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The first national soil fertility maps were prepared by Soil Resource Development Institute (SRDI) in 1998. Soil fertility maps includes phosphorus, potassium, sulfur, Zinc, boron, organic matter and pH status maps.

Second soil fertility maps include phosphorus, potassium, sulfur, Zinc, boron, organic matter and pH status maps were prepared in 2010.

Soil Fertility Atlas Bangladesh 2020, includes phosphorus (Loamy to Clayey Soils of Upland Crops), phosphorus (Loamy to Clayey Soils of Wetland Rice Crops), potassium (Loamy to Clayey Soils of Upland Crops), potassium (Loamy to Clayey Soils of Wetland Rice Crops), sulfur (Loamy to Clayey Soils of Upland Crops), sulfur (Loamy to Clayey Soils of Wetland Rice Crops), zinc, boron, calcium, magnesium, pH and organic matter status map.

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মুজিববর্ষের অঙ্গীকার
কৃষি হবে দুর্বার

SOIL FERTILITY ATLAS BANGLADESH 2020

Strengthening of Soil Research and Research Facilities (SRSRF) Project

Soil Resource Development Institute (SRDI)
Ministry of Agriculture

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Prologue

The first national soil fertility maps were prepared by Soil Resource Development Institute (SRDI) in 1998. These maps were prepared on the basis of soil nutrient data generated during Reconnaissance Survey (RSS) and semi-detailed soil survey for the preparation of upazila wise "Land and Soil Resources Utilization Guides" popularly known as "Upazila Nirdeshika". Soil fertility maps includes phosphorus, potassium, sulfur, Zinc, boron, organic matter and pH status maps. These maps were incorporated in "Fertilizer Recommendation Guide-2005". Second soil fertility maps include phosphorus, potassium, sulfur, Zinc, boron, organic matter and pH status maps were prepared in 2010. These maps were prepared on the basis of soil nutrient database generated for the preparation of Upazila Nirdeshika. These maps also incorporated in "Fertilizer Recommendation Guide-2012" and "Fertilizer Recommendation Guide-2018". Phosphorus status map was made for only for Loamy to Clayey Soils of Wetland Rice Crops considering critical limits and fertility class for modified Olsen method (neutral to calcareous soils) values for both Bray & Kurtz method (Acid soils) values and modified Olsen method values. Potassium and sulfur status maps were prepared for Loamy to Clayey Soils of Wetland Rice Crops. Zinc and Boron status maps were prepared considering as usual soil fertility class described in "Fertilizer Recommendation Guide- 2005, 2012 and 2018". Soil Reaction (pH) and Soil Organic Matter (SOM) status maps were also prepared, considering classification described in Fertilizer Recommendation Guides. There is an urgent necessity to have new soil fertility maps by National Agricultural Research System (NARS) scientists and also by Bangladesh Agricultural Research Council (BARC). These maps were used in Agro-Ecological Zones (AEZ) wise fertilizer recommendation for major crops and cropping patterns of that particular AEZ. These maps also used for the estimation of fertilizer requirements and distribution of fertilizers. These data and maps were also used in location specific soil fertility management.

Understanding the necessity of updated national soil fertility maps "Strengthening of Soil Research and Research Facilities (SRSRF)" project under SRDI took initiative to prepare new national level soil fertility maps. Soil Resources Development Institute collected soil samples during semi-detailed soil survey conducted for preparing "Land and Soil Resources Utilization Guides" for every upazilas of the country. Sample intensity is at least one sample for every 200 hectares of land. Intensity increases with the differences in the physiography, agro-ecological zones, mapping units, land type, soil group etc. Collected soil samples were analyzed for plant nutrients such as nitrogen, phosphorus, potassium, sulfur, zinc, boron, calcium, magnesium, iron, copper, manganese and also for soil pH, organic matter and soil salinity. These chemical data were inserted in UpazilaNirdeshika as hard copy and also digitized in GIS platform. First round of soil survey and Upazila Nirdeshika publication completed during 1985 to 2002. Second round of survey and publication is going on and so far, 245 Upazila Nirdeshika is already published and chemical data is digitized in GIS platform. Present Soil Fertility Maps 2020, are prepared, based on soil chemical data of the upazila nirdeshika updated up to 2018. Maps included phosphorus (Loamy to Clayey Soils of Upland Crops), phosphorus (Loamy to Clayey Soils of Wetland Rice Crops), potassium (Loamy to Clayey Soils of Upland Crops), potassium (Loamy to Clayey Soils of Wetland Rice Crops), sulfur (Loamy to Clayey Soils of Upland Crops), sulfur (Loamy to Clayey Soils of Wetland Rice Crops), zinc, boron, calcium, magnesium, pH and organic matter status map. Nitrogen status map is not prepared as because nitrogen status is between very low to low in entire country. These maps may further be updated with the availability of new data.

These maps will be useful for fertilizer management planning, procurement of fertilizers, distribution and for fertilizer recommendations broadly. More over these maps may be useful for next Fertilizer Recommendation Guide to be prepared by Bangladesh Agricultural Research Council (BARC) and these maps will serve for selection of research topic and research sites.

Contents

Background

As a first step of graduation from developing to developed country ensuring food security, necessity of sustainable and environment-friendly agricultural system is imperative. To make Bangladesh food sufficient agriculture sector has been given highest priority. The government is trying sincerely for developing agriculture sector in consideration with 7th five-year plan, National Agriculture Policy and SDG. As per vision 2021, sufficiency in food was targeted by 2013. Despite population growth, various steps were taken by present pro people government to make Bangladesh food sufficient before estimated time.

