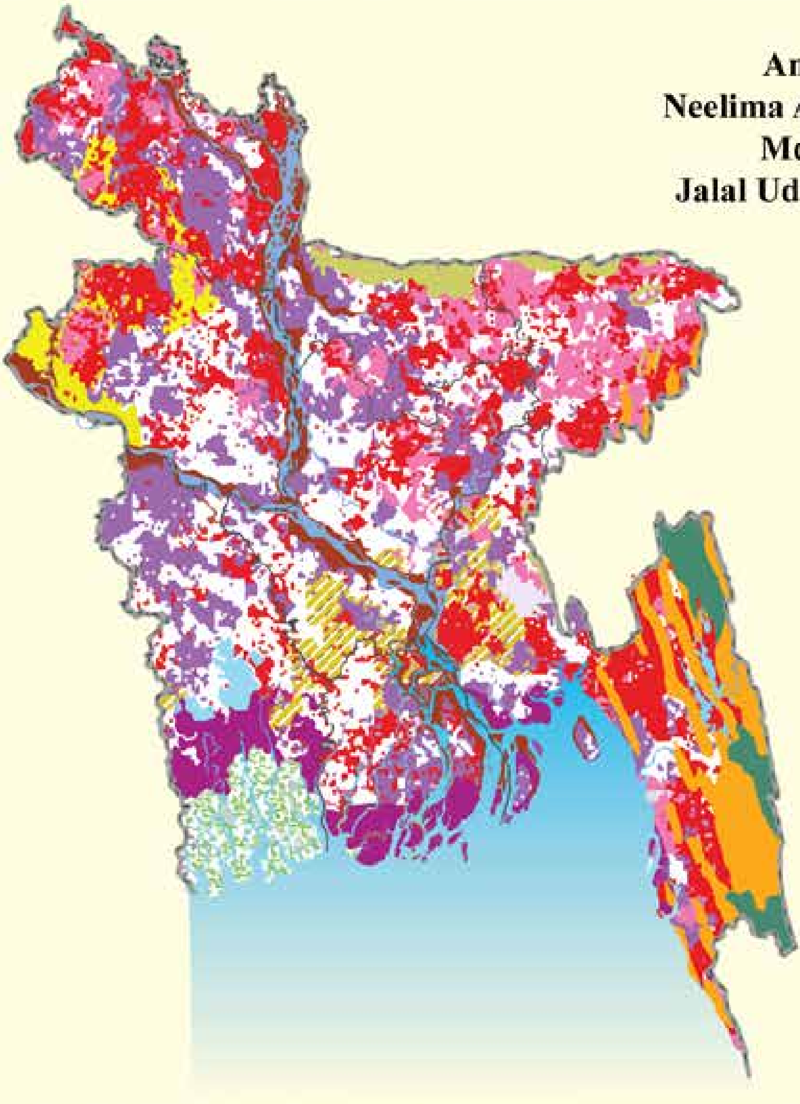
LAND DEGRADATION IN BANGLADESH

Baseline Study of Land Degradation Processes 1985-2000



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Neelima Akter Kohinoor
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Jalal Uddin Md. Shoaib

Prepared under Decision Support for Mainstreaming and Scaling Up of Sustainable Land Management (DS-SLM) Project

মৃত্তিকা সম্পদ উন্নয়ন ইনস্টিটিউট

Food and Agriculture Organization of the United Nations

পরিবেশ অধিদপ্তর

Soil Resource Development Institute [SRDI]
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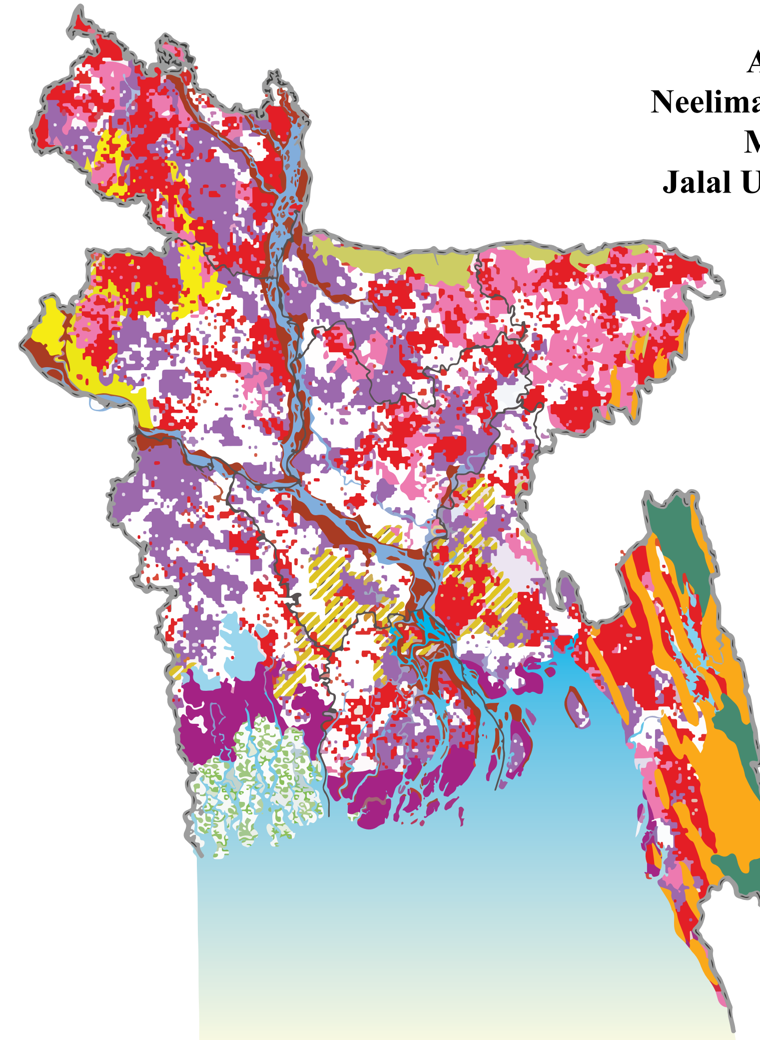

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ISBN:

978-984-34-815-2

Date of Publication:

February, 2020

Soil Resource Development Institute

Krishi Khamar Sarak, Dhaka-1215

Bangladesh.

Prepared under Decision Support for Mainstreaming and Scaling Up of Sustainable Land Management (DS-SLM) Project, GoB-SRDI-DoE-FAO, Dhaka

Printing costs incurred by:

Establishing National Land Use and Land Degradation Profile Toward Mainstreaming SLM Practices in Sector Policies (ENALULDEP/SLM) Project SRDI-DoE-UNEP

Design & Print

Jenifa Corporation
Mobile: +8801916 999 333
E-mail: jenifa.bd@gmail.com

Print Production:

Execute Printers
Mariam Villa (2nd Floor)
87 Naya Paltan, Masjid Lane, Dhaka-1000.
Hotline: +8801766-500100, 01766-500200
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Citation:

Zahid, A.M., Kohinoor, N.A., Hossain, M.A. and Shoaib, J.U. 2020. Land Degradation in Bangladesh: Baseline Study of Land Degradation Processes 1985-2000. FAO Supported Research Report. SRDI, Dhaka

Acronyms

AEZ	Agro-Ecological Zones
BARC	Bangladesh Agricultural Research Council
BMDA	Barind Multipurpose Development Authority
BMD	Bangladesh Meteorological Department
CUCE	Cornel University Cooperative Extension
DAE	Department of Agricultural Extension
DoE	Department of Environment
FD	Forest Department
DS-SLM	Decision Support for Mainstreaming and Scaling-up of Sustainable Land Management
ENALULDEP/SLM	Establishing National Land Use and Land Degradation Profile Toward Mainstreaming SLM Practices in Sector Policies
FAO	Food and Agriculture Organization of the United Nations
FRG	Fertilizer Recommendation Guide
GIS	Geographical Information System
GLASOD	Global Assessment of Human-induced Soil Degradation
GOB	Government of the People's Republic of Bangladesh
LDN	Land Degradation Neutrality
NRCS	Natural Resources Conservation Service
SAARC	South Asian Association for Regional Cooperation
SLM	Sustainable Land Management
SMRC	Salinity Management and Research Center
SRDI	Soil Resource Development Institute
UK	United Kingdom
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
USAID	The United States Agency for International Development
UTM	Universal Transverse Mercator
WDB	Water development Board

Ackonwledgement

Soil Resource Development Institute (SRDI) has developed the land degradation base map for Soil Resource Development Institute (SRDI) has deve The task was done by the support from "Decision Support for Mainstreaming and the year 2000. The task was done by the support for of Sustainable Land Management (DS-SLM)" GCP/GLO/337/GFF project. under the Ministry of Environment, Forest and Climate Change (MoEFCC) and Ministry of Agriculture (MOA) with supervision from Department of Environment (DoE) and technical uport from Food and Agriculture Organization of the United Nations (FAO). Due to CovidPandemic situation the outcomes of DS-SLM project could not be published within the project time frame. Finally, the report has been published with the financial support from ongoing Establishing National Land Use and Land Degradation Profile toward Mainstreaming SLM Practices in Sector Policies" [ENALULDEP/SLM) project.

The authors expressed their gratitude to Mr. Abdullah Al Mohsin Chowdhury, honorable former Secretary, MoEFCC, Md. Nasiruzzaman, honorable Secretary, MoA and Dr. S. M. Munjurul Hannan Khan, Additional Secretary, MoEFCC for their overall guidance to accomplish the project work. The authors are greatly indebted to Dr. A.K.M Rafique Ahammed, Director General of the DoE, Mr. Bidhan Kumer Bhander, Director General of the SRDI, and Dr. Md. Sohrab Ali, the National Project Coordinator (NPC) of DS-SLM project and Director, DoE for their constant support and encouragement to prepare the manuscript.

The authors extend their gratitude to the members of the expert committee that was formed to formulate and finalize the methodology of land degradation map preparation. Special mention is to Dr. Zahurul Karim, honorable Secretary (Rtd.), Ministry of Fisheries and Livestock, GoB and Member, Science Policy Interface (SPI), UNCCD. We are also grateful to the distinguished participants of twenty-four organizations of the consultation workshop who contributed for validation and creation of a common understanding on land degradation parameters used to produce the base map.

The authors would like to express their sincere gratitude towards Dr. Kristofer Johnson, International Consultant, FAO and FAO team members Md. Fazlay Arafat, Rashed Jalal and Nayeema Rashid who provided their significant contributions to make the land degradation mapping successful.

Finally, the authors would like to express their gratitude to SRDI scientists and their associates who performed field surveys and laboratory analysis to prepare Upazila Land and Soil Resources Utilization Guides during 1985-2000.

- Authors

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Executive Summary

Since the world's agricultural production has been growing disproportionately with cultivated area, the land resources are in continuous pressure. Excessive demographic pressure and unsustainable agricultural practices have intensified naturally slow processes of land degradation. It may be further exacerbated in places by external drivers, including climate change, competition with other sectors and socio-economic changes.

Land degradation can be defined as decline in productivity and ecosystem function. It may be assessed by use of periodically determined different fertility index data. Deviation from the normal or standard may serve as an assessment of land degradation and improvement – if other factors that may be responsible are taken into account. UNEP has defined land degradation as a temporary or permanent lowering of the productive capacity of land. The degree of degradation is estimated in relation to changes in agricultural suitability, in relation to declined productivity and also in some cases in relation to biotic functions. Because land is fixed in quantity, there is ever-increasing competition to extract goods and services from land resources. Therefore, a multi-sectoral project had been taken for decision support and mainstreaming sustainable land management (SLM) practices to attain land degradation neutrality (LDN) targets in 2030. The global project "Decision support for mainstreaming and scaling up of sustainable land management (DS-SLM)" is aimed at improving the capability and the decision making of the country in the mainstreaming and scaling up of SLM to combat Land Degradation. The project had been developed and implemented in a partnership between 15 countries, CDE/WOCAT Secretariat, FAO, and the GEF as the resource partner. For Bangladesh component, Soil Resources Development Institute (SRDI) was one of the executing agencies.

Systemic description of land degradation situation in Bangladesh was first accomplished by SRDI in 1993 (FAO-RAPA 1994) and then by BARC in 1999 (Karim and Iqbal, 2001) based on the available information. Six processes of land degradation scenarios delineated in maps at that time. Under the DS-SLM project, SRDI conducted the baseline study of land degradation processes from the year 1985 to 2000 and prepared the land degradation report of Bangladesh. In this report, sixteen processes of LD are delineated in maps in a way that can be updated in future with adding up newly generated data.

Major land degradation processes which dealt within the project framework were soil nutrient depletion, soil organic matter depletion, acidification, salinization, soil erosion in hilly areas, riverbank erosion, drought, sandy over-wash, water-logging, and soil pollution (arsenic contamination). Land degradation class or the degree of degradation is estimated in relation to declined productivity, changes in agricultural suitability, in some cases, to social conditions that affect people and decline safe food production. Four degradation classes recognized are: i. very severe, ii. severe, iii. moderate, and, iv. light. The land parcel has not gone under any type of degradation is designated as "none".

Data used for land degradation assessment were mostly taken from the database generated by SRDI during Semi-Detailed Soil Survey of 450 Upazilas in Bangladesh from 1985 to 2000 (SRDI Stuff 1985-2000). Soft-copy format database were stored in GIS platform in DPS (Data Processing and Statistical) Section of SRDI. Besides, AEZ database (FAO, 1988), reports and maps produced by BARC (2005), SRDI (2000), BARC (2001), BWDB (2000), BARC (2000), BGS-DPHE (2001) and expert opinions were the basis for the assessment.

Land degradation (LD) Map of Bangladesh 2000 as a baseline or benchmark map have been developed combining the other ten individual LD type maps by superimposition of a type of LD map layer on the other type map layer. In this way, all 10 map layers were placed one after another. Other features added upon the LD map layers are Sundarbans mangrove, reserve forest, lake, and wide river.

Degraded land in respect to soil nutrient depletion was found around 10.96 million ha. This was combined depletion effect of phosphorus (6.6 million ha), potassium (5.27 million ha), sulphur (6.53 million ha), zinc (5.55 million ha) and boron (5.11 million ha). Degraded land in respect to soil organic matter depletion is around 11.64 million ha; in respect to soil erosion (hilly areas) is 1.70 million ha; riverbank erosion 1.74 million ha, sandy over-wash 0.42 million ha; acidification 8.37 million ha, salinization 1.02 million ha; drought 1.43 million ha, water-logging 0.10 million ha; and arsenic contamination 4.49 million ha.

Land degradation types or processes are not mutually exclusive. That means, where soil erosion [like, in hilly areas] is taking place, there soil organic matter depletion also may occur; or, where salinization is the hotspot problem, there nutrient depletion problem may rise. Almost all of land of the country had gone under one or more types of and different levels of land degradation processes. Moderate to very severe classes of land degradation took place in 10.70 million ha area of the country during 1985-2000. It was about 72.5% of the country area. None to light degradation was: 2.4 million ha (16.3%)

Dried up Tista river, Panchagarh.

Riverbank erosion, Monpura.

1. Introduction

Land degradation processes are on-going over large part of the Earth surface. Most of the degradation is due to soil erosion and biodiversity loss in the less populated areas, while water shortage, soil depletion and soil pollution are most common in the most agricultural areas. Since 1961 to 2009, the world's agricultural production has grown between 2.5 and 3 times while the cultivated area has grown only by 12 percent. Input-intensive, mechanized agriculture and irrigation have largely contributed to this rapid increase in productivity (FAO 2011). However, achievements in production have been associated with management practices that have intensified land degradation processes in too many places. Across the world, a series of agricultural production systems are at risk due to a combination of excessive demographic pressure and unsustainable agricultural practices. These physical constraints may be further exacerbated in places by external drivers, including climate change, competition with other sectors and socio-economic changes. This warrants attention for assessment of extent and severity of land degradation and scaling up of sustainable land management (SLM) practices throughout the globe.

Land degradation is always with us, but its causes, extent and severity are contested. Land degradation can be defined as decline in productivity and ecosystem function. It may be assessed by use of periodically determined different fertility index data. Deviation from the normal or standard may serve as an assessment of land degradation and improvement – if other factors that may be responsible are taken into account. Land degradation is defined variously by different institutions. In the project context, UNEP definition may be appropriate one: Land degradation is a temporary or permanent lowering of the productive capacity of land. It covers:

- Soil erosion
- Soil fertility decline
- Adverse human impacts on water resources
- Deforestation, and
- Lowering of the productive capacity of agricultural lands.

The degree of degradation is estimated in relation to changes in agricultural suitability, in relation to declined productivity and also in some cases in relation to biotic functions.

Much of our agricultural land has been gone under degradation. We must reverse, stop and/or slow down the process of land degradation, otherwise we have to suffer from food insecurity as well as destruction of species habitat and biodiversity. Because land is fixed in quantity, there is ever-increasing competition to control land resources and capitalize on the flows of goods and services from the land. This has the potential to cause social and political instability, fuelling poverty, conflict and migration (UNCCD, 2020). Therefore, a multi-sectoral project had been taken for decision support and mainstreaming SLM practices to attain land degradation neutrality (LDN) targets in 2030 and setting up of LD monitoring pathways. The global project "Decision support for mainstreaming and scaling up of sustainable land management (DS-SLM)" is aimed at improving the capability and the decision making of the country in the mainstreaming and scaling up of Sustainable Land Management to combat Land Degradation. In this connection, generation of baseline data and maps for different LD types/processes is of utmost importance.

1.1 Objectives of the study

1. To prepare geospatial database for baseline land degradation status
2. To prepare the land degradation base map 2000

2. Literature Review:

2.1 Definitions and terminology:

Land degradation is a natural or human-induced process that negatively affects the land to function effectively within an environmental system and can be defined as a process of degrading land from a former state. Land degradation is closely related to sensitivity, resilience, and carrying capacity of land, as well as to vulnerability of people living on and from these lands (Zorn & Komac, 2013). Land degradation has been a major global issue during the 20th century and will remain high on the international agenda in the 21st century. The importance of land degradation among global issues is enhanced because of its impact on world food security and quality of the environment. High population density is not necessarily related to land degradation; it is what a population does to the land that determines the extent of degradation (Eswaran, et al., 2001).

