (2000). Hierarchical Spatial Reasoning Applied to Spatial Data Infrastructures. Journal of Cartography. Volume 29, 2000 - Issue 2, Pages 41-50.

Rajabifard, Abbas & Williamson, Ian & Binns, Andrew. (2006). Marine Administration Research Activities within Asia and the Pacific Region - Towards a Seamless Land-Sea Interface.

Rajabifard, Abbas & Williamson, Ian. (2003). Asia-Pacific region and SDI activities. Journal of GIS Development July 2003 Vol. 7 Issue 7.

Rakai, Mele & Williamson, Ian. (1995). Implementing LIS/GIS from a Customary Land Tenure Perspective. Australian Surveyor. 40.

Rehman, N., Oliullah., & Sardar, Z.H., (2014). Bangladesh Country Report. Integrating Statistical and Geospatial Information System: Bangladesh Perspective. The United Nations Committee of Experts on Global Geospatial Information Management.

Relhan, G., Ionkova, K. & Huque, R. (2012). Good urban governance through ICT : issues, analysis, and strategies (English). Washington, DC: World Bank. P 39-40.

Relhan, G., Ionkova, K. & Huque, R. (2012). Good Urban Governance through ICT: Issues, Analysis, and Strategies. In: The World Bank. Washington, DC. P 13-15.

Royal Thai Survey Department (RTSD). (2015). Report of Thailand. Twentieth United Nations Regional Cartographic Conference for Asia and the Pacific Jeju, 6 - 9 October 2015.

Sachdeva, S. (2002). e-Governance Action Plan for India. Published online at development gateway, UNPAN and Australian Repository one-Governance.

Sami JANNE, and Khamvanh LORKHAMYONG. (2015). Establishing Sustainable NSDI: Combined Technical and Institutional Approach. FIG Working Week 2015. From the Wisdom of the Ages to the Challenges of the Modern World. Sofia, Bulgaria, 17-21 May 2015.

Sengja Jangmaw. (2015). [Project] Subregional Environmental Monitoring and Information Systems. Regional Resource Centre for Asia and the Pacific. Retrieved from: http://www.rrcap.ait.asia/Lists/Projects/dispform2.aspx?ID=16&ContentTypeId=0x0100048614375BC60447AE99B98EAE107CA7

Services, NAMRIA Website. Retrieved from: https://lmb.gov.ph/index.php/e-library/nat-l-cadastral-survey-program

Setyowati, Heratania & Heru Murti, Sigit & Dwinugroho, M & Napitupulu, Novelya & Wisnuwardhani, Evita. (2018). ESDM One Map Indonesia Exploring The Energy and Mineral Resources. 39th Asian Conference & Exhibition for Remote Sensing 2018, At Kuala Lumpur.

Silapathong, C. & Nualchawee, K. & Karnchanasutham, S. (2012). Toward spatially enabled country and society: The case of Thailand. 1. 559-563.

Singh M, Singh G. (2006). Use of information and communication technologies in today's farming. In: Proc of 19th national convention of agricultural engineers on role of information technology in high-tech agriculture and horticulture, Bangalore, India. p. 302–5.

Singh, I. (October, 2016). Made in Malaysia. Geospatial world Magazine. Volume 07, Issue 03, ISSN 2277-3134, Page 14-15.

Singh, Pramod. (2009). G-Governance in India: Search for a Suitable Framework and Research Directions. 15-19

Sr Azlim Khan, Abd.Raof Khan. (2011). Country Report of Malaysia. HIGH LEVEL FORUM ON GLOBAL GEOSPATIAL MANAGEMENT INFORMATION. First Forum Seoul, Republic of Korea, 24-26 October 2011.

Sr Azlim Khan, Abd.Raof Khan. (2011). Country Report of Malaysia. HIGH LEVEL FORUM ON GLOBAL GEOSPATIAL MANAGEMENT INFORMATION. First Forum Seoul, Republic of Korea, 24-26 October 2011.

Stakeholder, NSDI Sri Lanka Website. Retrieved from: https://www.nsdi.gov.lk/stakeholder

SUPARCO. (2012). Country Report of Pakistan. UN Committee of Experts in Global Geospatial Information Management. New York. 13 August -15 August 2012.

Survey Department of Nepal. (2012). COUNTRY REPORT ON GEOSPATIAL INFORMATION MANAGEMENT IN NEPAL. The United Nations Committee of Experts on Global Geospatial Information Management.