The expansion of modern agricultural farming practices like use of High Yielding Variety (HYV) together with intensified cultivation is needed to ensure food for all, which leads to an increased demand for fertilizers. Therefore, it is necessary to ensure timely supply of both organic and chemical fertilizers to meet the nutritional demand of these varieties. The use of chemical fertilizer is increasing with the increased demand for food production in the country. The use of urea fertilizer alone is the highest in the agriculture of the country. In FY2017-18, the total quantity of fertilizer used was 50.93 lakh MT, of which the use of Urea fertilizer is 24.27 lakh MT. Development support in fertilizer was 5200.67 crore taka in FY2017-18.

The fertility status of different region of the country varies considerably. Individual farmers have fragmented the land into smaller pieces causing wide variation in the management of each piece of land. This leads to a large variation in fertility level even between adjacent plots. Realizing the difficulties of generalization of fertility level, only an indicative status fertility level in different regions of the country is shown in the maps in this atlas.

There is an increasing trend in soil health degradation which can be attributed to higher crop removal due to increasing cropping intensity, use of modern varieties of crops (HYVs and hybrids), soil erosion, soil salinity, soil acidity, deforestation, nutrient leaching and minimum manure application. These factors are mostly due to irrational human interventions. Consequently, with advancement of time, new nutrient deficiency arises. Chronologically N, P, K, S, Zn and B deficiencies have appeared. Magnesium deficiency is reported in Old Himalayan Piedmont Plain and Tista Floodplain soils. Calcium deficiency also arises in Old Himalayan Piedmont Plain and Tista, part of Brahmaputra Flood Plain and North and Eastern Hills. There is sporadic information of Cu, Mo and Mn deficiencies in crops. Deficiencies of Fe and Cl are not yet found. It is estimated that the overall N balance of Bangladesh soils is negative, the P balance near zero and the K balance is highly negative.

The first national soil fertility maps were prepared by Soil Resource Development Institute (SRDI) in 1998. These maps were prepared on the basis of soil nutrient data generated during Reconnaissance Survey (RSS) and semi-detailed soil survey for the preparation of upazila wise "Land and Soil Resources Utilization Guides" popularly known as "UpazilaNirdeshika". Soil fertility maps includes phosphorus, potassium, sulfur, Zinc, boron, organic matter and pH status maps. These maps were incorporated in "Fertilizer Recommendation Guide-2005". Second soil fertility maps include phosphorus, potassium, sulfur, Zinc, boron, organic matter and pH status maps were prepared in 2010. These maps were prepared on the basis of soil nutrient database generated for the preparation of Upazila Nirdeshika. These maps also incorporated in "Fertilizer Recommendation Guide-2012" and "Fertilizer Recommendation Guide-2018". Phosphorus status map was made for only for Loamy to Clayey Soils of Wetland Rice Crops considering critical limits for modified Olsen method (neutral to calcareous soils) values for both Bray & Kurtz method (Acid soils) values and modified Olsen method values. Potassium and sulfur status maps were prepared for Loamy to Clayey Soils of Wetland Rice Crops. Zinc and Boron status maps were prepared considering as usual soil fertility class described in "Fertilizer Recommendation Guide- 2005, 2012 and 2018". Soil Reaction (pH) and Soil Organic Matter (SOM) status maps were also prepared, considering classification described in Fertilizer Recommendation Guides. There is an urgent necessity to have new soil fertility maps by National Agricultural Research System (NARS) scientists and also by Bangladesh Agricultural Research Council (BARC). These maps were used in Agro-Ecological Zones (AEZ) wise fertilizer recommendation for major crops and cropping patterns of that particular AEZ. These maps also used for the estimation of fertilizer requirements and distribution of fertilizers. These data and maps were also used in location specific soil fertility management.

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Intensity increases with the differences in the physiography, agro-ecological zones, mapping units, land type, soil group etc. Collected soil samples were analyzed for plant nutrients such as nitrogen, phosphorus, potassium, sulphur, zinc, boron, calcium, magnesium, iron, copper, manganese and also for soil pH, organic matter and soil salinity. These chemical data were inserted in Upazila Nirdeshika as hard copy and also digitized in GIS platform. First round of soil survey and Upazila Nirdeshika publication completed during 1985 to 2002. Second round of survey and publication is going on and so far, 245 Upazila Nirdeshika is already published and chemical data is digitized in GIS platform. Present Soil Fertility Maps 2020, are prepared, based on soil chemical data of the upazila nirdeshika updated up to 2018. Maps included phosphorus (Loamy to Clayey Soils of Upland Crops), phosphorus (Loamy to Clayey Soils of Wetland Rice Crops), potassium (Loamy to Clayey Soils of Upland Crops), potassium (Loamy to Clayey Soils of Wetland Rice Crops), sulfur (Loamy to Clayey Soils of Upland Crops), sulfur (Loamy to Clayey Soils of Wetland Rice Crops), zinc, boron, calcium, magnesium, pH and organic matter status map. Nitrogen status map is not prepared as because nitrogen status is between very low to low in entire country. These maps may further be updated with the availability of new data.

These maps will be useful for fertilizer management planning, procurement of fertilizers, distribution and for fertilizer recommendations broadly. More over these maps may be useful for next Fertilizer Recommendation Guide to be prepared by Bangladesh Agricultural Research Council (BARC) and these maps will serve for selection of research topic and research sites.

Methodology

The present study was carried out in the area of the cultivable land of Bangladesh (26° 37' 54.86" N and 87° 59' 59.96" E, and 20° 34' 1.85" N and 92° 40' 40.93" E), with a total area of 14757000 hectares.

The soil sample points were collected from the upazila Nirdeshika.The soil samples were subjected to physical and chemical analyses according to SRDI module for upazila Nirdeshika. The mapping units (MUs) were defined by grouping areas of soils on a 1:50,000 scale, according to the upazila Nirdeshika. The upazila Soil and landform map was delineated using visual interpretation of the soil distribution in the area. Soil-landscape relationships were established using visual interpretation of field observations, soil descriptions, and the subsidiary Aerial Photos and topographic maps.