Land degradation can be considered in terms of the loss of actual or potential productivity or utility as a result of natural or anthropic factors; it is the decline in land quality or reduction in its productivity. In the context of productivity, land degradation results from a mismatch between land quality and land use (Beinroth et al., 1994; cited in: Eswaran, et al., 2001). Mechanisms that initiate land degradation include physical, chemical, and biological. Important among physical processes are a decline in soil structure leading to crusting, compaction, erosion, desertification, environmental pollution, and unsustainable use of natural resources. Significant chemical processes include acidification, leaching, salinization, decrease in cation retention capacity, and fertility depletion. Biological processes include reduction in total and biomass carbon and decline in land biodiversity. The latter comprises important concerns related to eutrophication of surface water, contamination of groundwater, and emissions of trace gases (CO_2, CH_4, N_2O, NO_2) from terrestrial/aquatic ecosystems to the atmosphere. Soil structure is the important property that affects all three degradative processes. Thus, land degradation is a biophysical process driven by socioeconomic and political causes (Eswaran, et al., 2001).

2.2 Land degradation severity and extent:

Because of different definitions and terminology, a large variation in the available statistics on the extent and rate of land degradation exists. There is also a difference in terminology used to express the severity of land degradation. Dregne and Chou used the terms slight, moderate, severe, and very severe to designate the severity of degradation. Oldeman used the terms light, moderate, strong, and extreme, and these terms may not be comparable to those of Dregne and Chou. Oldeman et al. (1992), on the basis of expert judgment, attempted to differentiate natural from human-induced degradation. Differences in terminology and approaches, and also the areas included in the assessment, mean that the estimates of the different workers are difficult to compare (Oldeman et al., 1992, cited in Eswaran, et al., 2001; Eswaran et al., 2001).

Table 1. Estimates of all degraded lands (in million km^2) in dry areas (Dregne and Chou, 1994).

Continent	Total area	Degraded area †	% degraded
Africa	14.326	10.458	73
Asia	18.814	13.417	71
Australia and the Pacific	7.012	3.759	54
Europe	1.456	0.943	65
North America	5.782	4.286	74
South America	4.207	3.058	73
Total	**51.597**	**35.922**	**70**
† Comprises land and vegetation.			

Table 1 shows that degraded lands in dry areas of the world amount to 3.6 billion ha or 70% of the total 5.2 billion ha of the total land areas considered in these regions.

GLASOD (Global Assessment of Human-induced Soil Degradation) indicated that 15% of land is degraded. The highest proportions were reported for Europe (25%), Asia (18%) and Africa (16%); the least for North America (5%). As a proportion of the degraded area, soil erosion affects 83% of the global degraded land; nutrient depletion affects 4% globally; salinity less than 4% worldwide but 16% in West Asia; chemical contamination about 1% globally but 8% in Europe; soil physical problems 4% globally (Bai et al., 2008).

Table 2. GLASOD estimates of human-induced soil degradation (million ha)

Kind of degradation	World	Asia	West Asia	Africa	Latin America and Caribbean	North America	Australia and Pacific	Europe
Water erosion	1094	440	84	227	169	60	83	115
Wind erosion	548	222	145	187	47	35	16	42
Nutrient depletion	135	15	6	45	72	–	+	3
Salinity	76	53	47	15	4	–	1	4
Contamination	22	2	+	+	+	–	–	19
Physical	79	12	4	18	13	1	2	36
Other	10	3	1	2	1	–	1	2
Sum	1964	747	287	494	306	96	103	218

Land degradation is always with us, but its causes, extent and severity are contested. Bai et al. (2008) defined land degradation as a long-term decline in ecosystem function and productivity, and assessed it using long-term, remotely sensed normalized difference vegetation index (NDVI) data. But the caveat is that NDVI cannot be other than a proxy; it does not tell us anything about the kind of degradation or improvement. What is happening in degrading areas as identified, say, in South-East Asia is different from what is happening in the Pampas both in terms of the driving changes in soil use and management, and the symptoms of land degradation. However, this work was part of the FAO project Land Degradation Assessment in Drylands (LADA). From this work, land degradation statistics of SAARC countries with three other selected countries are given below (Table 3).

Table 3. Statistics of degrading areas (severely degraded?) of SAARC countries, Russia UK and USA 1981–2003[a]

Sl. No	Country	Degrading area (km^2)	% Territory	% Global degrading area	% Total population	Affected people
1.	Afghanistan	7658	1.17	0.025	2.56	671770
2.	Bangladesh	68422	47.52	0.199	49.12	72728775
3.	Bhutan	27011	57.47	0.073	54.99	1332662
4.	India	592498	18.02	1.751	16.50	177437809
5.	Nepal	54704	38.85	0.182	48.93	13332932
6.	Pakistan	20644	2.57	0.073	3.58	5838072
7.	Sri Lanka	21057	32.09	0.060	25.62	4788637
8.	Russia	2802060	16.41	16.519	6.20	8588604
9.	UK	23506	9.60	0.103	5.95	3324064
10.	USA	1983886	20.60	7.935	10.79	31144568
The World (land, excluding inland water bodies)		35058104	23.54	100.000	23.89	1537679148

[a]*Countries or regions with no degradation are not listed (e.g. the Maldives).*

Source: Z. G. Bai, D. L. Dent, L. Olsson, M. E. Schaepman, 2008, Proxy Global Assessment of Land Degradation in Soil Use Management, Vol., 24, Issue 3, September 2008, British Society of Soil Science.

According to the above estimation, 24 per cent of the land area has been degrading over the last 25 years, directly affecting the livelihoods of 1.5 billion people; this is on top of the legacy of thousands of years of mismanagement in some long-settled areas (Bai et al., 2008).

Table 4. Degradation status of global land in crops, permanent pasture, forest, and woodlands

Degradation category	Amount of land affected (million ha)	Lost production (percent)
Total usable land	8,735	
Not degraded	6,770	0
Degraded	1,965	
-lightly	650	5
-moderately	904	18
-strongly	**411**	**50**

Sources: Crosson 1997; O'Riordan 2000, cited in, Land Degradation M.A. Stocking, in International Encyclopedia of the Social & Behavioral Sciences, 2001

3. Methodology

Extensive investigations were made to find out earlier information on land degradation processes, types, severity and trends described and mapped in previous reports, documents, monographs and research papers including web pages and documents.

3.1 Data and tools

Some important data sources and tools used are listing below.

- Land and Soil Resources Database stored in GIS platform, around 45,000 data points (SRDI 1985-2000)
- Upazila Land and Soil Resources Utilization Guides, 450 volumes (SRDI 1985-2000)
- Aerial photographs (1998-2000), Survey of Bangladesh (SOB)
- Topsheets (1998-2000), SOB
- ArcGIS 10.5
- Microsoft Excel spreadsheet
- Historic Google Earth Pro imagery
- Books extensively consulted are:
    - Agroecological Regions of Bangladesh (FAO, 1988)
    - Collection and Analysis of Land Degradation Data (FAO-RAPA, 1994)
    - Problem Soils of Asia and the Pacific (FAO-RAPA, 1990)
    - Impact of Land Degradation in Bangladesh: Changing Scenario in Agricultural Land Use (Karim and Iqbal, 2001)
    - Geography of Bangladesh (Rashid, 1991)
    - The Geography of the Soils of Bangladesh (Brammer, 1996)
    - Research Experiences With Problem Soils of Bangladesh (Khan, et. al., 2008)
- Other maps and documents from SRDI, BARC, DoE, WDB, Forest Department, BMD, FAO, USAID, etc
- Group discussions/workshops

Table 5. Major land cover types and respective areas in Bangladesh in 1985-2000

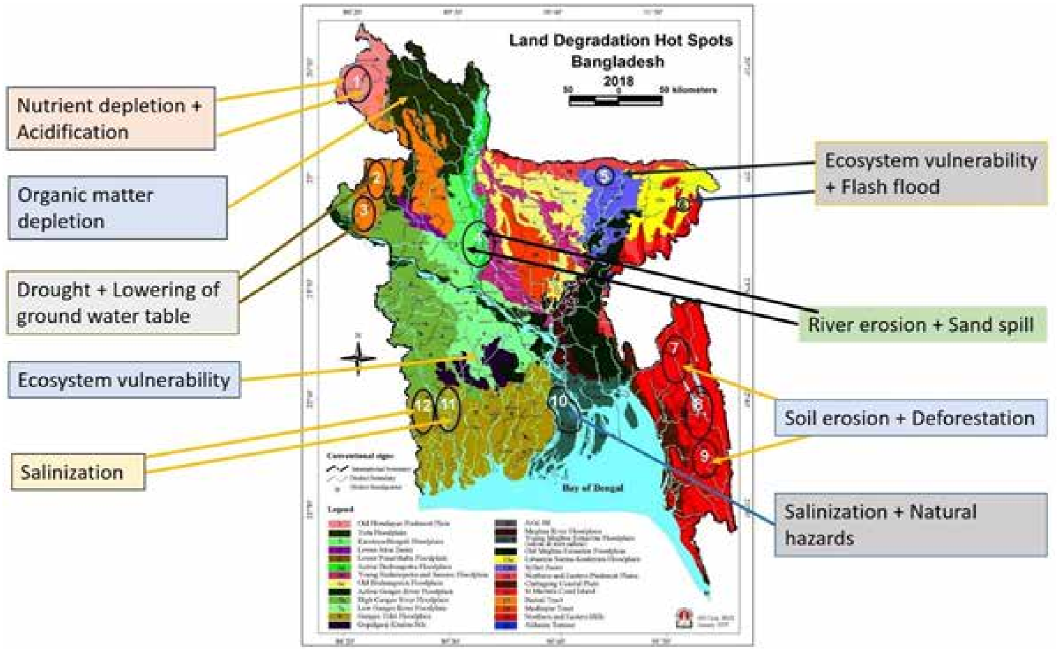
Land cover	Area in ha	Area in million ha	% area
A. Surveyed area:			
*Cropland	9,439,541	9.44	64.0
Forest area other than reserved forest	1,026,811	1.03	7.0
*Beel-haor, peat basin, aquaculture	251,774	0.25	1.7
*Tea garden	138,533	0.14	0.9
*Saltpan	24,306	0.02	0.2
*Rural settlement	1,458,031	1.46	9.9
*Urban area	47,495	0.05	0.3
Charland	712,079	0.71	4.8
Sub-total A	**13,098,570**	**13.10**	**88.8**
B. Unsurveyed area			
Lake	5,8261	0.06	0.4
River	88,8441	0.89	6.0
**Reserve forest	284,310	0.28	1.9
**Sundarban mangrove	427,418	0.43	2.9
Sub-total B	1,658,430	1.66	11.2
Total: A+B	**14,757,000**	**14.76**	**100.0**

*Area corresponds to Hasan et al., 2014

**Area corresponds to Forest Department, 1994

3.2 Land degradation hotspots selection for the study

The present assessment deals with 1985–2000, and, considering the state of the land during that period land degradation hotspots proposed by SRDI were as figured out below.



After several discussions meeting at SRDI and threadbare discussions in workshops held in Department of Environment, major land degradation hotspots, which would be dealt within the project framework, were selected as follows:

1. Soil nutrient depletion
2. Soil organic matter depletion
3. Acidification
4. Salinization
5. Soil erosion (in hilly areas)
6. Riverbank erosion
7. Drought (low rainfall, high temperature and ground water abstraction)
8. Sandy overwash
9. Water-logging
10. Soil pollution (Arsenic contamination)

3.3 Land degradation class: Degree of degradation

Land degradation class or the degree of degradation is estimated

- in relation to declined productivity, and
- in relation to changes in agricultural suitability,
- also in some cases in relation to social conditions that affect people and
- declined safe food production.

Four degradation classes recognized are:

1. Very severe, 2. Severe, 3. Moderate, and, 4. Light

1. **Very severe:** The land parcel is difficult to reclaim at farm level. Major engineering works are required for land restoration. Original biotic functions are largely destroyed. Production loss is between 50-75%
2. **Severe:** The land parcel is greatly reduced agricultural productivity but is still suitable for use in local farming systems. Major improvements are required to restore productivity. Original biotic functions are partially destroyed. Production loss is between 25-50%
3. **Moderate:** The land parcel has considerably reduced agricultural productivity but is still suitable for use in local farming systems. Restoration to full productivity is possible by modifications of the management system. Original biotic functions are mostly intact. Production loss is between 10-25%.
4. **Light:** The land has somewhat reduced agricultural suitability but is suitable for use in local farming systems. Restoration to full productivity is possible by modifications of the management system. Original biotic functions are largely intact. Production loss is between 0-10%.

None: The land parcel has not gone under any type of degradation is designated as "none". Its productivity is fully intact. Land gone under "improvement" or area of "bright spot" is also included in this nomenclature.

Table 6. Relative productivity loss according to degradation class

Degradation class	Very severe	Severe	Moderate	Light
Relative productivity loss	50-75%	25-50%	10-25%	<10%

[Modified from FRG, BARC 2018]

3.4 Assessment of individual land degradation types/severity

3.4.1 Soil nutrient depletion

Five nutrient elements are considered for degradation assessment for present soil nutrient depletion mapping, these are: phosphorus (P), potassium (K), sulphur (S), zinc (Zn) and boron (B). Data used for land degradation assessment were taken from the database generated by SRDI during Semi-Detailed Soil Survey of 450 Upazilas in Bangladesh from 1985 to 2000. Soil samples were collected from more than 45,000 sampling points and successive laboratory analysis was done. Data obtained from the survey and laboratory analysis were documented and stored in hardcopy format (Upazila Land and Soil Resources Utilization Guides, commonly known as Upazila Nirdeshika) in SRDI Library, Nirdeshika Cell and in respective District Offices of SRDI and soft-copy format in GIS platform in DPS (Data Processing and Statistical) Section of SRDI. Stored database in GIS platform in DPS (Data Processing and Statistical) Section were used for degradation analysis, prior rechecking was done where any issues arose, by making comparisons with the hardcopy data in Upazila Nirdeshika (Guidebook) and by taking suggestions from the scientists involved in survey time.

For generating individual nutrient map, inverse distance weighting (IDW) interpolation method has been applied to create surface from the soil nutrient point shape file and then reclassified according to degradation class values of each nutrient element using ArcGIS.

For generating combined nutrient decline map, degradation class values were assigned on the data of each element followed by multiplying with a specific weightage for each element. Then weighted average was calculated followed by IDW interpolation and reclassification. Degradation class values were determined through interpolation of soil test value in relation to critical limit and relative crop yield.

Table 7. Degradation Class as per critical limit of phosphorus

Critical limit (µg/g)	Degradation class				
	Very severe	Severe	Moderate	Light	No
5.0	<=3.75	3.751-7.50	7.501-9.80	9.801-11.25	>11.25

Interpretation of soil test values based on critical limits, loamy to clayey soils for wetland rice crops and Bray and Kurtz method (acidic soils)

Table 8. Degradation Class as per critical limit of potassium

Critical limit (µg/g)	Degradation class				
	Very severe	Severe	Moderate	Light	No
0.12	<=0.075	0.076-0.15	0.151-0.195	0.1951-0.225	>0.225

Interpretation of soil test values based on critical limits, loamy to clayey soils for wetland rice crops

Table 9. Degradation class as per critical limit of sulphur

Critical limit (µg/g)	Degradation class				
	Very severe	Severe	Moderate	Light	No
10.0	<=9.0	9.1-18.0	18.1-23.5	23.6-27.0	>27

Interpretation of soil test values based on critical limits, loamy to clayey soils for wetland rice crops

Table 10. Degradation class as per critical limit of zinc

Critical limit (µg/g)	Degradation class				
	Very severe	Severe	Moderate	Light	No
0.6	<=0.45	0.451-0.90	0.91-1.20	1.21-1.35	>1.35

Interpretation of soil test values based on critical limits, loamy to clayey soils for wetland rice crops

Table 11. Degradation class as per critical limit of boron

Critical limit (µg/g)	Degradation class				
	Very severe	Severe	Moderate	Light	No
0.2	<=0.15	0.151-0.30	0.31-0.40	0.401-0.45	>0.45

Interpretation of soil test values based on critical limits, loamy to clayey soils for wetland rice crops

3.4.2 Soil organic matter depletion

Land degradation class due to organic matter depletion is derived and modified from organic matter status class depicted in Fertilizer Recommendation Guide-2005.

Table 12. Degradation class as per soil organic matter content

	*Degradation class				
	Very severe	Severe	Moderate	Light	No
Organic matter content (%)	<1.0	1.0-1.7	1.71-2.5	2.51-3.0	>3.0

Adopted and modified from BARC, 2005. Fertilizer Recommendation Guide-2005, Bangladesh Agricultural Research Council (BARC), Soils Publication No. 45.

3.4.3 Soil erosion in hilly areas

Percentage slope is used both to evaluate credibility and ease of management. Although somewhat unsatisfactory, slope appears the most useful criterion to investigate credibility (FAO, 1985). Data used for soil erosion in hilly areas are taken from AEZ database (FAO, 1988) and Semi-Detailed Soil Survey database (SRDI, 1985-2000).

Polygons of topsoil erosion are generated using AEZ database and Nirdeshika database through cartographic method and then digitized to construct shape files. The degradation classes for soil erosion are determined as severe, moderate and light according to severity of the erosion hazards. Erosion severity was determined as per overall steepness of the slopes which intriguers erosion of hill soils.

Table 13. UNEP/FAO Approach vs. Local Approach of slope classes

Slope class	Slope gradient (%)		Land erosion
	UNEP/FAO, 1997*	Local approach	Local approach
1.	0-3: flat to gentle	0-5: level/ almost level	Very little/ little
2.	3-12: moderate	5-15: gently sloping	Little/ Medium
3.	12-20: steep	15-30: moderate	Medium/excessive
4.	20-35: very steep	30-50: steep	Excessive/extreme
5.	>35: extreme	50-70: very steep	Extreme
6.		>70: extreme	Extreme

*UNEP/FAO approach developed within the frame of the UNEP Priority Action Program and tested in different Mediterranean countries (UNEP, 1997)

Table 14. Degradation Class as per Erosion Susceptibility of hilly areas

Hill range, height and sloping class	Degradation class			
	Very severe	Severe	Moderate	Light
Hill ranges	-	Mainly high hill ranges	Mainly low hill ranges	Low hills and Piedmont plains
Height		300-1000m	<300m, often 100m	
Sloping class and landscape	-	Mainly very steep [>40% to often 100%] and are subject to landslide erosion. Only small areas of floodplains occur in valleys.	With short steep slopes, some areas with rolling to early-level relief.* Floodplain land occupies <10% of the landscape.	Low hills + sloping piedmont plains. ** Floodplain land occupies 10-30% of the landscape.
Erosion susceptibility		Severe + very severe	Moderate + severe	Gentle + moderate

**e.g., in the best tea-growing areas of Sylhet region. **bordering the northern and eastern hills, subject to flash floods during the rainy season, covering most or parts of the upazilas of Nalitabari (Sherpur), Tahirpur, Bishwamvarpur, Dowarabazar, Companiganj (Sylhet), Gowainghat, Madhabpur, Habiganj Sadar, Chunarughat, Sreemangal, Kamalganj and Kulaura.*

3.4.4 Riverbank erosion:

Data used for riverbank erosion are taken from AEZ database (FAO, 1988) and Semi-Detailed Soil Survey database (SRDI , 1985-2000). Polygons of riverbank erosion are generated using AEZ database and Nirdeshika database through cartographic method and then digitized to construct shape files. The degradation class for bank erosion are determined as moderate as per Karim & Iqbal (2001) and other expert opinions.