Survey Department, Website. Ministry of Natural Resources and Environmental Conservation. REPUBLIC OF THE UNION OF MYANMAR. Retrieved from: http://surveydepartment.gov.mm/eng/?q=activities/145

Survey Division. Ministry of Lands and Mineral Resources website. Retrieved from: http://www.lands.gov.fj/index.php/department/department-of-lands/corporate-service-2

Survey of Bangladesh Website. Retrieved from: http://www.sob.gov.bd/site/page/7e9999d4-37af-41f3-a28e-3b299c3987e8/-

Survey of India, Website. Retrieved from: http://www.surveyofindia.gov.in

Survey of India. Annual Report 2016-17.

Survey of Pakistan. Website. Retrieved from: http://www.surveyofpakistan.gov.pk/Overview

Sustainable Development Goals, UN. Retrieved from: https://www.un.org/sustainable development/sustainable-development-goals/

TAN Liat Choon, Khadijah Binti HUSSIN. (2012). Towards E-Government's 3D Property. International Journal of Scientific & Engineering Research Volume 3, Issue 3, March -2012.

Tandang Yuliadi Dwi Putra, Yoshihide Sekimoto & Ryosuke Shibasaki. (2019). Toward the Evolution of National Spatial Data Infrastructure Development in Indonesia. ISPRS Int. J. Geo-Inf. 2019.

Thailand. (2012). Report of Thailand on Cartographic and Geographical Information System Activities. Nineteenth United Nations Regional Cartographic Conference for Asia and the Pacific. Bangkok, 29 October – 1 November 2012

The Bertelsmann Stiftung and the Sustainable Development Solutions Network (SDSN), (July, 2018). SDG INDEX AND DASHBOARDS REPORT 2018.

The Department of Science & Technology. July, 2017. India Country Report. The United Nations Committee of Experts on Global Geospatial Information Management.

The department, Survey of Sri Lanka. Retrieved from: https://www.survey.gov.lk/sdweb/ page_content_about_us.php?id=8b8450664ade43f34efbc32a73059fdab247679f

The Fijian government (2014), Fiji Takes Lead Role in Geospatial Development.

The Geospatial Information Agency (BIG). (2012). COUNTRY REPORT GEOSPATIAL INFORMATION IN INDONESIA. 19th United Nations Regional Cartographic Conference for Asia and the Pacific. 18th Permanent Committee on GIS Infrastructure for Asia and the Pacific Meeting. Bangkok, Thailand, 28 October - 1 November 2012.

The Philippine Geospatial Data Infrastructure (PGDI) Master Plan 2011-2020. Version 1.0.

THE ROYAL THAI SURVEY DEPARTMENT. (2015). THAILAND REPORT ON THE GEODETIC WORK PERIOD 2011 – 2014. PRESENTED AT THE XXVI GENERAL ASSEMBLY OF THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS.

Thurston, J. & Ball, M. (2007). What's the Role and Value of a National Mapping Agency?. Sensors and systems.

Tiangco P. N. & Linda SD. Papa (2006). Philippines Country Report 2006. Integration of Built and Natural Environmental Datasets within a National SDI. PCGIAP-Data Integration Template 2006.

United Nations General Assembly. (2013). Technical advisory support activities carried out in 2013 in the framework of the United Nations Platform for Space-based Information for Disaster Management and Emergency Response. Committee on the Peaceful Uses of Outer Space. V.13-88505 (E). P 2.

USGS develops GIS data framework for Afghanistan, (2011), Geospatial World. Retrieved from https://www.geospatialworld.net/news/usgs-develops-gis-data-framework-for-afghanistan/?sa=X&ved=2ahUKEwi51Mz2re7mAhXyoFsKHROJDI4QFjAAegQIABAB

Village Information System Website. India. Retrieved from: http://www.villageinformationsystem.org/

Walkthrough of GIS Assisted SDG Implementation, Institute for Conscious Global Change. Retrieved from http://www.icgc.ngo/doclib/GISassistedSDG.pdf

WIENTIAN KODCHABUDTHADA.[Presentation] The development of Thailand Spatial Data Infrastructure (NSDI). Myanmar Information Management Unit.

World Bank (2008). A partnership beyond expectations: The story of POWERGRID. [News] The World Bank. Retrieved from: https://www.worldbank.org/en/news/feature/2008/06/02/india-powergrid-partnership

World Bank, (2019). Geospatial Technology and Information for Development. Retrieved from: https://www.worldbank.org/en/topic/land/brief/geospatial-technology-and-information-for-development.

World Bank. (2010). [story] In Afghanistan and India, Low-Tech Approaches Aid Monitoring. The World Bank. Retrieved from: https://www.worldbank.org/en/news/feature/2010/06/01/in-afghanistan-and-india-low-tech-approaches-aid-monitoring.

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