Due to the large amount of data available for use as covariates in modelling, it was necessary to use a data-mining technique to select the most suitable dataset as an optimal set of predictors to run the model, affording the lowest error. Generally, we use smaller neighborhoods or a minimum number of points when the phenomenon has a great amount of variation.

We used a selection process where the covariates were ranked based on their importance, selecting the top twelve with highest importance for soil mapping. The selection procedure was performed by using the IDW, combined with correlation analyses for removal of covariates with higher correlation with others. Inverse distance weighted (IDW) interpolation determines cell values using a linearly weighted combination of a set of sample points. The weight is a function of inverse distance. The surface being interpolated should be that of a locationally dependent variable.

Workflow for developing DSM shown below

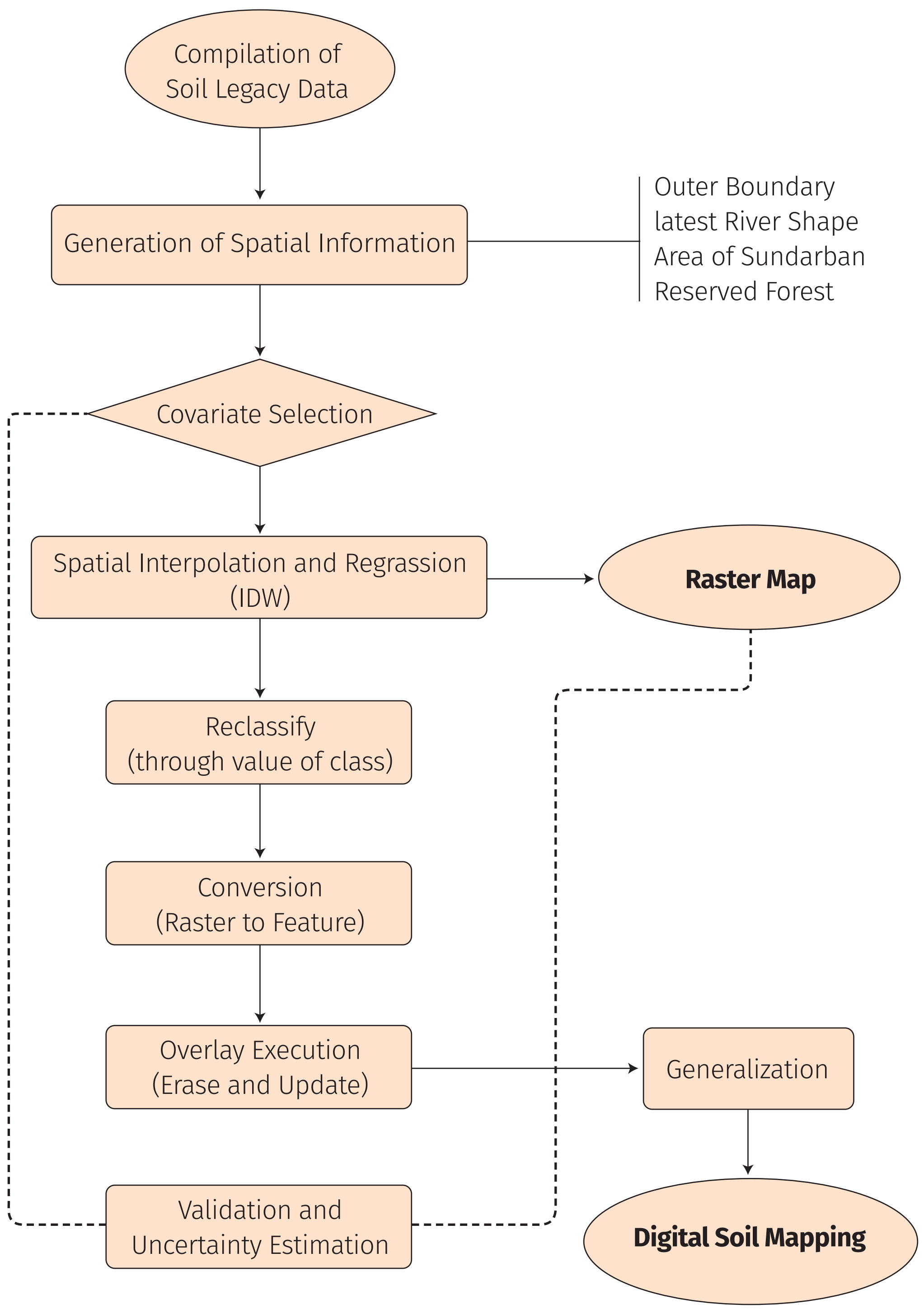

Fig. 1 Workflow for developing Digital Soil Mapping (DSM)