3.4.5 Sandy overwash

Data used for sandy overwash are taken from AEZ database (FAO, 1988) and Semi-Detailed Soil Survey database (SRDI, 1985-2000). Expert opinions are taken.

Polygons of sandy overwash are generated using AEZ database and Nirdeshika database through cartographic method and then digitized to construct shape files. The degradation class for sandy overwash are determined as moderate and light as per severity of the erosion hazards took place on the standing crops, dwelling houses, roads, etc., in the northern and eastern piedmont areas of the country.

3.4.6 Acidification

For generating acidification map, inverse distance weighting (IDW) interpolation method has been applied to create surface from the pH values point shape file and then reclassified according to degradation class values of pH using ArcGIS.

For establishing the degradation class of acidification, performance of hundreds of crops in different pH range was investigated around the globe. SRDI classification of soil reaction is also consulted which is given below.

Table 15.a. Soil reaction (pH) class

pH	Soil reaction class						
	Very strongly acidic	Strongly acidic	Slightly acidic	Neutral	Slightly alkaline	Strongly alkaline	Very strongly alkaline
Value	<4.5	4.5-5.5	5.6-6.5	6.6-7.3	7.4-8.4	8.5-9.0	>9.0

Table 15.b. Degradation Class as per critical limit of soil reaction (pH)

pH	Degradation class			
	Very severe	Severe	Moderate	Light
Value	<4.5	4.5-5.0	5.1-5.5	>5.5

3.4.7 Salinization

Degradation class for salinization is developed from salinity class in Bangladesh with some modification to accommodate 5 (five) salinity classes into 4 (four) categories of land degradation in consideration with the effect of different degrees of salinity on crop production.

Table 16. Degradation class as per severity of salinity

Salinity classes (dS/m) predominantly occur	****Degradation class***			
	Very severe	Severe	Moderate	Light
	S4+S5	S2+S3+S4	S1+S2	S0+S1

S0=<2.0; S1=2.0-4.0; S2=4.1-8.0; S3=8.1-12.0; S4=12.1-16.0; S5=>16 dS/m

*Adopted and modified from Salinity Status Map (SRDI, 2000).

3.4.8 Drought

Land degradation class for drought is developed from land degradation map of SRDI (1993, cited in FAO-RAPA 1994), drought-prone area maps of BARC (2001), AEZ map of FAO (1988) and data produced by BWDB (2000). Land, soil and climatic characteristics of the landscapes are considered as under.

- Rainfall
- Temperature
- Groundwater abstraction
- Elevation of landscapes
- Soil water infiltration
- Soil texture

Map was generalized from combining three separate maps of Rabi drought prone areas, Pre- Kharif drought prone areas and Kharif (T. aman) drought prone areas produced under BARC/UNDP/FAO GIS Project: BGD/95/006, November 2000 (BARC 2000).

Table 17. Degradation class and descriptions of drought

Drought	***Degradation class**			
	Very severe	Severe	Moderate	Light
Rainfall	Very low	Very low	Low	Low
Temperature	Very high	Very high	High	High
Groundwater abstraction	Excessive	High	Moderate	Low
Elevation of landscapes	Very high	Very high	Very high	High
Soil water infiltration rate	Moderate	Moderate	Rapid or High	Moderate
Soil texture	Topsoil silt loam to silty clay loam, subsoil clay	Topsoil silt loam to silty clay loam, subsoil clay	Deep, rapidly permeable sandy loams, sandy clay loams predominate. Some loam to clay.	Silt loam and silty clay loam on ridges and clay in basins.

3.4.9 Water-logging

For the particular purpose of the project, a more practical definition is proposed: "water-logging is the state whereby the soil becomes saturated with water within the depth of the active root zone for a period that affects yield and quality of economic crops and/or socio-economic activities of the people of the affected area becomes extensively disrupted and/or where it comes as a new phenomenon owing to anthropogenic interference of the natural landscapes" (modified from FAO, 1977). Degrees of degradation as affected by water-logging could be as Table 18.

Table 18. Degradation class as per severity of water-logging

Degradation class	Description
Very severe	50-75% yield reduction and/or disruption of socio-economic activities
Severe	25-50% yield reduction and/or disruption of socio-economic activities
Degradation class	**Description**
Moderate	10-25% yield reduction and/or disruption of socio-economic activities
Light	<10% yield reduction and/or disruption of socio-economic activities

3.4.10 Soil pollution (Arsenic contamination)

Land degradation class due to arsenic contamination is derived and reclassified from Arsenic Contamination in Groundwater Map developed by British Geological Survey and Department of Public Health Engineering (BGS-DPHE, 2001).

Table 19. Degradation class as per severity of arsenic contamination

Arsenic contamination	*Degradation class			
	Very severe	Severe	Moderate	Light
micro-gram/litre	>300	200-300	75-200	50-75

Adopted and modified from BGS-DPHE, 2001.

3.5 National Land Degradation Map: Baseline Year 2000

Land degradation Map of Bangladesh as a baseline or benchmark map have been developed combining the other ten individual land degradation (LD) type maps, where nutrient depletion map itself is a combined map from 5 separate nutrient maps. Therefore, information of 15 maps is overlaid into the national degradation map. In case of preparing the national degradation map superimposition of one type of LD map layer on the other type map layer was done. In this way, all 10 map layers were placed one after another. In the process, the sequence (lowermost to uppermost) of LD map layers and land degradation classes considered to prepare the final national LD map are as follow:

a Arsenic – 1+2

b Organic matter depletion map 1+2

c Drought 1+2

d Acidification 1+2

e Soil nutrient depletion 1+2+3

f Salinization 1+2+3

g Water-logging 2

h River erosion 3

i Soil erosion 1+2

j Sandy overwash 3

Where, 1= very severe; 2= severe; and 3= moderate.

Other features added upon the LD map layers are Sundarbans mangrove, reserve forest, lake, and wide river.

Very severe and severe degrees or classes of land degradation in case of arsenic contamination, organic matter depletion, drought, acidification, and soil erosion have been considered to make National Land Degradation Map. Soil nutrients and salinity have the higher direct impacts on crop productivity than the LD types that have just been mentioned here, hence, moderate class of degradation in addition to very severe and severe classes have been considered for these cases. Water-logging have only severe class of degradation and river erosion have moderate impact, accordingly they are included. In all cases, light class of land degradation are not considered to create the final national map.


Sundarbans at Satkhira.


Excavation work in Bilgulli Canal at Satkhira.

4. Results and Discussion

4.1 Soil fertility decline

In the 1960s, scientist Ernst Klapp defined soil fertility as "the natural, sustainable ability of a soil to produce plants". Soil organic matter, soil organic carbon and macronutrients such as (N, P, K) are the best indicators of soil fertility (Berner, 2016; Sarhat, 2015). Soil organic matter (SOM) has long been suggested as the single most important indicator of soil productivity (Berner, 2006; Hijbeek, 2017). It is because SOM is known to improve many soil properties such as soil structure, water holding capacity and nutrient supply (Hijbeek, 2017). Healthy soil has the capacity to function as a living system to sustain plant and animal productivity (Pankhurst, et al., 1997). If we use soil unsustainably, it loses its productivity, and becomes more sensitive to weather and erosion; harvests decline (Berner, 2016). Therefore, soil fertility decline could be closely related to:

1. Soil nutrient depletion
2. Soil organic matter depletion

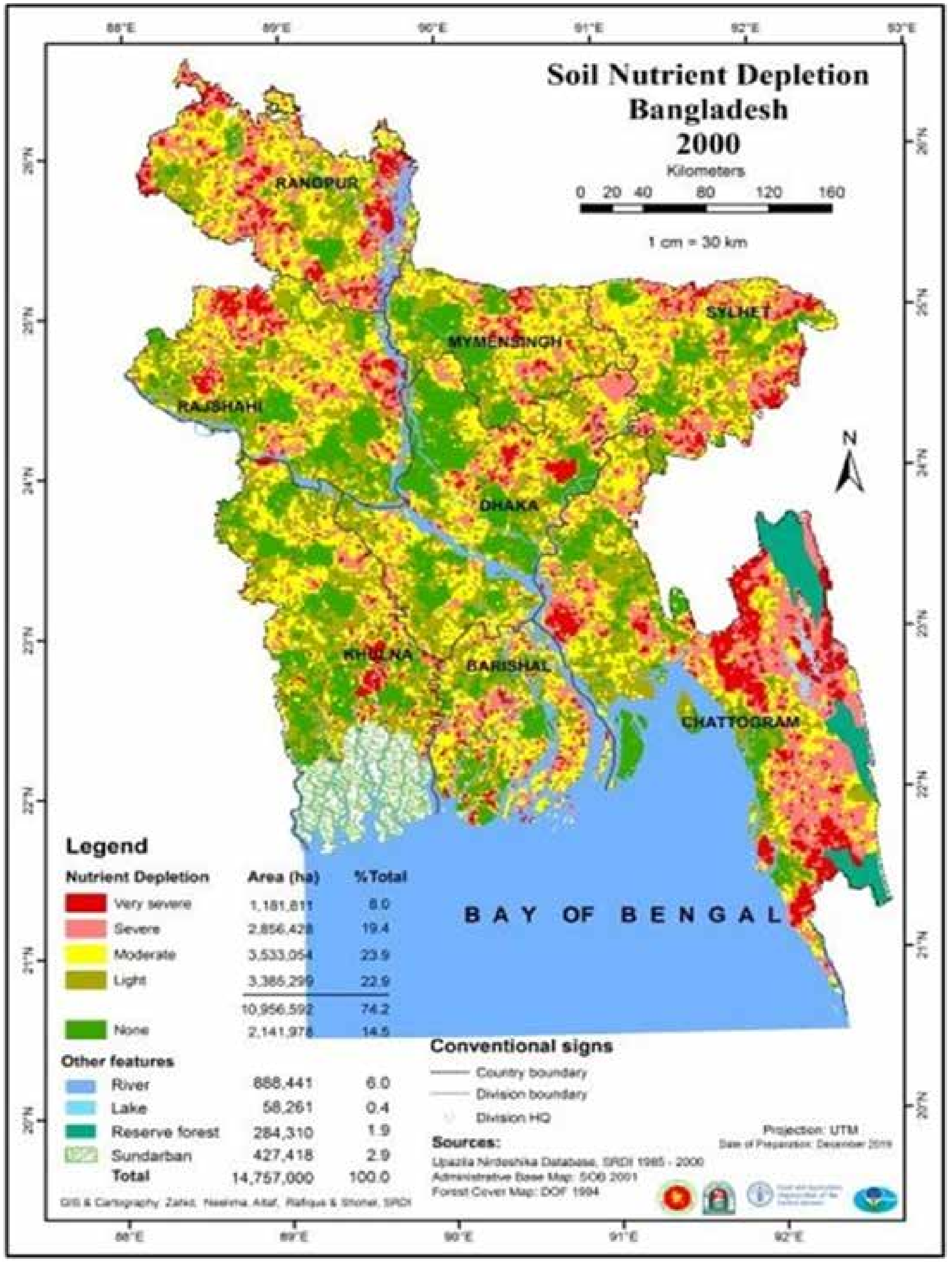
4.1.1. Soil nutrient depletion

Soil nutrients are the chemical elements and compounds present in soil that are necessary for plant life. Plant growth and yield is heavily affected due to lack of soil nutrients. A fertile soil contains all the major nutrients for basic plant nutrition (e.g., nitrogen, phosphorus, and potassium), as well as other nutrients needed in smaller quantities (e.g., calcium, magnesium, sulfur, zinc, boron, copper, iron, manganese). For repeated and intensive cultivation of land, lack of adequate reinforcement from external sources, and other degradation factors acting on land, these elements are continuously depleting from the soil.

Table 20. Soil nutrient depletion as land degradation analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Soil nutrient depletion**	i. Very severe	1.18	8.0
2.		ii. Severe	2.86	19.4
3.		iii. Moderate	3.53	23.9
4.		iv. Light	3.39	22.9
5.	Degraded land [i+ii+iii+iv]		**10.96**	**74.2**
6.	Non-degraded land		**2.14**	**14.5**
7.	**Other features**			
8.	a. Rivers		0.89	6.0
9.	b. Lake		0.06	0.4
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to soil nutrient depletion is around 10.96 million ha which amounts to 74.2% of the country area. Among this, very severely and severely degraded land accounts for about 4.04 million ha which is equivalent to 28.4 % of geographical area of the country.

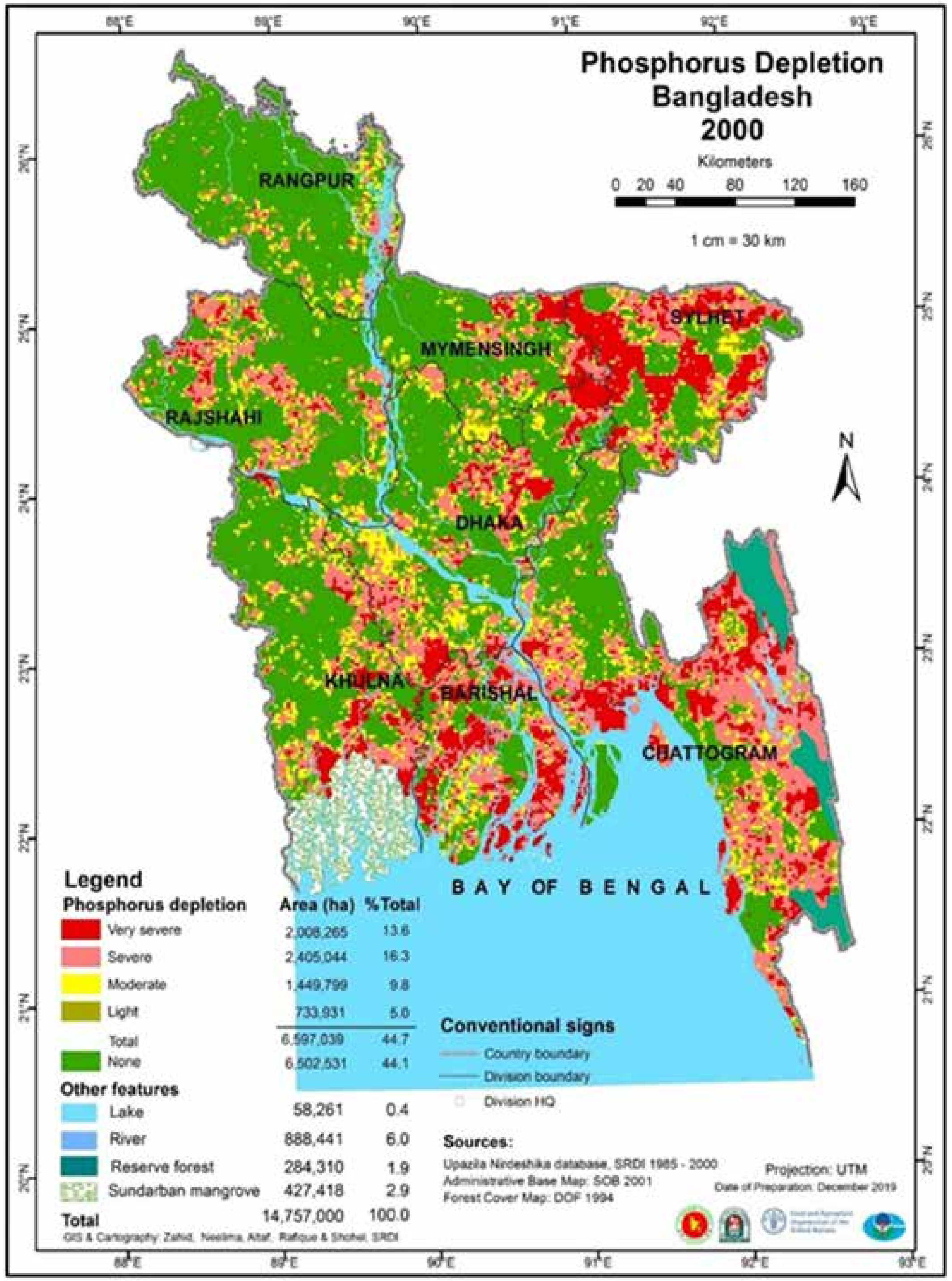


4.1.2. Phosphorus (P) depletion

Table 21. Phosphorus depletion as land degradation analysis for baseline year 2000.

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Phosphorus depletion**	i. Very severe	2.01	13.6
2.		ii. Severe	2.41	16.3
3.		iii. Moderate	1.45	9.8
4.		iv. Light	0.73	5.0
5.	Degraded land [i+ii+iii+iv]		**6.60**	**44.7**
6.	Non-degraded land		**6.50**	**44.1**
7.	**Other features**			
8.	a. Rivers		0.89	6.0
9.	b. Lake		0.06	0.4
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to phosphorus is around 6.6 million ha which amounts to 44.7% of the country area. Among this, severely and very severely degraded land in respect to P depletion accounts for about 4.41 million ha which is equivalent to 29.9 % of geographical area of the country.