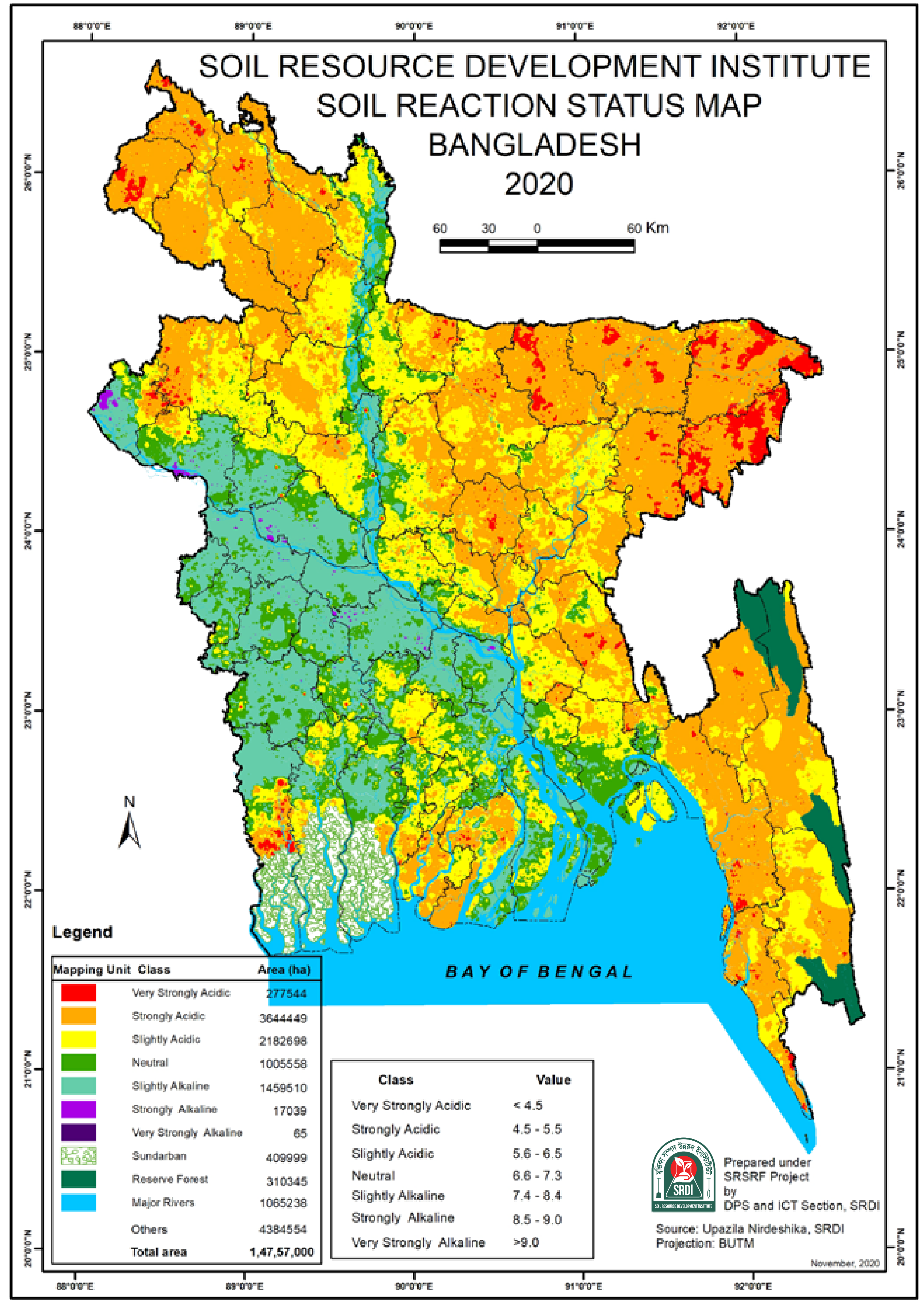

Fig.2 Soil Reaction (pH) Status Map, Year 2020.

Soil Reaction (pH) 2020

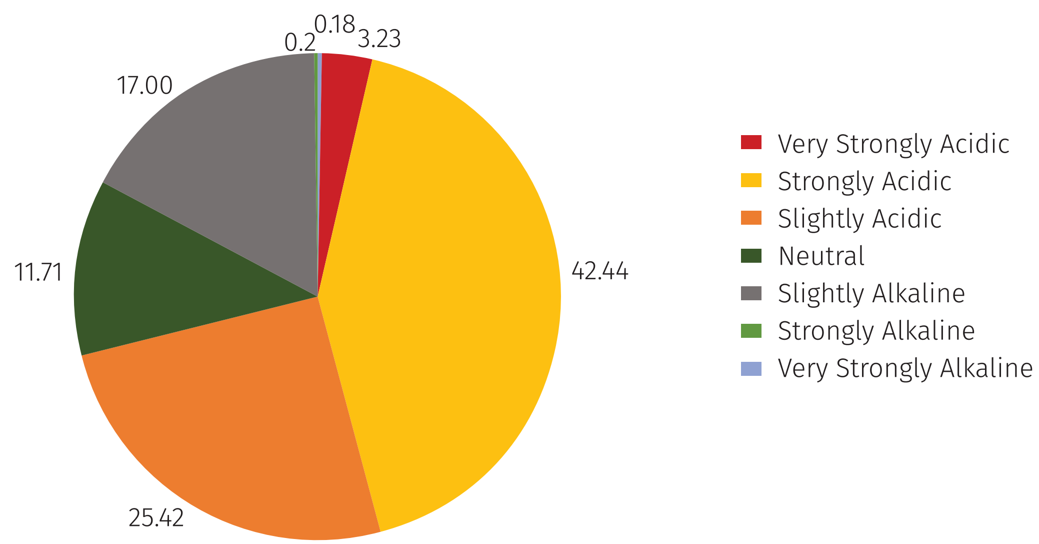

Fig. 3 Soil Reaction (pH) status (% of arable lands) under different class

Table 1 Soil reaction (pH) status (area and percentage of arable lands) under different pH class

Soil Reaction (pH) Class	Area (ha)	Percentage of Arable Land
Very Strongly to Strongly Acidic	3921994	45.67
Slightly Acidic	2182698	25.42
Neutral	1005558	11.71
Slightly Alkaline	1459510	17
Strongly Alkaline	17039	0.2
Very Strongly Alkaline	65	Trace
Total	8586863	100.00