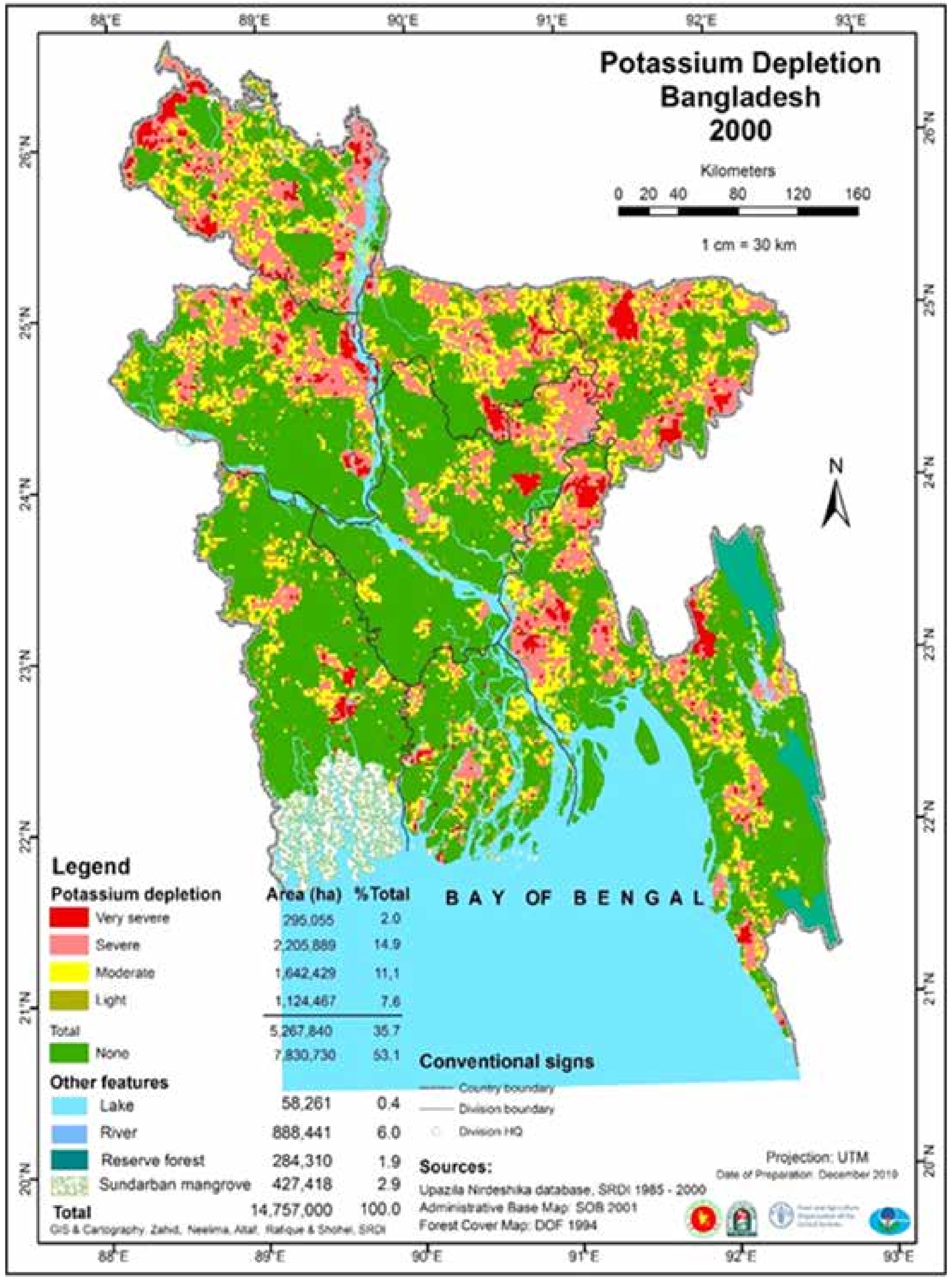


4.1.3. Potassium (K) depletion

Table 22. Potassium depletion as land degradation analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Potassium depletion**	i. Very severe	0.30	2.0
2.		ii. Severe	2.21	14.9
3.		iii. Moderate	1.64	11.1
4.		iv. Light	1.12	7.6
5.	Degraded land [i+ii+iii+iv]		**5.27**	**35.7**
6.	Non-degraded land		**7.83**	**53.1**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to potassium is around 5.27 million ha which amounts to 35.7% of the country area. Among this, severely and very severely degraded land accounts for about 2.51million ha which is equivalent to 16.9 % of geographical area of the country.

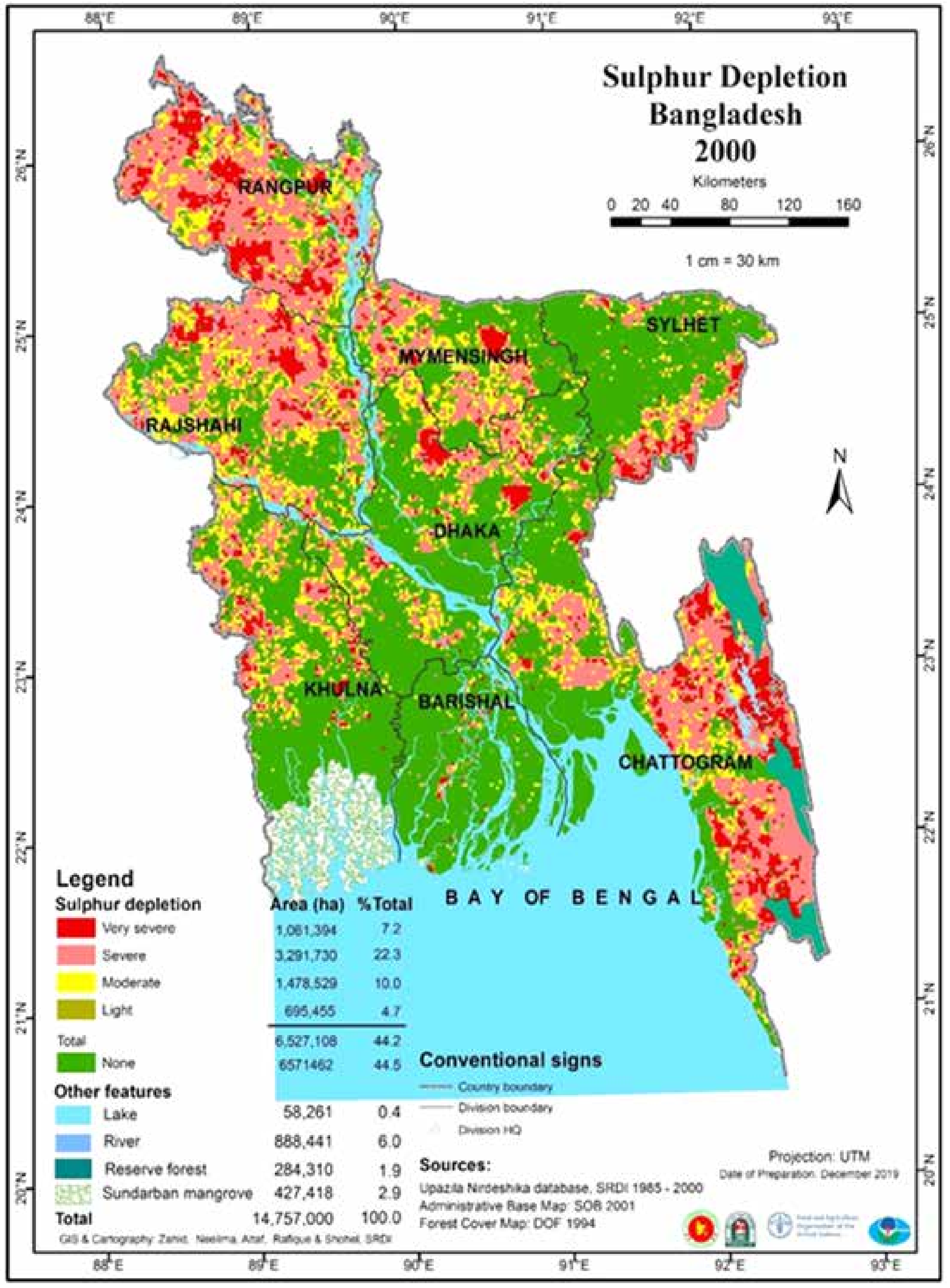


4.1.4. Sulphur (S) depletion

Table 23. Sulphur depletion as land degradation analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Sulphur depletion**	i. Very severe	1.06	7.2
2.		ii. Severe	3.29	22.3
3.		iii. Moderate	1.48	10.0
4.		iv. Light	0.70	4.7
5.	Degraded land [i+ii+iii+iv]		**6.53**	**44.2**
6.	Non-degraded land		**6.57**	**44.5**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to sulphur is around 6.53 million ha which amounts to 44.2% of the country area. Among this, severely and very severely degraded land accounts for about 4.35 million ha which is equivalent to 29.5% of geographical area of the country.

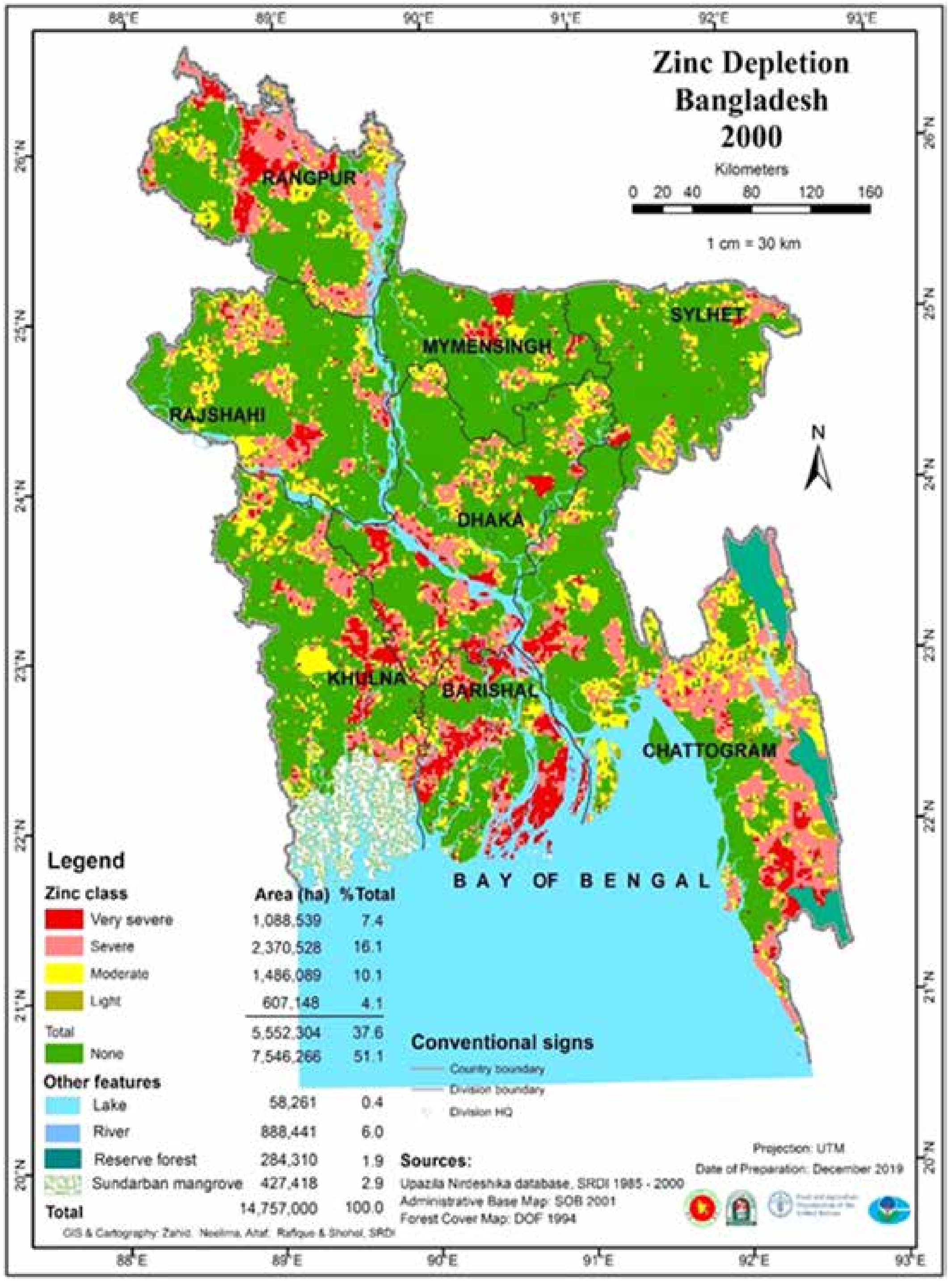


4.1.5. Zinc (Zn) depletion

Table 24. Zinc depletion as land degradation analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Zinc depletion**	i. Very severe	1.09	7.4
2.		ii. Severe	2.37	16.1
3.		iii. Moderate	1.49	10.1
4.		iv. Light	0.61	4.1
5.	Degraded land [i+ii+iii+iv]		**5.55**	**37.6**
6.	Non-degraded land		**7.55**	**51.1**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to zinc depletion is around 5.55 million ha which amounts to 37.6% of the country area. Among this, severely and very severely degraded lands account for about 3.46 million ha which is equivalent to 23.5% of geographical area of the country.

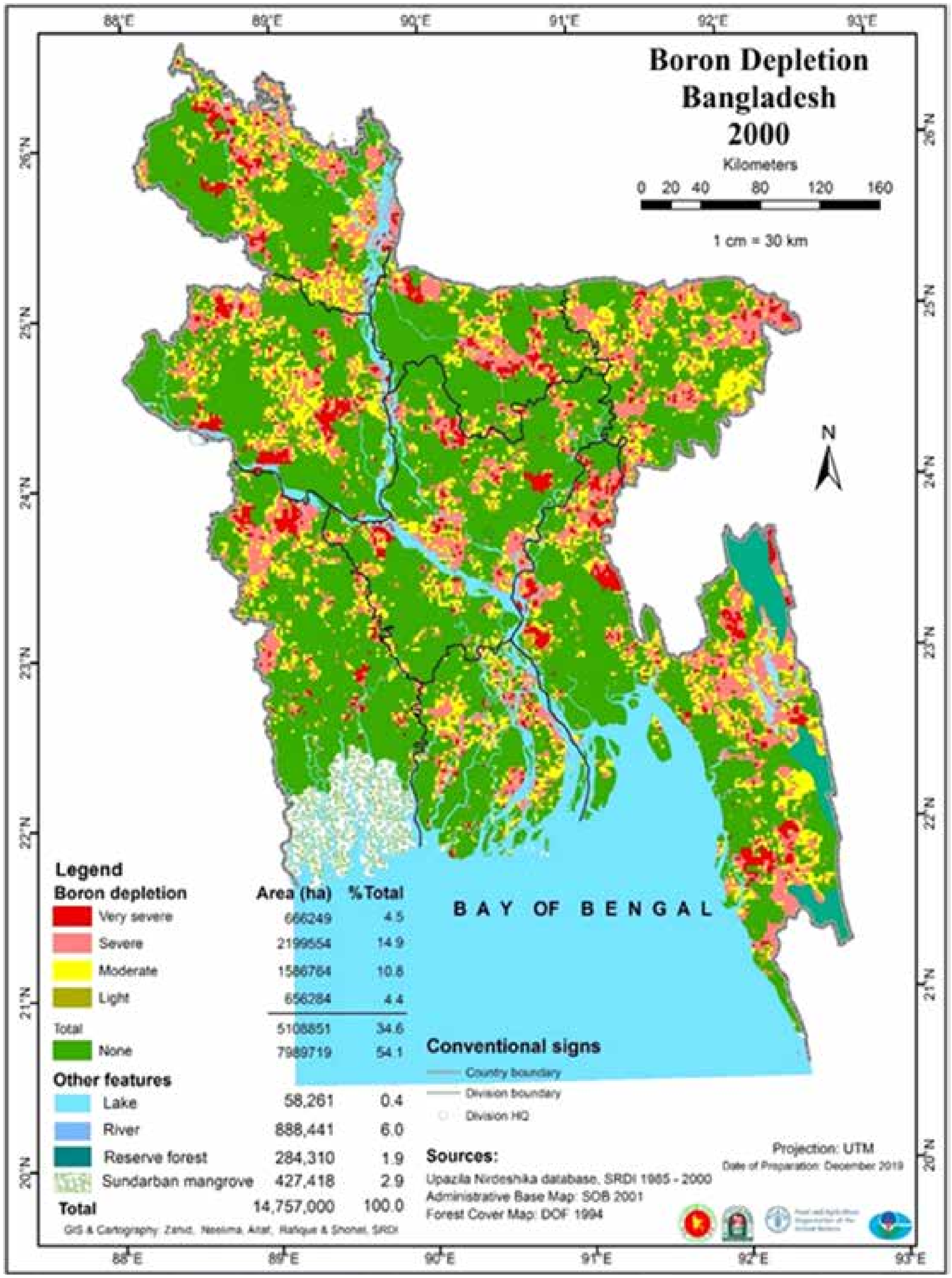


4.1.6. Boron (B) depletion

Table 25. Boron depletion as land degradation analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Boron depletion**	i. Very severe	0.67	4.5
2.		ii. Severe	2.20	14.9
3.		iii. Moderate	1.59	10.8
4.		iv. Light	0.66	4.4
5.	Degraded land [i+ii+iii+iv]		**5.11**	**34.6**
6.	Non-degraded land		**7.99**	**54.1**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to boron depletion is around 5.11 million ha which amounts to 34.6% of the country area. Among this, severely and very severely degraded lands account for about 2.87 million ha which is equivalent to 19.4% of geographical area of the country.