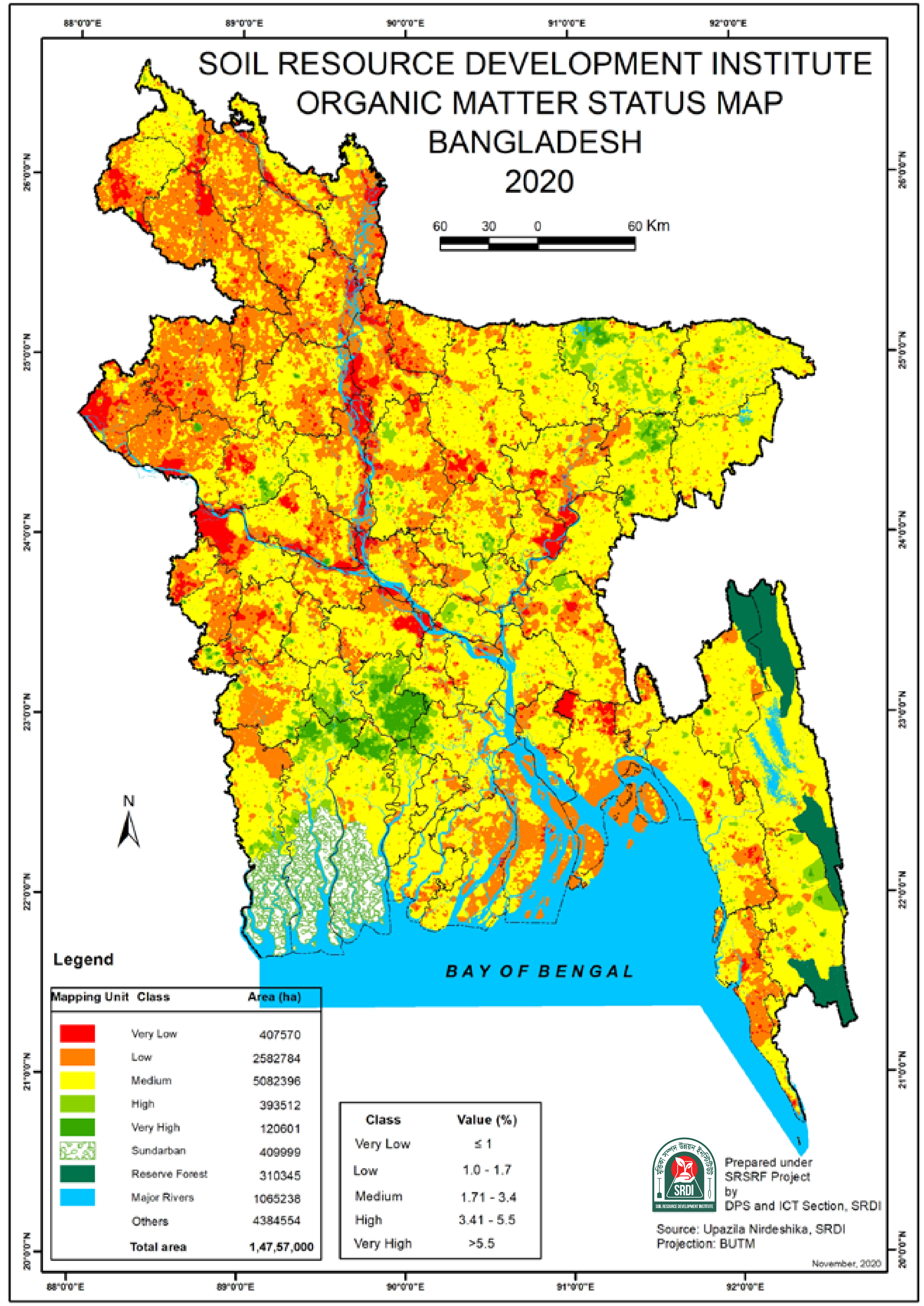

Fig. 4 Soil Organic Matter Status Map, Year 2020.

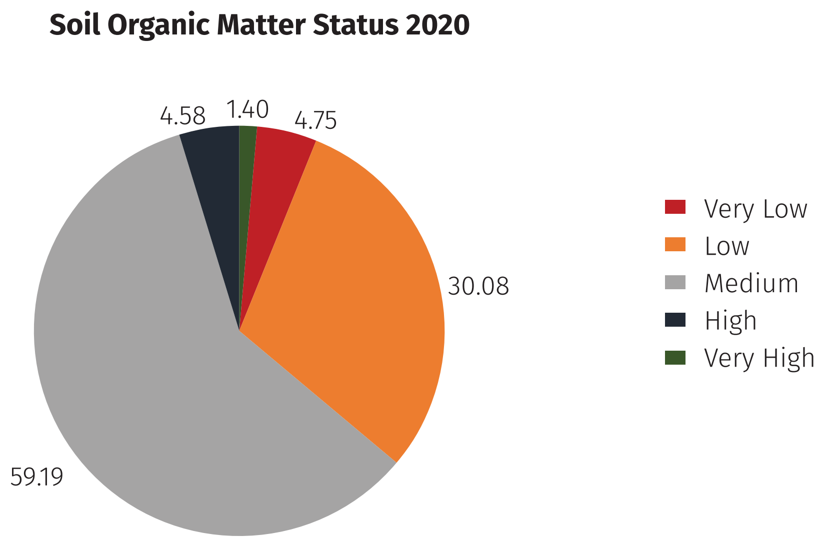

Fig. 5 Soil organic matter status (% of arable lands) under different class

Table 2 Organic matter status (area and percentage of arable lands) under different fertility class

Fertility Class	Area (Ha)	Percentage of arable land
Very Low to Low	2990355	34.83
Medium	5082396	59.19
High	393512	4.58
Very High	120601	1.4
Total	8586864	100.00