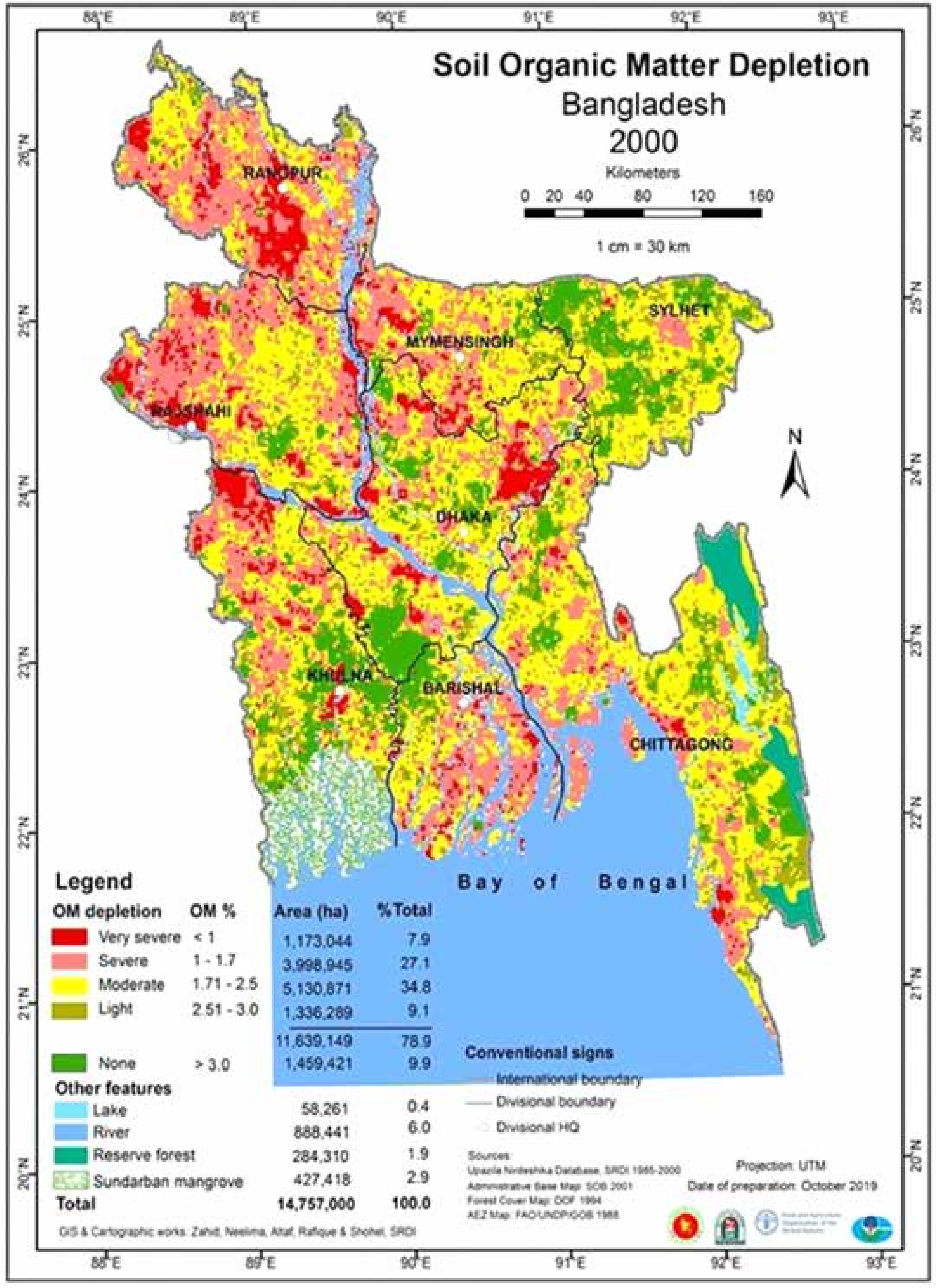
4. 1.7. Soil organic matter depletion

Organic matter itself is composed of living biomass like microorganisms, dead tissue or partly decomposed materials and stable, fully decomposed humus. Soil organic matter contributes to soil productivity in many different ways. It influences the physical, chemical and biological properties of soil. It serves as a reservoir of nutrients for crops (chiefly, N, P, S), enhances aggregate stability, increases nutrient exchange (CEC, mainly Ca, Mg & K), improves water holding capacity, water infiltration, soil aeration, buffering capacity (ability of a soil to resist pH change), reduces compaction, helps to reduce runoff, and provides food for the living organisms. The percentage of organic matter that occurs naturally in soil varies greatly, from 1 percent to more than 90 percent in muck soils. Most of our productive agricultural soils have between 3 to 6% organic matter (CUCE, 2008; BARC, 2012; NRCS, undated).

Table 26. Soil organic matter depletion for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Soil organic matter depletion**	i. Very severe	1.17	7.9
2.		ii. Severe	4.00	27.1
3.		iii. Moderate	5.13	34.8
4.		iv. Light	1.34	9.1
5.	Degraded land [i+ii+iii+iv]		**11.64**	**78.9**
6.	Non-degraded land		**1.46**	**9.9**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to soil organic matter depletion is around 11.64 million ha which amounts to 78.9% of the country area. Among this, severely and very severely degraded lands account for about 5.17 million ha which is equivalent to 35 % of geographical area of the country.



4.2 Water erosion

Land degradation as affected by water is caused in various ways. Water erosion covers all forms of soil erosion by water including sheet erosion, rill erosion and gullying. Human-induced enhancement of landslides influenced by clearing of vegetation and earth removal also included. Though the land degradation as topsoil erosion is evident in vast floodplain areas, only some sporadic areas are identified through research findings that is very insufficient for national scale mapping. Accelerated water erosion is found on sloping hills, active riverbanks and northern piedmont plains adjoining to the Indian border. Thus, major water erosions in our country may be termed as:

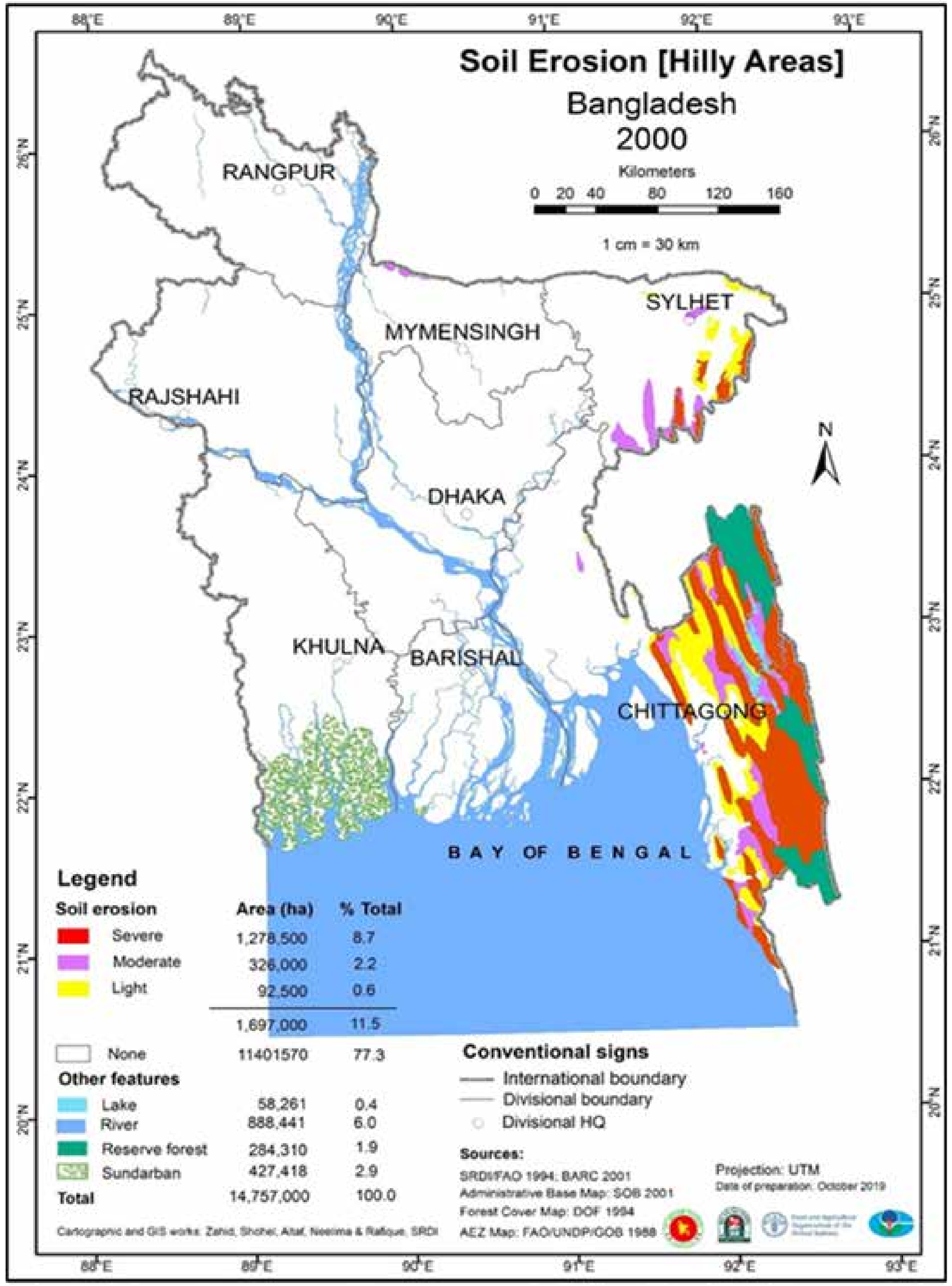
a. Soil erosion in hilly areas
b. Riverbank erosion
c. Sandy overwash

4.2.1 Soil erosion in hilly areas

Table 27. Soil erosion in hilly areas analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Soil erosion [hilly areas]**	i. Very severe	-	
2.		ii. Severe	1.28	8.7
3.		iii. Moderate	0.33	2.2
4.		iv. Light	0.09	0.6
5.	Degraded land [i+ii+iii+iv]		**1.70**	**11.5**
6.	Non-degraded land		**11.40**	**77.3**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to soil erosion (hilly areas) is around 1.7 million ha which amounts to 11.5% of the country area. Among this, severely degraded land accounts for about 1.28 million ha which is equivalent to 8.7% of geographical area of the country.



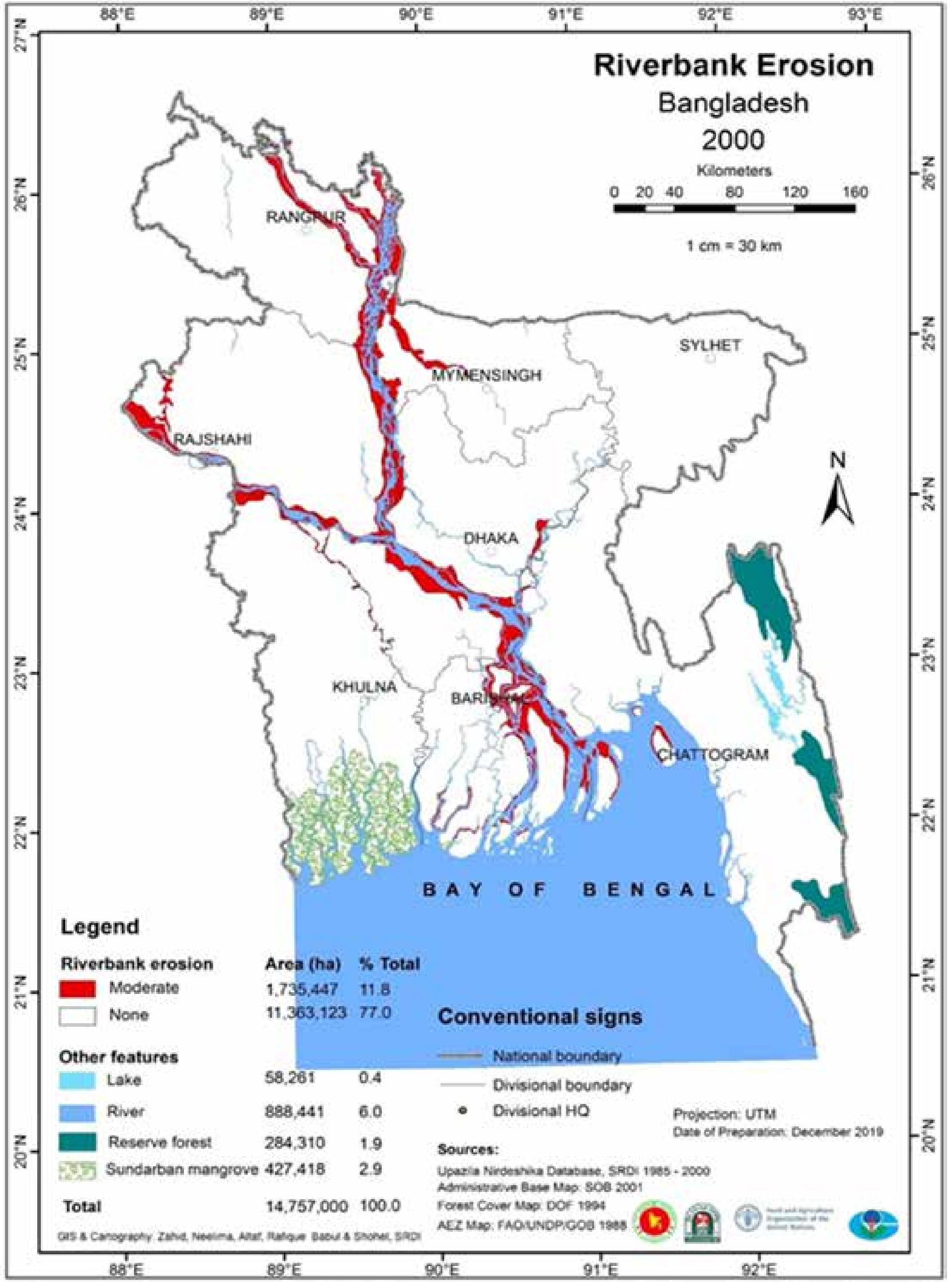
4.2.2 Riverbank erosion

Riverbank erosion is rampant in areas along the active river channels of the Ganges (the Padma & the Meghna), the Brahmaputra-Jamuna, the Tista, the Dharla, the Garai-Madhumati, the Arial Khan and in the coastal and off-shore areas of Bangladesh. In Bangladesh, riverbank erosion is caused mainly due to strong river current, enhanced by mechanized river traffic, channel diversion during the rainy season, and siltation of riverbeds.

Table 28. Riverbank erosion analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Riverbank erosion**	i. Very severe	-	-
2.		ii. Severe	-	-
3.		iii. Moderate	1.74	11.8
4.		iv. Light	-	-
5.	Degraded land [i+ii+iii+iv]		**1.74**	**11.8**
6.	Non-degraded land		**11.36**	**77.0**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to riverbank erosion is around 1.74 million ha which amounts to 11.8% of the geographical area of the country.



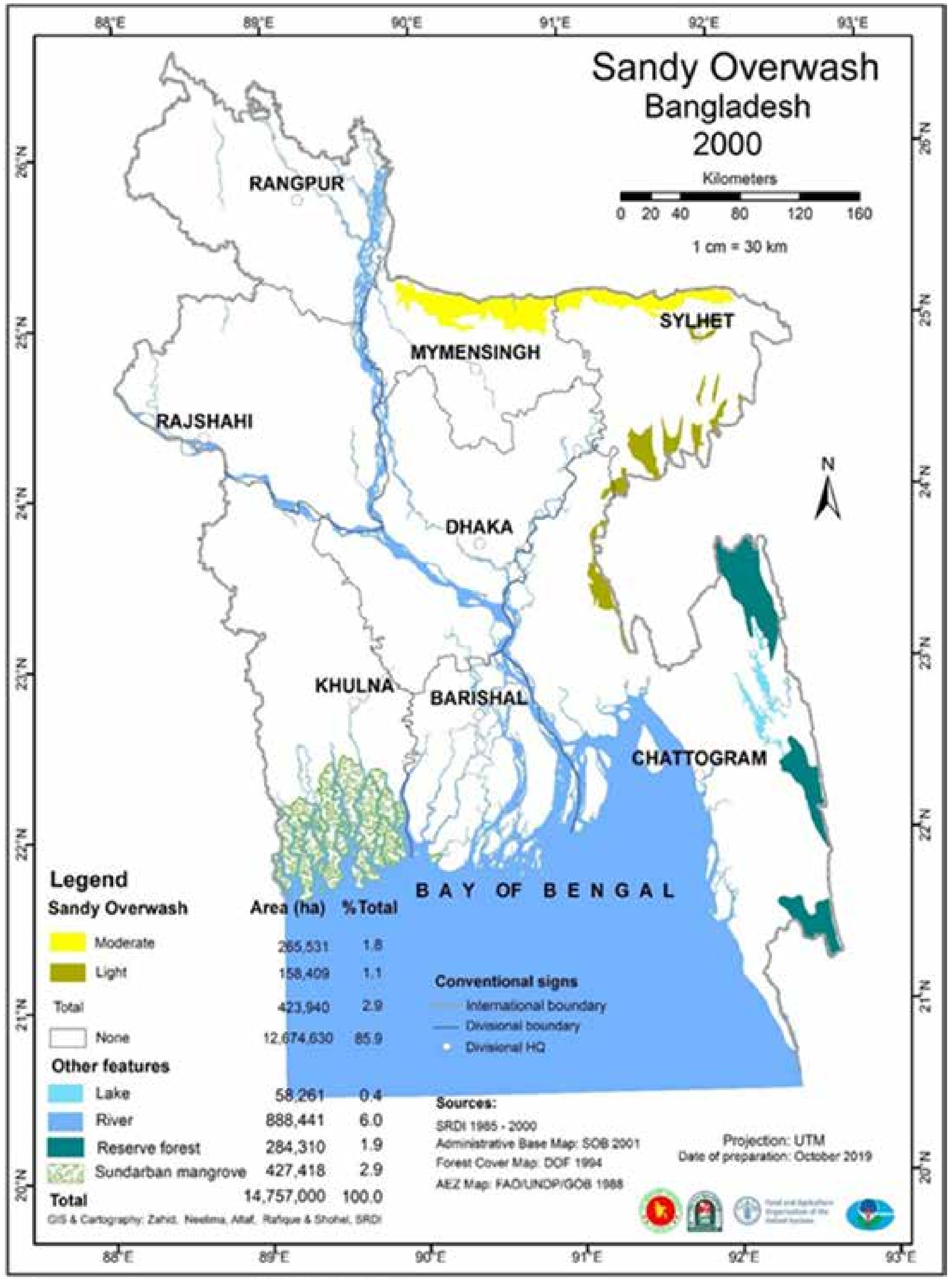
4.2.3. Sandy overwash

The soils, gravels and sandy coarse materials eroded from the hills are usually deposited in the downstream areas. Before deposition in the downstream or basins, the eroded material runs down with the greater velocity along with run-off water, destroying standing crops on the foothill or adjoining piedmont areas, breaches roads and houses. This is more common in the northern piedmont areas of the country.

Table 29. Sandy overwash analysis for baseline year 2000

Sl. No.	Degradation Type	Degradation Class	Area in million ha	Percentage of total
1.	**Sandy overwash**	i. Very severe	-	-
2.		ii. Severe	-	-
3.		iii. Moderate	0.27	1.8
4.		iv. Light	0.16	1.1
5.	Degraded land [i+ii+iii+iv]		**0.42**	**2.9**
6.	Non-degraded land		**12.67**	**85.9**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to sandy overwash is around 0.42 million ha which amounts to 2.9% of the geographical area of the country.