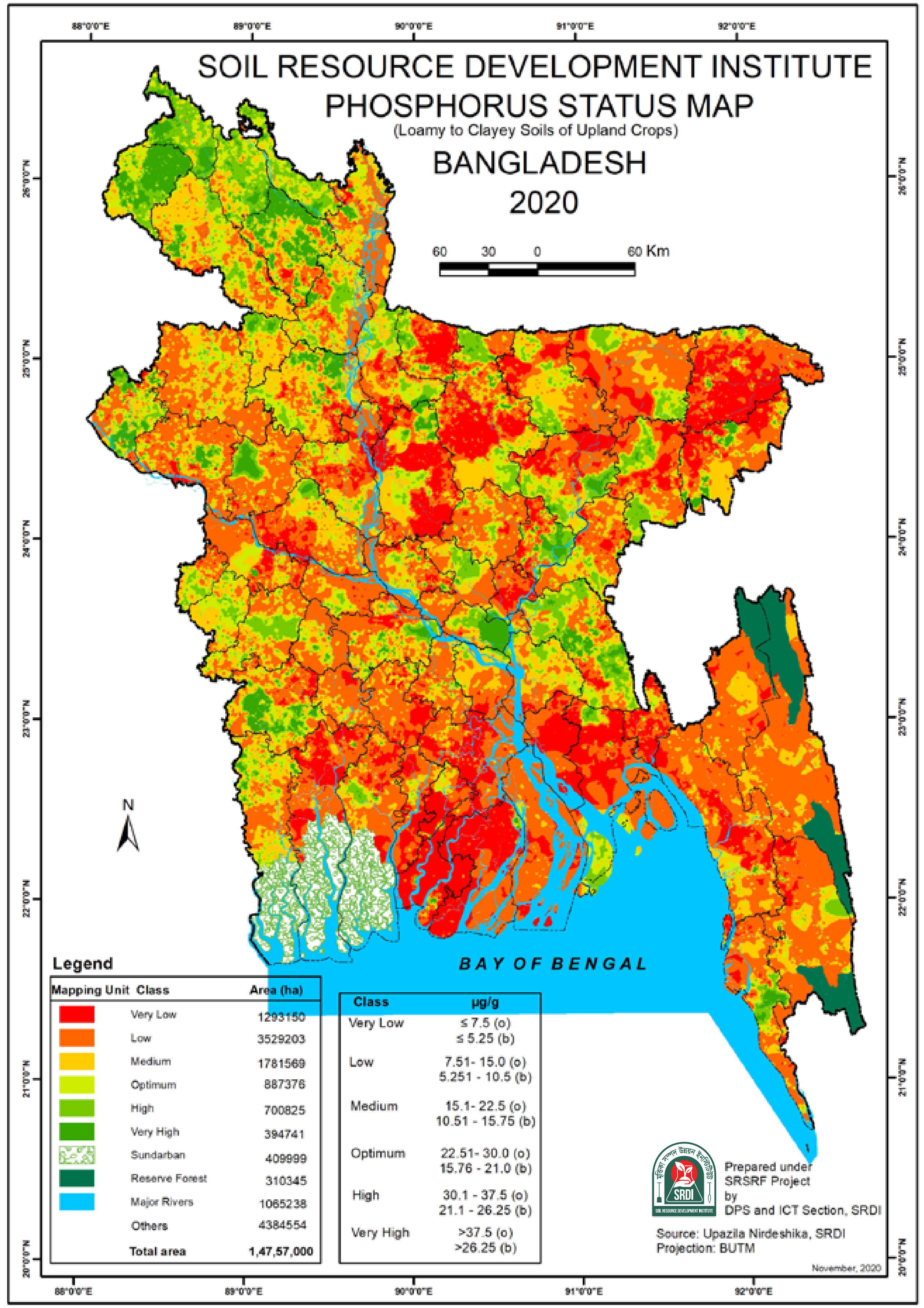

Fig. 6 Phosphorus Status Map for Loamy to Clayey Soils of Upland Crops, Year 2020.

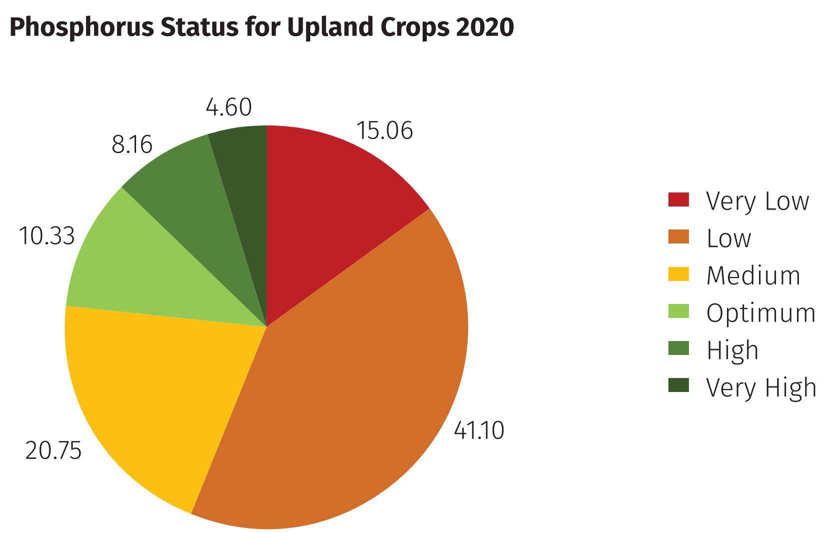

Fig. 7 Phosphorus status (% of arable lands) under different fertility class for loamy to clayey soils of upland crops.

Table 3 Phosphorus status (area and percentage of arable lands) under different fertility class for loamy to clayey soils of upland crops

Fertility Class	Area (Ha)	Percentage of arable land
Very Low to Low	4822353	56.16
Medium	1781569	20.75
Optimum	887376	10.33
High to Very High	109566	12.76
Total	8586864	100.00

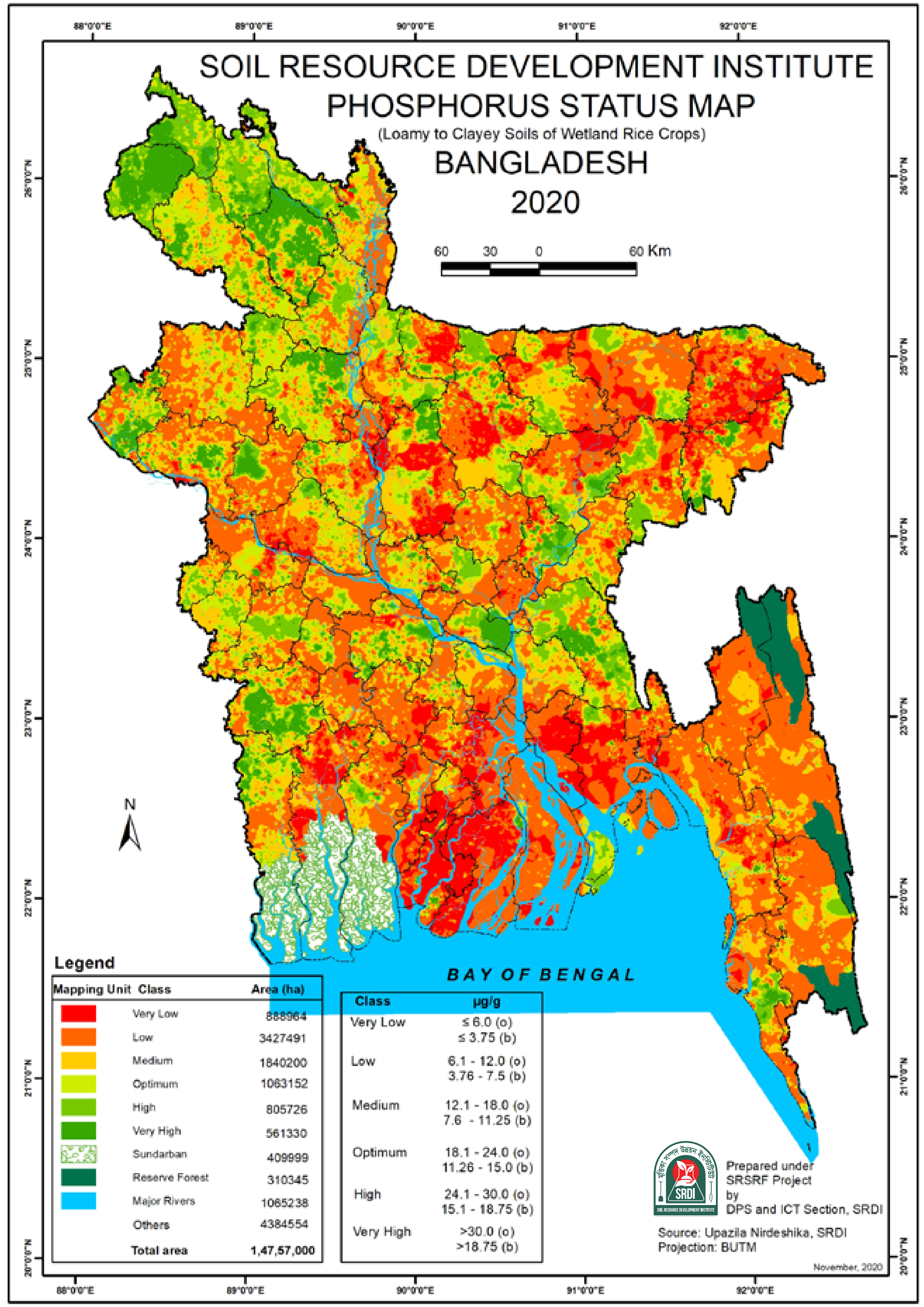

Fig. 8 Phosphorus Status Map for Loamy to Clayey Soils of Wetland Rice Crops, Year 2020.

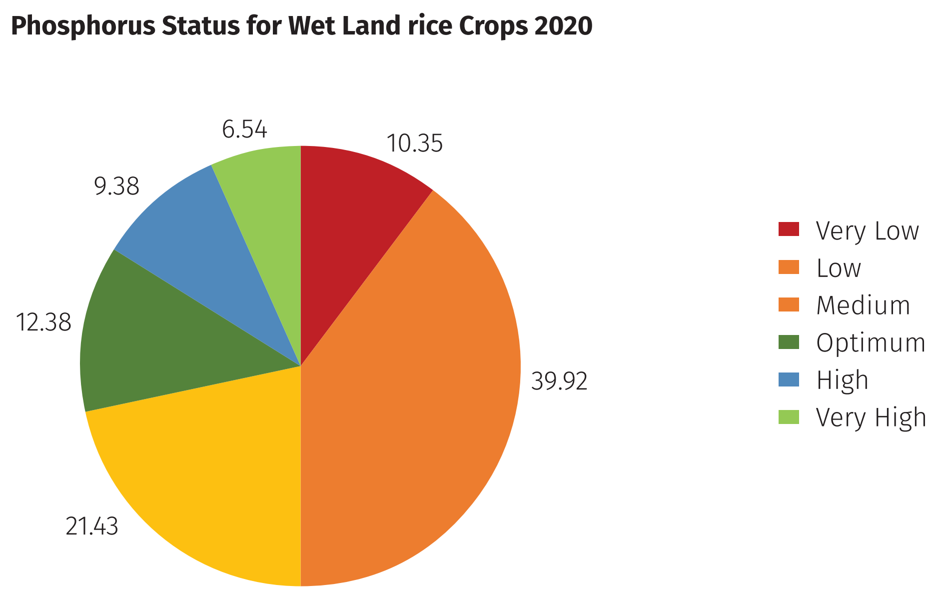

Fig. 9 Phosphorus status (% of arable lands) under different fertility class for loamy to clayey soils of wetland rice crops.