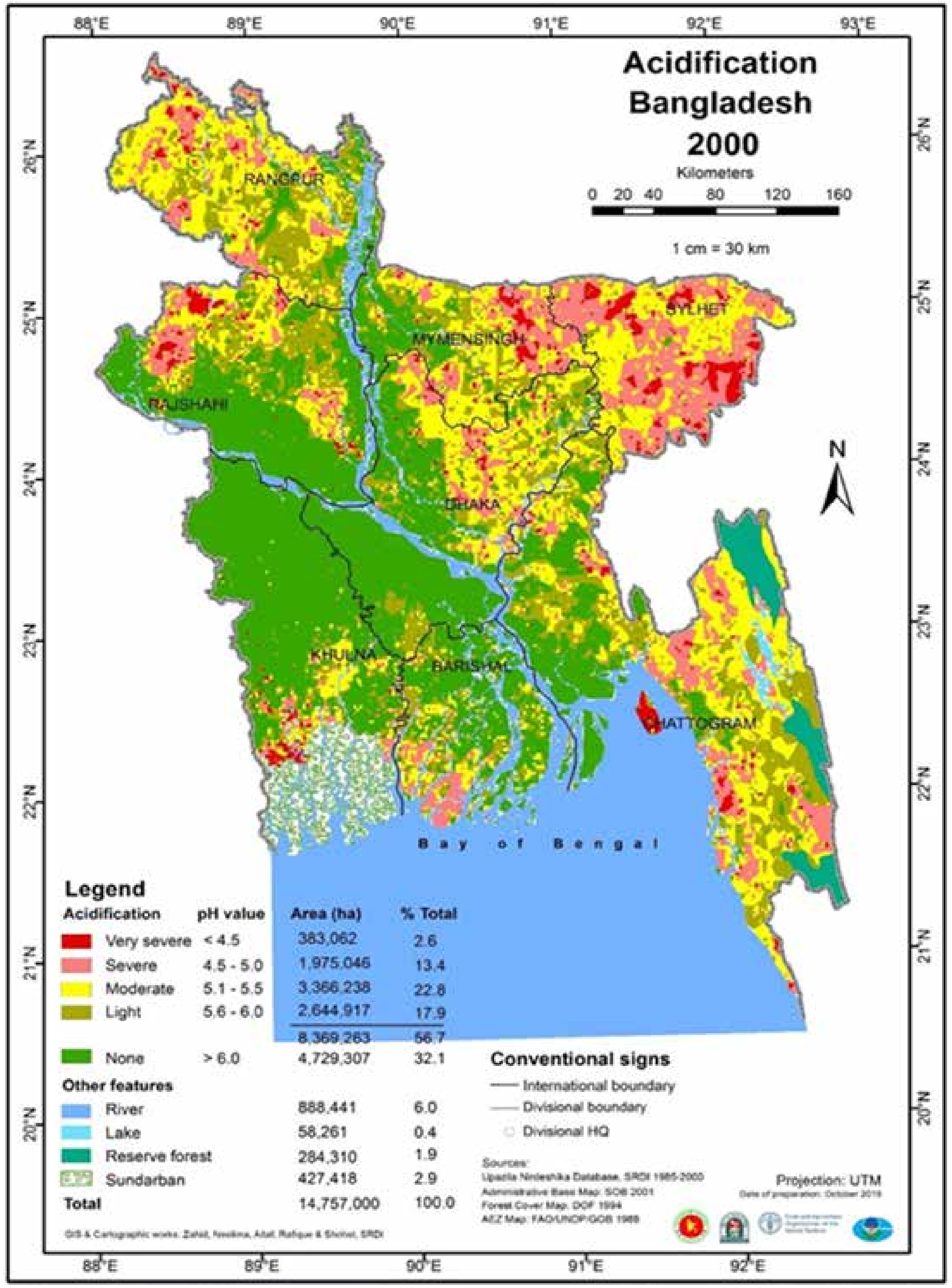
4.3 Acidification

Acid soils possess toxic concentration of Al3+, Fe3+ and Mn2+, lower concentration of P and low availability of bases which together cause reduction in crop yield. Geomorphologically, acid sulphate soils, peat soils, acid basin clays, terrace soils and hill soils are slightly to strongly acidic in reaction.

Table 30. Acidification as land degradation analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Acidification**	i. Very severe	0.38	2.6
2.		ii. Severe	1.98	13.4
3.		iii. Moderate	3.37	22.8
4.		iv. Light	2.64	17.9
5.	Degraded land [i+ii+iii+iv]		**8.37**	**56.7**
6.	Non-degraded land		**4.73**	**32.1**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to acidification is around 8.37 million ha which amounts to 56.7% of the geographical area of the country. Among this, severely and very severely degraded land accounts for about 2.36 million ha which is equivalent to 16.0% of the country.



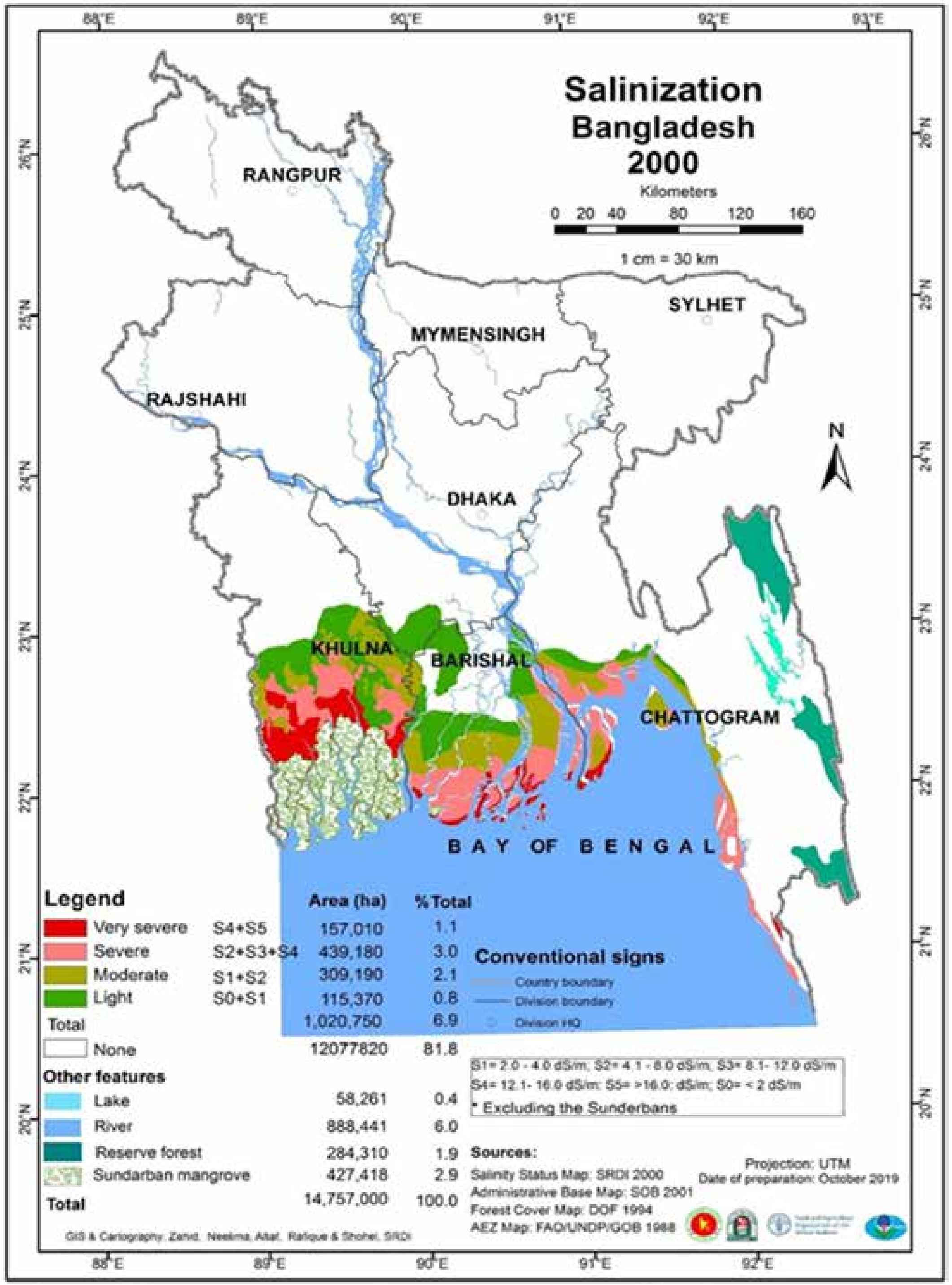
4.4 Salinization

All soils contain some water-soluble salts. Plants absorb essential plant nutrients in the form of soluble salts, but excessive accumulation of soluble salts, called soil salinity, suppresses plant growth. Saline or salt affected soils are common in southern coastal regions of the country. Soils are saline due to proximity to the saltwater of the sea. Salinity may develop due to irrigation by saline water, or by upward movement of salts into the soil from shallow ground water. When precipitation is insufficient (December-May) to leach ions from the soil profile, salts accumulates in the soil. Decreased flow from the upstream rivers of the country also influences the process of salinization. Both magnitude and extent of soil salinity are increasing with time. Impact of salinization is more apparent than other form of land degradation.

Table 31. Salinization as land degradation analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Salinization**	i. Very severe	0.16	1.1
2.		ii. Severe	0.44	3.0
3.		iii. Moderate	0.31	2.1
4.		iv. Light	0.12	0.8
5.	Degraded land [i+ii+iii+iv]		**1.02**	**6.9**
6.	Non-degraded land		**12.08**	**81.8**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to salinization is around 1.02 million ha which amounts to 6.9% of the geographical area of the country. Among this, severely and very severely degraded land accounts for about 0.6 million ha which is equivalent to 4.1 % of the country.

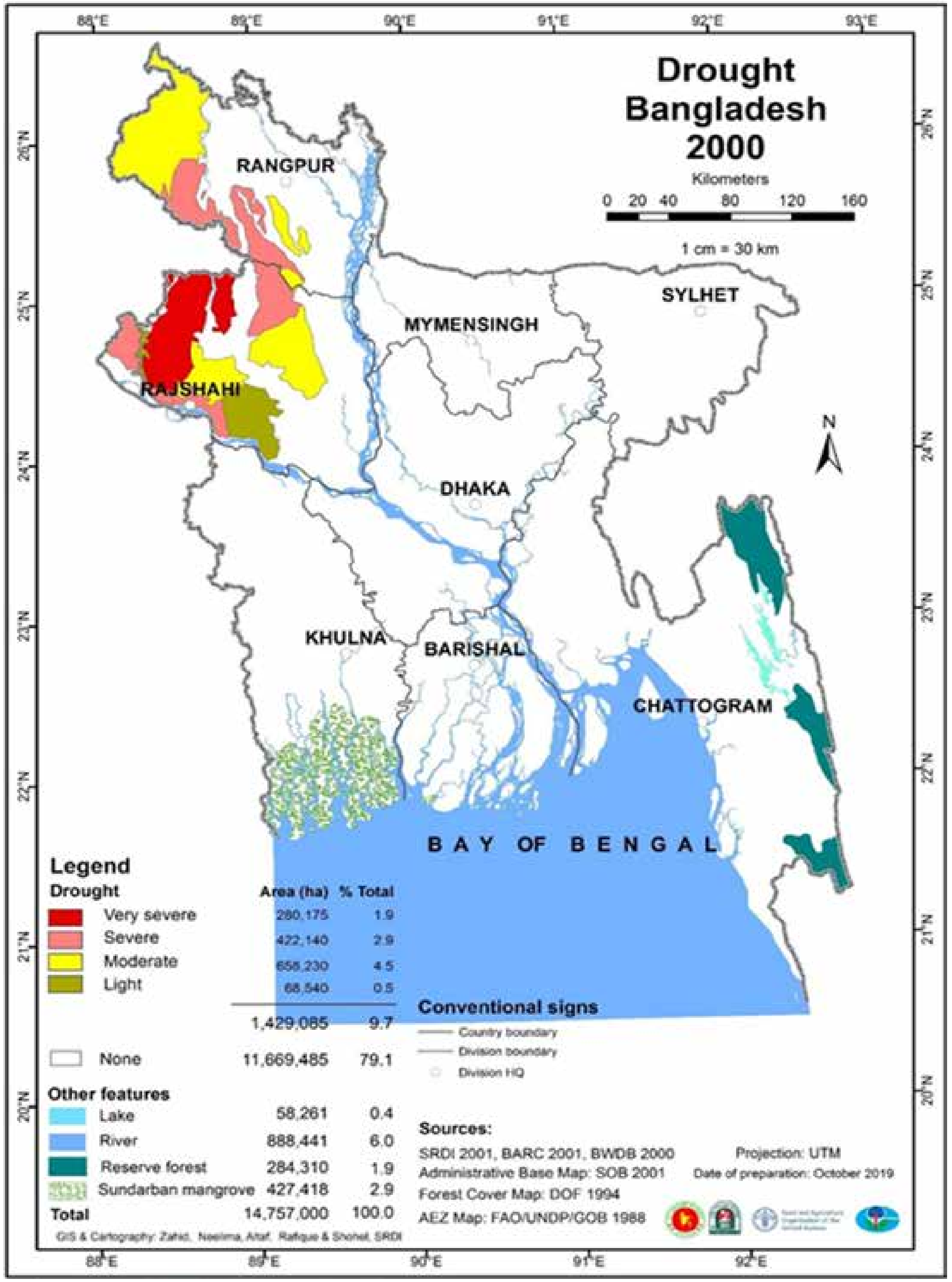


4.5 Drought

Table 32. Drought as land degradation analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Drought**	i. Very severe	0.28	1.9
2.		ii. Severe	0.42	2.9
3.		iii. Moderate	0.66	4.5
4.		iv. Light	0.07	0.5
5.	Degraded land [i+ii+iii+iv]		**1.43**	**9.7**
6.	Non-degraded land		**11.67**	**79.1**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to drought is around 1.43 million ha which amounts to 9.7% of the geographical area of the country. Among this, severely and very severely degraded land accounts for about 0.7 million ha which is equivalent to 4.8% of the country.

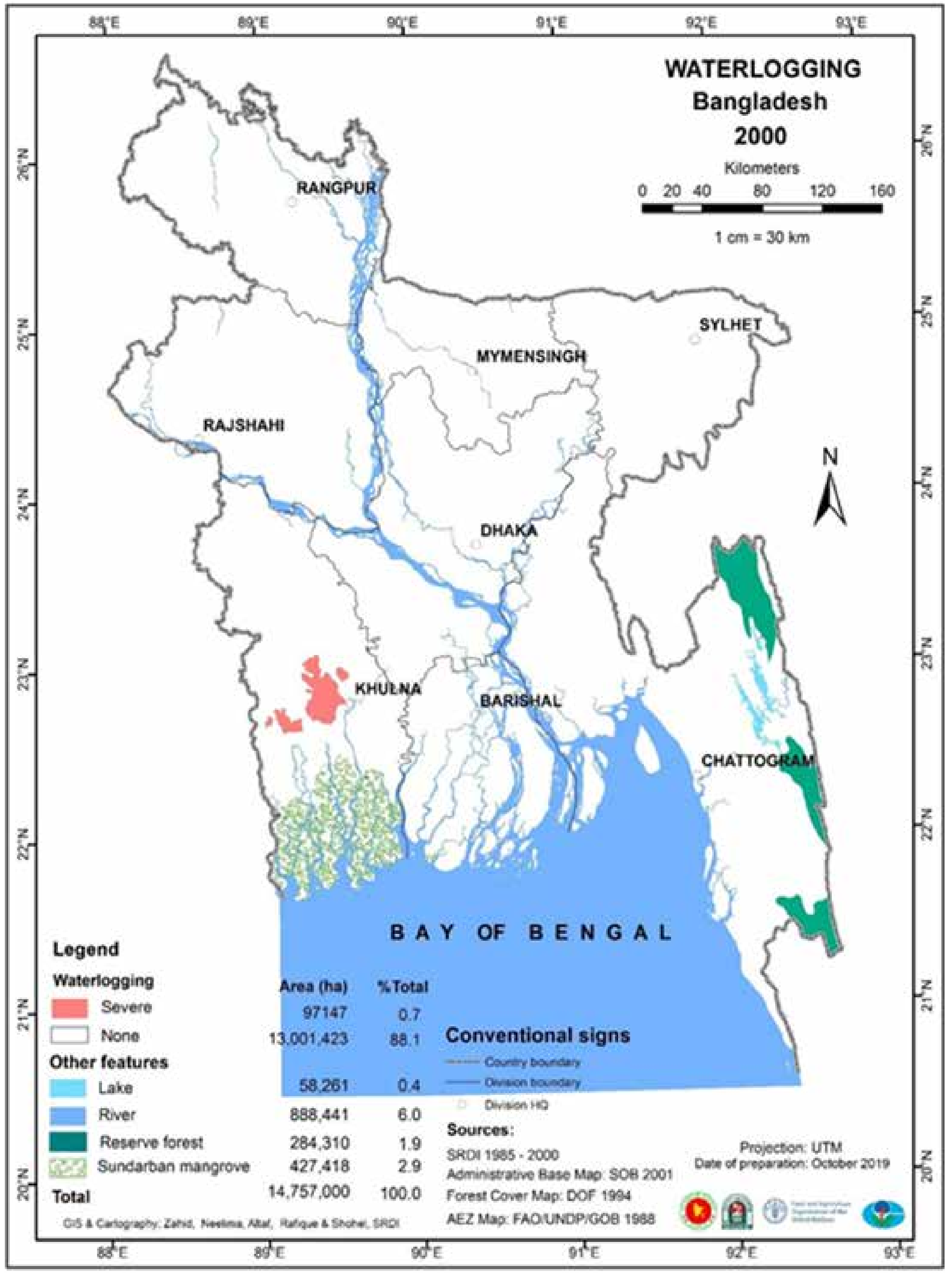


4.6 Water-logging

Table 33. Water-logging as land degradation analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Water-logging**	i. Very severe	-	-
2.		ii. Severe	0.10	0.7
3.		iii. Moderate	-	-
4.		iv. Light	-	-
5.	Degraded land [i+ii+iii+iv]		**0.10**	**0.7**
6.	Non-degraded land		**13.00**	**88.1**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to water-logging is around 0.10 million ha which amounts to 0.7% of the geographical area of the country.

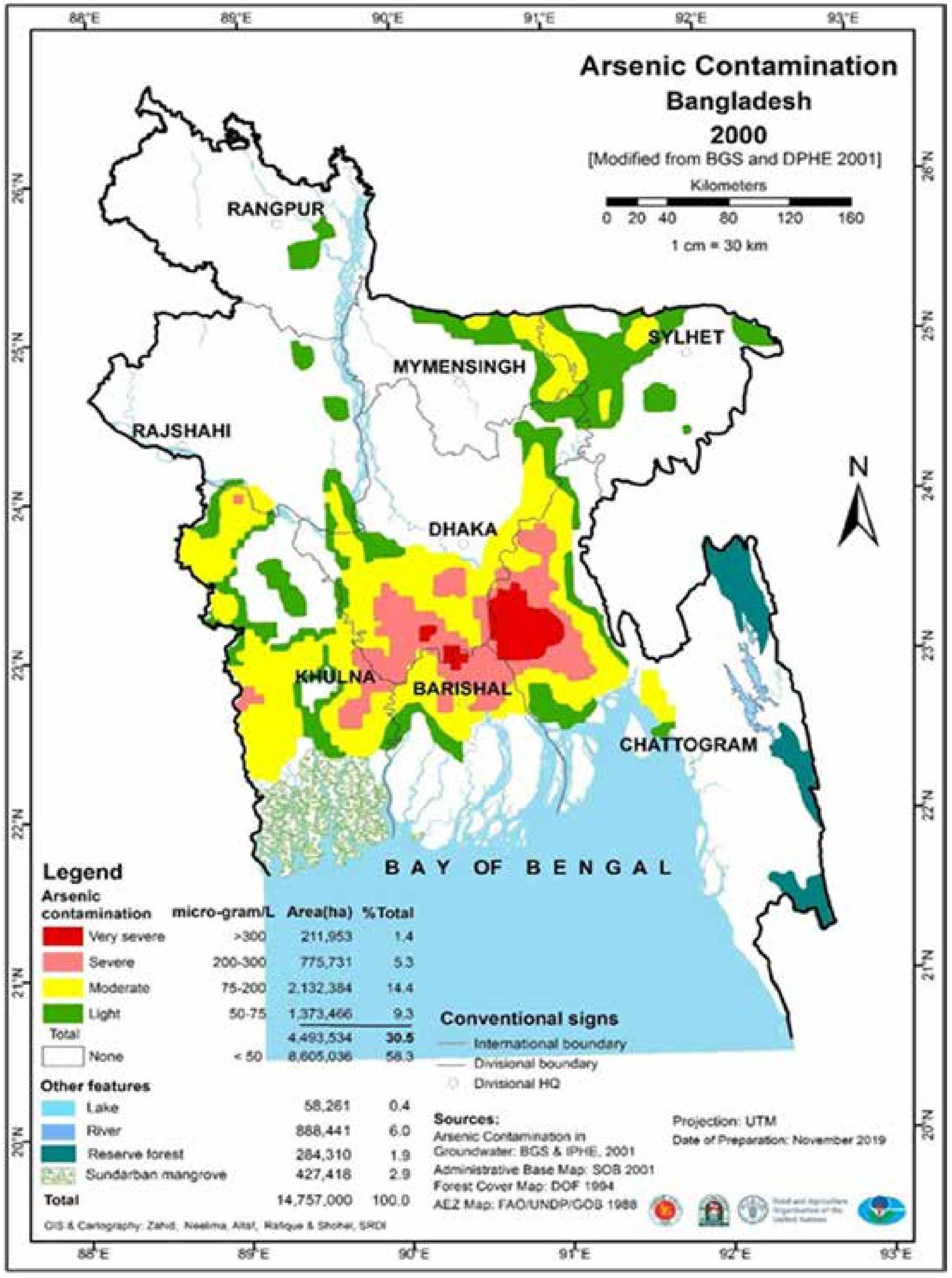


4.7 Soil Pollution: Arsenic (As) contamination

Table 34. As contamination as land degradation analysis for baseline year 2000

Sl. No.	Degradation type	Degradation class	Area in million ha	Percentage of total
1.	**Arsenic contamination**	i. Very severe	0.21	1.4
2.		ii. Severe	0.78	5.3
3.		iii. Moderate	2.13	14.4
4.		iv. Light	1.37	9.3
5.	Degraded land [i+ii+iii+iv]		**4.49**	**30.5**
6.	Non-degraded land		**8.61**	**58.3**
7.	**Other features**			
8.	a. Rivers		0.06	0.4
9.	b. Lake		0.89	6.0
10.	c. Reserved forest		0.28	1.9
11.	d. Sundarbans mangrove		0.43	2.9
12.	Others total [a+b+c+d]		**1.66**	**11.2**
	Grand total [5+6+12]		**14.76**	**100.0**

Degraded land in respect to arsenic contamination is around 4.49 million ha which amounts to 30.5% of the geographical area of the country. Among this, severely and very severely degraded land accounts for about 0.99 million ha which is equivalent to 6.7 % of the country.



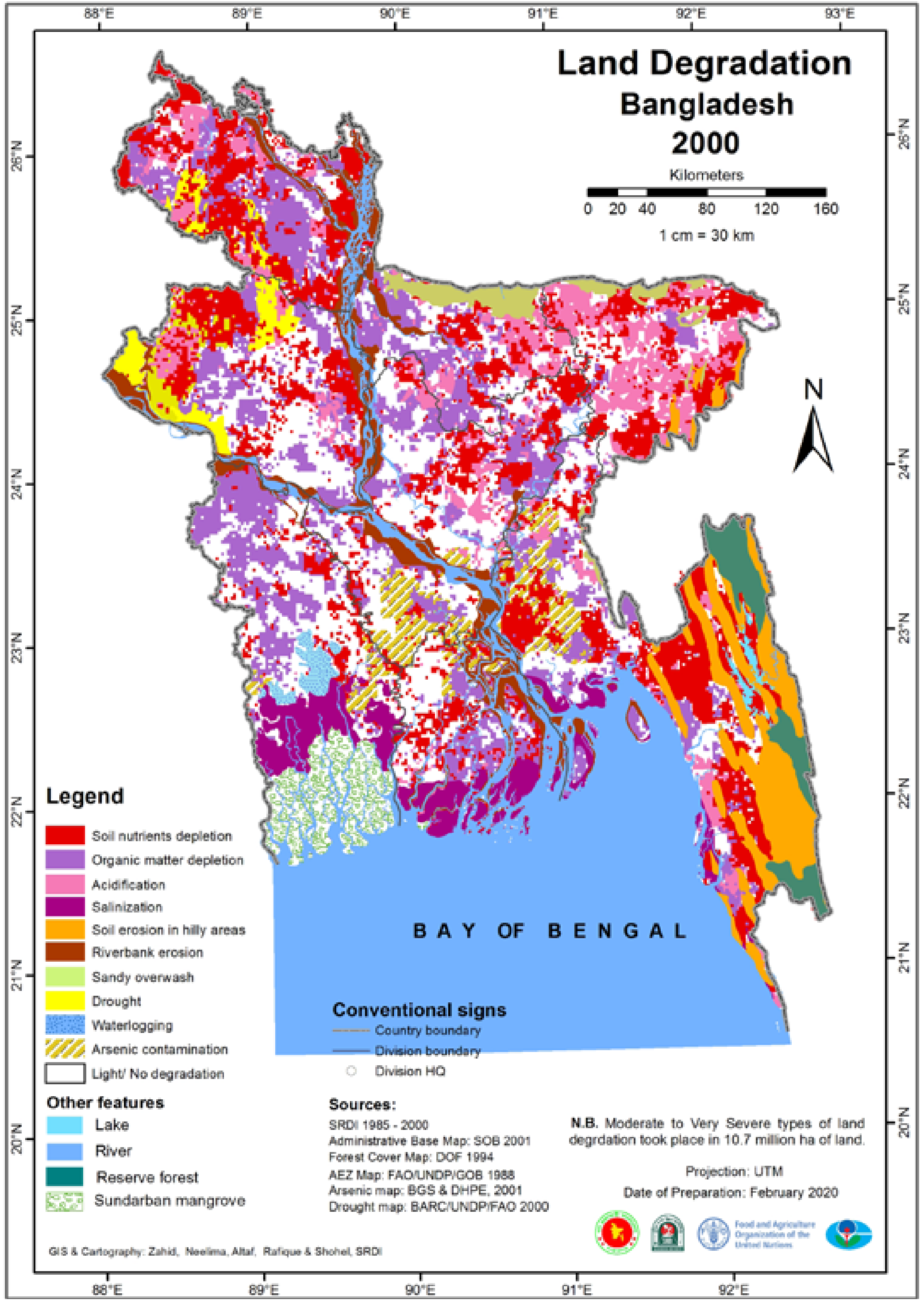
4.8 Land Degradation Bangladesh 2000

Table 35. Land degradation in Bangladesh: Baseline 2000

Types of Land Degradation	Degradation class (mha)				Total area (mha)	% of country area
	Very severe	Severe	Moderate	Light		
Soil Fertility Decline:						
1. Soil nutrient depletion	1.18	2.86	3.53	3.39	10.96	74.2
- P depletion	2.01	2.41	1.45	0.73	6.60	44.7
- K depletion	0.30	2.21	1.64	1.12	5.27	35.7
- S depletion	1.06	3.29	1.48	0.70	6.53	44.2
- Zn depletion	1.09	2.37	1.49	0.61	5.55	37.6
- B depletion	0.67	2.20	1.59	0.66	5.11	34.6
2. Soil organic matter depletion	1.17	4.00	5.13	1.34	11.64	78.9
Water erosion:						
3. Soil erosion [Hilly areas]	-	1.28	0.33	0.90	1.70	11.5
4. Riverbank erosion	-	-	1.74	-	1.74	11.8
5. Sandy overwash	-	-	0.27	0.16	0.42	2.9
6. Acidification	0.38	1.98	3.37	2.64	8.37	56.7
7. Salinization	0.16	0.44	0.31	0.12	1.02	6.9
8. Drought	0.28	0.42	0.66	0.07	1.43	9.7
9. Water-logging	-	0.10	-	-	0.10	0.7
10. Soil pollution [Arsenic contamination]	0.21	0.78	2.13	1.37	4.49	30.5

4.9 Key message

- Different types of land degradation taking place in the country are soil fertility decline (soil nutrient depletion and soil organic matter depletion), soil erosion in hills, riverbank and piedmont areas, acidification, salinization, drought, water-logging and soil pollution.
- Land degradation types or processes are not mutually exclusive. For example, where soil erosion [in hilly areas] is taking place, there soil organic matter depletion also may occur; or, where salinization is the hotspot problem, there nutrient depletion problem may rise.
- Moderate to very severe classes of land degradation took places in 10.7million ha area of the country during 1985-2000.
- It was about 72.5% of the country area.
- None to Light degradation was: 2.4 million ha (16.3% of the country area)
- Other areas (1.66 million ha) include rivers, lake, reserve forest and sundarban mangrove (11.2% of the country area).



5. Conclusion

The greatest challenge facing agriculture in the twenty first century is the necessity to increase productivity per unit area of land and to simultaneously attain ecological and environmental sustainability as the earth ecosystems are manipulated to obtain this productivity (Rattan Lal, 2009). In Bangladesh context it is more relevant as it is a densely populated country with limited land resource. Major land degradation processes since 1985-2000 were soil nutrient depletion, soil organic matter depletion, acidification, salinization, soil erosion [hilly areas], riverbank erosion, drought, sandy overwash, water-logging, and soil pollution (arsenic contamination). Land degradation types or processes are not mutually exclusive. That means, where soil erosion is taking place, there soil organic matter depletion also may occur; or, where acidification is the major problem, there nutrient depletion simultaneously occurs. Degradation classes recognized were very severe, severe, moderate, and light. In respect of sustainable land management (SLM) practices severely and very severely degraded land areas have the greatest importance, whereas lightly degraded land has the least importance. The study revealed that moderate to very severe classes of land degradation took place in around 10.7 million of hectare areas which amount to 72.5% of the country area. Now that the processes, extent and severity of different degrees of land degradation in the country have been identified and delineated we can think for the interventions to be taken immediately or in the long term. This report may play a great role in decision support for mainstreaming SLM practices in the sector policies.

CONCLUSION

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Ameer Md. Zahid got his M.S. in 1997 and B.Sc. Ag. (Hons.) in 1994 from Bangladesh Agricultural University (BAU). He joined SRDI in 1999 as a Scientific Officer, BCS (Agriculture). Since then he has been working for the institute in different capacities, e.g., semi-detailed, detailed and reconnaissance soil survey & survey report preparation, flood, drought and other agricultural disasters survey, assessing land degradation and identification of problem soils and their management, render advisory services to the farmers and other stakeholders, agricultural project planning and implementation. He got training on Soil and Water Management from EICA, Egypt in 2008 and attended training on Modeling Scenarios for Low Emission Development Strategies, IFPRI, Washington, DC, USA in 2013. He is now Principal Scientific Officer (PSO) at the institute.

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Md. Altaf Hossain is a career soil scientist with more than 20 years of experience in land resource inventory, and soil resource management having keen interest in degradation aspect of land resources, currently holding the position of "principal scientific officer" in Soil Resource Development Institute (SRDI). He received his Bachelors and Master's degree from two prestigious institutes of Bangladesh namely BAU and BSMRAU respectively.

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J. U. Shoaib is a regular contributor of World Overview of Conservation Approaches and Technologies (WOCAT) and documented many Sustainable Land Management (SLM) best practices in Bangladesh. He is a life member of Soil Science Society of Bangladesh and General Secretary, Indian Association of Soil Water Conservationist (IASWC), Asiatic Society of Bangladesh (ASB). At present he is Editor of the journal of Soil Science Society of Bangladesh.

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Bidhan Kumar Bhander
Director General, SRDI

Agriculturist Bidhan Kumar Bhander, BCS (Ag) took charge on 24th February 2020 as the Director General of Soil Resource Development Institute (SRDI) under the Ministry of Agriculture. He obtained B. Sc (AG) Honors and Master's degree from Bangladesh Agricultural University (BAU) in 1989. In the past, he successfully executed various responsibilities of the Government of the People's Republic of Bangladesh, including program director and project director. He played a special role in the development of Agriculture of South Bengal along with saline areas. He has participated in various national and foreign meetings/ seminars related to various agricultural activities along with Soil Science. He has published 11 books on the soil and water salinity management, the use of fertilizers and water for crop production.

He has keen interest in innovation research to build Bangladesh a digital one and a developed country. Two innovations viz., Online Fertilizer Recommendation System [OFRS] and Online River Water Salinity [ORWS] Software have been invented. Five technologies have been developed in Salinity Management and Research Centre, Batiaghata, Khulna of SRDI are: Pitcher Irrigation System, Farm-Pond Technology, Double-layered Mulching, Shallow Ridge and Furrow Method, Flying Bed Agriculture. He was born in the village of Arazi Makor Dhon in Mongla Upazila of Bagerhat District.

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Director, DoE

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Since his beginning his carrier as an Assistant Director in the Department of Environment (DoE) in 1996, he is now working as Director, Dhaka Metropolitan Office of the DoE. During his tenure he was involved in formulating different guidelines, policies and planning documents. He serves as a member of different technical committees in and outside DoE. On behalf of the Ministry of Environment, Forest and Climate Change (MoEFCC), Dr. Sohrab looks after the United Nations Convention to Combat Desertification (UNCCD) for long since. Also he is working as Science and Technology Correspondent to the UNCCD for over a decade. Additionally, he implemented various projects. As Project Director (PD) he is now implementing two projects funded by Global Environment Facility (GEF). He successfully completed GEF funded global (implemented in 15 countries) project titled "Decision Support and Scaling up of Sustainable Land Management (SLM) Practices" as National Project Coordinator (NPC) under which this knowledge product has been developed.

OVERVIEWED BY








PHOTOS






Photographs : Land Degradation Base Map 2000 Bangladesh presented by SRDI in Expert Consultation Workshop arranged by FAO and DoE under the DS-SLM project in DoE Auditorium, Agargaon, Dhaka on 10-10-2019. Mr. Abdullah Al Mohsin Chowdhury, Honorable former Sectretary of MoEFCC, Dr. S M Manjurul Hannan Khan, Addl. Sec., MoEFCC, Dr. A. K. M. Rafique Ahammed, DG, DoE, various distinguished scientists from different organizations/ institutions including Prof. Dr. Zahurul Karim & Jalal Uddin Shoaib were present.

Annexture I

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
পরিবেশ অধিদপ্তর
পরিবেশ ভবন, ই/১৬ আগারগাঁও
শেরে বাংলা নগর, ঢাকা ১২০৭

স্মারক নং- ২২.০২.০০০০.১১১.১৪.০০৯.২০১৯/৯১১

তারিখ: ১৪ শ্রাবণ, ১৪২৬ / ২৯ জুলাই ২০১৯

বিষয়ঃ Decision Support for Mainstreaming and Scaling up of Sustainable Land Management শীর্ষক প্রকল্পের আওতায় অনুষ্ঠিতব্য "Expert consultation on land degradation map preparation of Bangladesh" শীর্ষক কর্মশালায় অংশগ্রহণের জন্য মনোনয়ন প্রসঙ্গে।

বিষয়ে উল্লেখিত প্রকল্পটি Global Environment Facility (GEF) - এর অর্থায়নে বাস্তবায়িত একটি গ্লোবাল প্রকল্প। প্রকল্পটি ১৫ টি দেশে (আর্জেন্টিনা, বসনিয়া-হারজেগোবিনা, বাংলাদেশ, চীন, কলম্বিয়া, ইকুয়েডর, লেসোথো, মরক্কো, নাইজেরিয়া, পানামা, ফিলিপাইন, থাইল্যান্ড, তিউনিসিয়া, তুরস্ক এবং উজবেকিস্তান) বাস্তবায়িত হচ্ছে। পরিবেশ, বন ও জলবায়ু পরিবর্তন মন্ত্রণালয় এর আওতায় পরিবেশ অধিদপ্তর উক্ত প্রকল্পের বাংলাদেশ অংশের প্রধান বাস্তবায়নকারি সংস্থা এবং FAO হচ্ছে GEF Agency। সহ-বাস্তবায়নকারী (Co-implementing) সংস্থাসমূহ হলো কৃষি সম্প্রসারণ অধিদপ্তর, মৃত্তিকা সম্পদ উন্নয়ন ইন্সটিটিউট এবং বরেন্দ্র বহুমুখী উন্নয়ন কর্তৃপক্ষ। এই প্রকল্পের অন্যান্য কার্যক্রমের মধ্যে জাতীয় পর্যায়ে land degradation ম্যাপ তৈরি অন্যতম। land degradation ম্যাপ তৈরির কৌশল প্রণয়নের নিমিত্তে সংশ্লিষ্ট প্রতিনিধিদের অংশগ্রহণে একটি দিনব্যাপী কর্মশালার আয়োজন করা হয়েছে। উক্ত কর্মশালাটি আগামী ৫ই অগাস্ট ২০১৯, সকাল ১১.০০ টায় কনফারেন্স রুম (নতুন ভবন), পরিবেশ অধিদপ্তর, আগারগাঁও, শেরে বাংলা নগর, ঢাকায় অনুষ্ঠিত হবে। উক্ত কর্মশালায় আপনার সুচিন্তিত মতামত জাতীয় পর্যায়ে land degradation ম্যাপ তৈরিতে গুরুত্বপূর্ণ ভূমিকা পালন করবে।

উক্ত কর্মশালায় যোগদানের জন্য উপযুক্ত কর্মকর্তা মনোনয়ন প্রদানের জন্য নির্দেশক্রমে অনুরোধ করা হলো।

২৯.০৭.১৯
(ড. মুঃ সোহরাব আলি)
(ন্যাশনাল প্রজেক্ট কো-অর্ডিনেটর)
ফোনঃ ৮১৮১৭৮৯

বিতরণ (জ্যেষ্ঠতার ক্রমানুসারে নয়):

১. সচিব, কৃষি মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)

২. প্রধান বন সংরক্ষক, বন বিভাগ, আগারগাঁও, শেরে বাংলা নগর, ঢাকা ১২০৭। (০২ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)

শেখ হাসিনার বাংলাদেশ
পরিচ্ছন্ন বাংলাদেশ

৩. মহাপরিচালক, কৃষি সম্প্রসারণ অধিদপ্তর, খামারবাড়ি, ফার্মগেট, ঢাকা- ১২১৫ (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)। [দৃঃ আঃ ড. এ এস এম আব্দুর রাজ্জাক, উপপরিচালক, (আমদানি)]

৪. মহাপরিচালক, বাংলাদেশ ভূতাত্ত্বিক জরিপ অধিদপ্তর, সেগুনবাগিচা, ঢাকা-১০০০ (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

৫. মহাপরিচালক, বাংলাদেশ পানি উন্নয়ন বোর্ড, ওয়াপদা ভবন (৩য় তলা), মতিঝিল বা/এ, ঢাকা - ১০০০। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

৬. মহাপরিচালক, বাংলাদেশ পরিসংখ্যান ব্যুরো, আগারগাঁও, শেরে বাংলা নগর, ঢাকা ১২০৭। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

৭. পরিচালক, মৃত্তিকা সম্পদ উন্নয়ন ইন্সটিটিউট, খামারবাড়ি, ফার্মগেট, ঢাকা- ১২১৫ (০২ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)। [দৃঃ আঃ আমীর মোঃ জাহিদ, উর্ধ্বতন বৈজ্ঞানিক কর্মকর্তা]

৮. নির্বাহী পরিচালক, বরেন্দ্র বহুমুখী উন্নয়ন কর্তৃপক্ষ, রাজশাহী (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)। [দৃঃ আঃ এ. টি. এম. রফিকুল ইসলাম, উপ-ব্যবস্থাপক (কৃষি)]

৯. পরিচালক, বাংলাদেশ আবহাওয়া অধিদপ্তর, আগারগাঁও, শেরে বাংলা নগর, ঢাকা ১২০৭। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১০. চেয়ারম্যান, বাংলাদেশ মহাকাশ গবেষণা ও দূর অনুধাবন প্রতিষ্ঠান (স্পারসো), আগারগাঁও, শেরে বাংলা নগর, ঢাকা ১২০৭। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১১. চেয়ারম্যান, বাংলাদেশ কৃষি উন্নয়ন কর্পোরেশন, কৃষি ভবন ৪৯-৫১, দিলকুশা বাণিজ্যিক এলাকা, ঢাকা-১০০০ (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১২. Chairman, Department of Soil, Water and Environment, University of Dhaka, (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১৩. Chairman, Department of Soil Science, Sher-e-Bangla Agricultural University, (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১৪. Director, Institute of Water and Flood Management, Bangladesh University of Engineering and Technology, (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১৫ Director, Geographic Information System Division, Center for Environmental and Geographic Information Services, House # 6, Road # 23/C, Gulshan 1, Dhaka-1212, (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১৬. Project Coordinator, SLM-Project, Department of Environment, Agargaon, Sher-e-Bangla Nagar, Dhaka 1207 (০৩ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১৭. Professor Dr. Zahurul Karim, Secretary (retired), Government of the People's Republic of Bangladesh.

১৮. Dr. A.J.M. Sirajul Karim, Retired Professor of Department of Soil Science, Bangabandhu Sheikh Mujibur Rahman Agricultural University.

ANNEXTURE I

Annexure II

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
পরিবেশ, বন ও জলবায়ু পরিবর্তন মন্ত্রণালয়
পরিকল্পনা-৬

স্মারক নং- ২২.০২.০০০০.১১১.১৪.০০৯.২০১৯-১৯১

২২ আশ্বিন ১৪২৬
তারিখ: ------------------
০৭ অক্টোবর ২০১৯

বিষয়: Decision Support for Mainstreaming and Scaling up of Sustainable Land Management শীর্ষক প্রকল্পের আওতায় অনুষ্ঠিতব্য " Expert consultation on land degradation base map 2000 preparation of Bangladesh" শীর্ষক কর্মশালায় অংশগ্রহণের জন্য মনোনয়ন প্রসঙ্গে।

বিষয়ে উল্লেখিত প্রকল্পটি Global Environment Facility (GEF) - এর অর্থায়নে বাস্তবায়িত একটি গ্লোবাল প্রকল্প। প্রকল্পটি ১৫ টি দেশে (আর্জেন্টিনা, বসনিয়া-হারজেগোবিনা, বাংলাদেশ, চীন, কলম্বিয়া, ইকুয়েডর, লেসোথো, মরক্কো, নাইজেরিয়া, পানামা, ফিলিপাইন, থাইল্যান্ড, তিউনিসিয়া, তুরস্ক এবং উজবেকিস্তান) বাস্তবায়িত হচ্ছে। পরিবেশ, বন ও জলবায়ু পরিবর্তন মন্ত্রণালয় এর আওতায় পরিবেশ অধিদপ্তর উক্ত প্রকল্পের বাংলাদেশ অংশের প্রধান বাস্তবায়নকারি সংস্থা এবং FAO হচ্ছে GEF Agency। সহ-বাস্তবায়নকারী (Co-implementing) সংস্থাসমূহ হলো কৃষি সম্প্রসারণ অধিদপ্তর, মৃত্তিকা সম্পদ উন্নয়ন ইন্সটিটিউট এবং বরেন্দ্র বহুমুখী উন্নয়ন কর্তৃপক্ষ। এই প্রকল্পের অন্যান্য কার্যক্রমের মধ্যে জাতীয় পর্যায়ে land degradation ম্যাপ তৈরি অন্যতম এবং মৃত্তিকা সম্পদ উন্নয়ন ইন্সটিটিউট কর্তৃক land degradation base map 2000 প্রস্তুত করা হয়েছে। উক্ত ম্যাপটি validation এর নিমিত্তে সংশ্লিষ্ট প্রতিনিধিদের অংশগ্রহণে একটি দিনব্যাপী কর্মশালার আয়োজন করা হয়েছে। কর্মশালাটি আগামী ১০ই অক্টোবর ২০১৯, সকাল ১০.০০ টায় অডিটোরিয়াম (নতুন ভবন), পরিবেশ অধিদপ্তর, আগারগাঁও, শেরে বাংলা নগর, ঢাকায় অনুষ্ঠিত হবে। উক্ত কর্মশালায় আপনার সুচিন্তিত মতামত জাতীয় পর্যায়ে land degradation ম্যাপ তৈরিতে গুরুত্বপূর্ণ ভূমিকা পালন করবে।

উক্ত কর্মশালায় প্রধান অতিথির আসন অলংকরণ করবেন জনাব আবদুল্লাহ আল মোহসীন চৌধুরী, সচিব, পরিবেশ, বন ও জলবায়ু পরিবর্তন মন্ত্রণালয়, এবং বিশেষ অতিথি হিসেবে উপস্থিত থাকবেন ড. এস. এম মনজুরুল হান্নান খান, অতিরিক্ত সচিব (উন্নয়ন), পরিবেশ, বন ও জলবায়ু পরিবর্তন মন্ত্রণালয়। কর্মশালায় সভাপতিত্ব করবেন ড. এ. কে. এম. রফিক আহাম্মদ, মহাপরিচালক, পরিবেশ অধিদপ্তর। উক্ত কর্মশালায় যথাসময়ে যোগদানের জন্য অনুরোধ করা হলো।

(তানজিনা শাহরীন)
সিনিয়র সহকারী প্রধান
ফোনঃ ৯৫৪৪০২৫৭
Email: shahrinp@gmail.com

বিতরণ (জ্যেষ্ঠতার ক্রমানুসারে নয়):

১. সচিব, কৃষি মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)

২. প্রধান বন সংরক্ষক, বন অধিদপ্তর, আগারগাঁও, শেরে বাংলা নগর, ঢাকা ১২০৭। (০৩ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ) [দৃঃ আঃ ড. মরিয়ম আক্তার, সহকারী বন সংরক্ষক, বন অধিদপ্তর, আঁগারগাঁও, ঢাকা]

৩. অতিরিক্ত সচিব (উন্নয়ন/প্রশাসন/পরিবেশ/পরিবেশ দূষণ নিয়ন্ত্রন/জলবায়ু পরিবর্তন), পরিবেশ, বন ও জলবায়ু পরিবর্তন মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।

৪. মহাপরিচালক, বাংলাদেশ ধান গবেষণা ইনস্টিটিউট, জয়দেবপুর, গাজীপুর (০২ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

৫. মহাপরিচালক, কৃষি সম্প্রসারণ অধিদপ্তর, খামারবাড়ি, ফার্মগেট, ঢাকা- ১২১৫ (০৩ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)। [দৃঃ আঃ ড. এ এস এম আব্দুর রাজ্জাক, উপপরিচালক, (আমদানি)]

৬. মহাপরিচালক, বাংলাদেশ পাট গবেষণা ইনস্টিটিউট, ঢাকা (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

৭. মহাপরিচালক, মৎস্য অধিদপ্তর, বাংলাদেশ (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

৮. মহাপরিচালক, বাংলাদেশ ভূতাত্ত্বিক জরিপ অধিদপ্তর, সেগুনবাগিচা, ঢাকা-১০০০। (০২ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

৯. মহাপরিচালক, বাংলাদেশ পানি উন্নয়ন বোর্ড, ওয়াপদা ভবন (৩য় তলা), মতিঝিল বা/এ, ঢাকা - ১০০০। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১০. মহাপরিচালক, বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউট, গাজীপুর (০২ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১১. মহাপরিচালক, প্রাণিসম্পদ অধিদপ্তর, খামারবাড়ি, ফার্মগেট, ঢাকা। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১২. মহাপরিচালক, প্রাণিসম্পদ অধিদপ্তর, খামারবাড়ি, ফার্মগেট, ঢাকা। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১৩. মহাপরিচালক, পানিসম্পদ পরিকল্পনা সংস্থা, (ওয়ারপো ভবন), গ্রীন রোড, ঢাকা। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১৪. মহাপরিচালক, বাংলাদেশ পরিসংখ্যান ব্যুরো, আগারগাঁও, শেরে বাংলা নগর, ঢাকা ১২০৭। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)। [দৃঃ আঃ মিজ. সাহেলা খাতুন, উপ-পরিচালক]

১৫. নির্বাহী চেয়ারম্যান, বাংলাদেশ কৃষি গবেষণা কাউন্সিল, বি.এ.আর. সি. কমপেক্স, ফার্মগেট, ঢাকা। (০২ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

১৬. ব্যবস্থাপনা পরিচালক, পল্লী কর্ম সহায়ক ফাউন্ডেশন, আগারগাঁও, শেরে বাংলা নগর, ঢাকা ১২০৭। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)

১৭. মিজ. কেয়া খান, যুগ্ম সচিব (পরিবেশ অধিশাখা-২), পরিবেশ, বন ও জলবায়ু পরিবর্তন মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা

১৮. জনাব সামসুর রহমান খান, উপসচিব (উন্নয়ন), পরিবেশ, বন ও জলবায়ু পরিবর্তন মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।

১৯. নির্বাহী পরিচালক, বরেন্দ্র বহুমুখী উন্নয়ন কর্তৃপক্ষ, রাজশাহী (০২ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)। [দৃঃ আঃ এ. টি. এম. রফিকুল ইসলাম, উপ-ব্যবস্থাপক (কৃষি)]

২০. চেয়ারম্যান, বাংলাদেশ কৃষি উন্নয়ন কর্পোরেশন, কৃষি ভবন ৪৯-৫১, দিলকুশা বাণিজ্যিক এলাকা, ঢাকা-১০০০ (০২ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)। [দৃঃ আঃ মি. মুহাম্মদ জাকিরুল ইসলাম, যুগ্ম পরিচালক]

২১. চেয়ারম্যান, বাংলাদেশ মহাকাশ গবেষণা ও দূর অনুধাবন প্রতিষ্ঠান (স্পারসো), আগারগাঁও, শেরে বাংলা নগর (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।[দৃঃ আঃ ড. মাহমুদুর রহমান, প্রধান বৈজ্ঞানিক কর্মকর্তা]

২২. নির্বাহী পরিচালক, কৃষি গবেষণা ফাউন্ডেশন, বি.এ.আর. সি. কমপেক্স, ফার্মগেট, ঢাকা।

২৩. নির্বাহী পরিচালক, Institute of Water Modelling (IWM), মহাখালী, ডি ও এইচ এস, ঢাকা। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ।

২৪. পরিচালক, মৃত্তিকা সম্পদ উন্নয়ন ইন্সটিটিউট, খামারবাড়ি রোড, ফার্মগেট, ঢাকা- ১২১৫ (০৪ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ। [দৃঃ আঃ আমীর মোঃ জাহিদ, উর্ধ্বতন বৈজ্ঞানিক কর্মকর্তা]

২৫ পরিচালক, কৃষি তথ্য সার্ভিস, কৃষি মন্ত্রণালয়, খামারবাড়ি, ঢাকা (০২ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)

২৬. পরিচালক, SAARC Agriculture Centre (SAC), ঢাকা (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)

২৭. নির্বাহী পরিচালক, আরণ্যক ফাউন্ডেশন, মাটিকাটা, ঢাকা।

২৮. পরিচালক, বাংলাদেশ আবহাওয়া অধিদপ্তর, আগারগাঁও, শেরে বাংলা নগর, ঢাকা ১২০৭। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

২৯. পরিচালক, (পরিকল্পনা/ প্রা. স. ব্য. / ঢাকা অঞ্চল/ পরিবেশগত ছাড়পত্র/ আইন/ বায়ুমান ব্যবস্থাপনা/ আন্তঃ কনভেনশন/ প্রশাসন/ মনিটরিং ও এনফোর্সমেন্ট), পরিবেশ অধিদপ্তর, আগারগাঁও, ঢাকা।

৩০. চেয়ারম্যান, মাটি, পানি ও পরিবেশ বিভাগ, ঢাকা বিশ্ববিদ্যালয় (০২ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ) [দৃঃ আঃ প্রফেসর ড. মোঃ খলিলুর রহমান, চেয়ারম্যান]

৩১. চেয়ারম্যান, মৃত্তিকা বিজ্ঞান বিভাগ, শেরে এ বাংলা কৃষি বিশ্ববিদ্যালয় (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ) [দৃঃ আঃ প্রফেসর ড. সৈকত চৌধুরী]

৩২. চেয়ারম্যান, কৃষি সম্প্রসারন ও তথ্য ব্যবস্থা বিভাগ, শেরে এ বাংলা কৃষি বিশ্ববিদ্যালয় (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)

৩৩. চেয়ারম্যান, কৃষিতত্ত্ব বিভাগ, শেরে এ বাংলা কৃষি বিশ্ববিদ্যালয় (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)

৩৪. কান্ট্রি রিপ্রেজেন্টেটিভ, আই. ইউ. সি. এন. মহাখালী, ডি ও এইচ এস (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)

৩৫. নির্বাহী পরিচালক, সি. এন. আর. এস. বনানী, ঢাকা (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)

৩৬. পরিচালক, পানি ও বন্যা ব্যবস্থাপনা ইনস্টিটিউট, বাংলাদেশ প্রকৌশল বিশ্ববিদ্যালয়, ঢাকা। (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

৩৭. নির্বাহী পরিচালক, সিইজিআইএস, গুলশান, ঢাকা (০১ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)।

৩৮. প্রকল্প সমন্বয়ক, SLM-Project, পরিবেশ অধিদপ্তর, আগারগাঁও, ঢাকা। (০৩ জন কর্মকর্তা মনোনয়নের জন্য অনুরোধসহ)। [দৃঃ আঃ মি. জালাল উদ্দিন মোঃ শোয়েব,]

৩৯. প্রফেসর ড. জহুরুল করিম, প্রাক্তন সচিব, গণপ্রজাতন্ত্রী বাংলাদেশ সরকার।

৪০. ড. এ. যে. এম. সিরাজুল করিম, অবসরপ্রাপ্ত প্রফেসর, মৃত্তিকা বিজ্ঞান বিভাগ, বঙ্গবন্ধু শেখ মুজিবর রহমান কৃষি বিশ্ববিদ্যালয়।

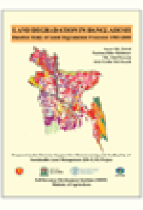
অনুলিপিঃ

১। সচিব মহোদয়ের একান্ত সচিব, পরিবেশ, বন ও জলবায়ু পরিবর্তন মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।

২। অতিরিক্ত সচিব (উন্নয়ন) মহোদয়ের ব্যক্তিগত কর্মকর্তা, পরিবেশ, বন ও জলবায়ু পরিবর্তন মন্ত্রণালয়, বাংলাদেশ সচিবালয়, ঢাকা।

৩। সহকারী পরিচালক, মহাপরিচালক মহোদয়ের দপ্তর, পরিবেশ অধিদপ্তর, আগারগাঁও, ঢাকা-১২০৭

৪। সহকারী পরিচালক (সেবা), কনফারেন্স রুম (নতুন ভবন) প্রস্তুত রাখার অনুরোধসহ।]



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ISBN: 978-984-34-815-2
978984348152