Table 4 Phosphorus status (area and percentage of arable lands) under different fertility class for loamy to clayey soils of wetland rice crops

Fertility Class	Area (Ha)	Percentage of arable land
Very Low to Low	4316455	50.27
Medium	1840200	21.43
Optimum	1063152	12.38
High to Very High	1367056	15.92
Total	8586864	100.00

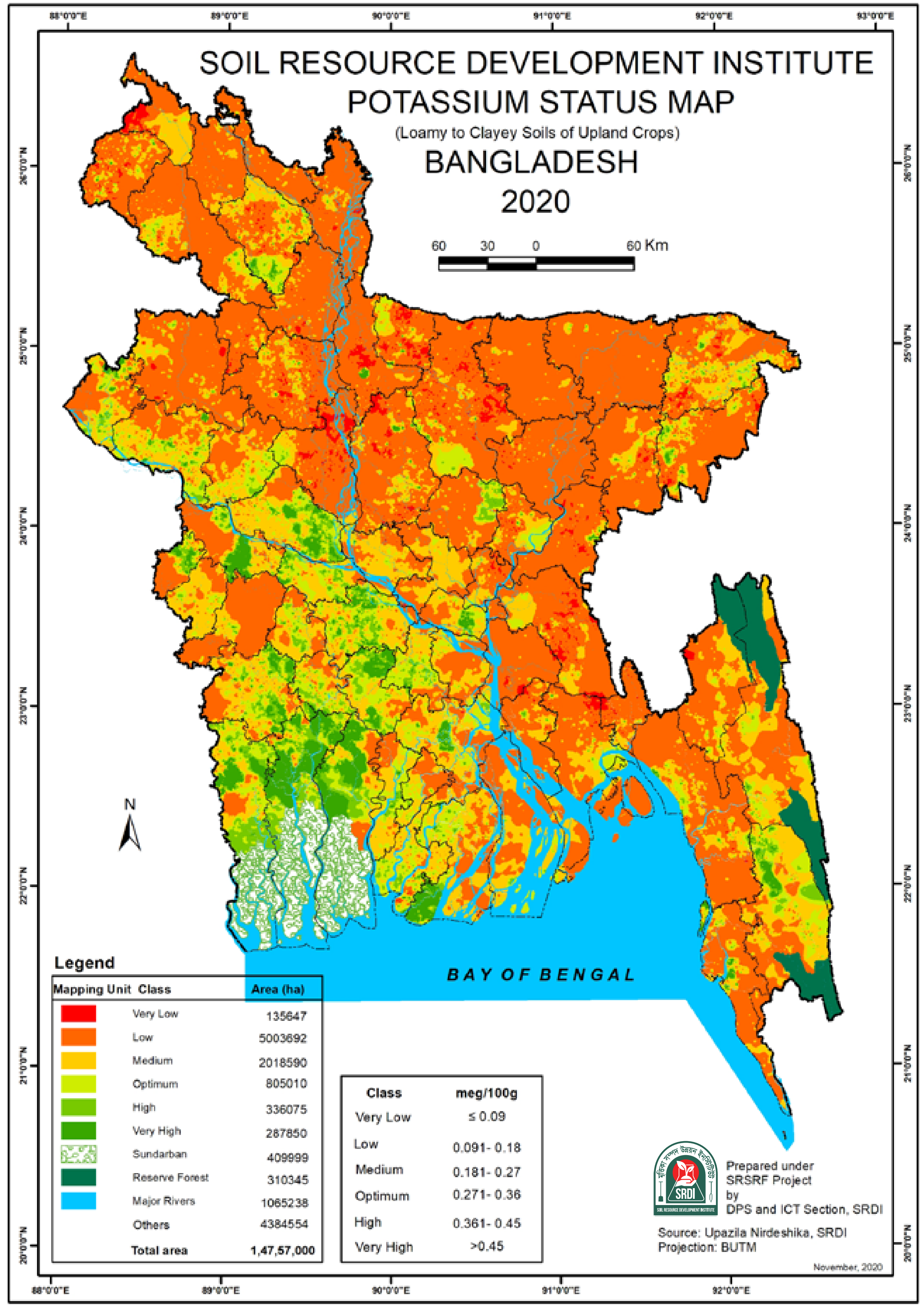

Fig. 10 Potassium Status Map for Loamy to Clayey Soils of Upland Crops, Year 2020.

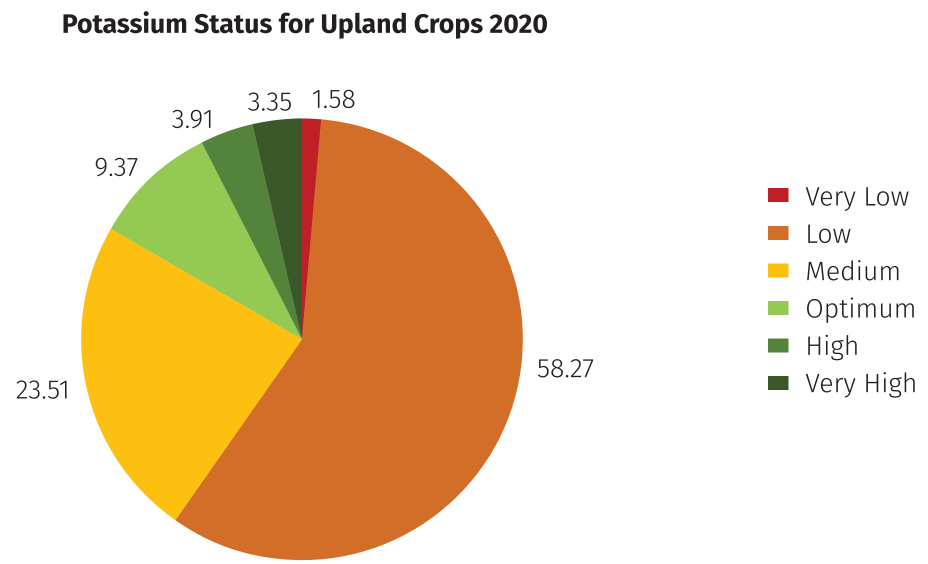

Fig. 11 Potassium status (% of arable lands) under different fertility class for loamy to clayey soils of upland crops.

Table 5 Potassium status (area and percentage of arable lands) under different fertility class for loamy to clayey soils of upland crops

Fertility Class	**Area (Ha)**	**Percentage of arable land**
Very Low to Low	5139339	59.85
Medium	2018590	23.51
Optimum	805010	9.37
High to Very High	623925	7.27
Total	8586864	100.00

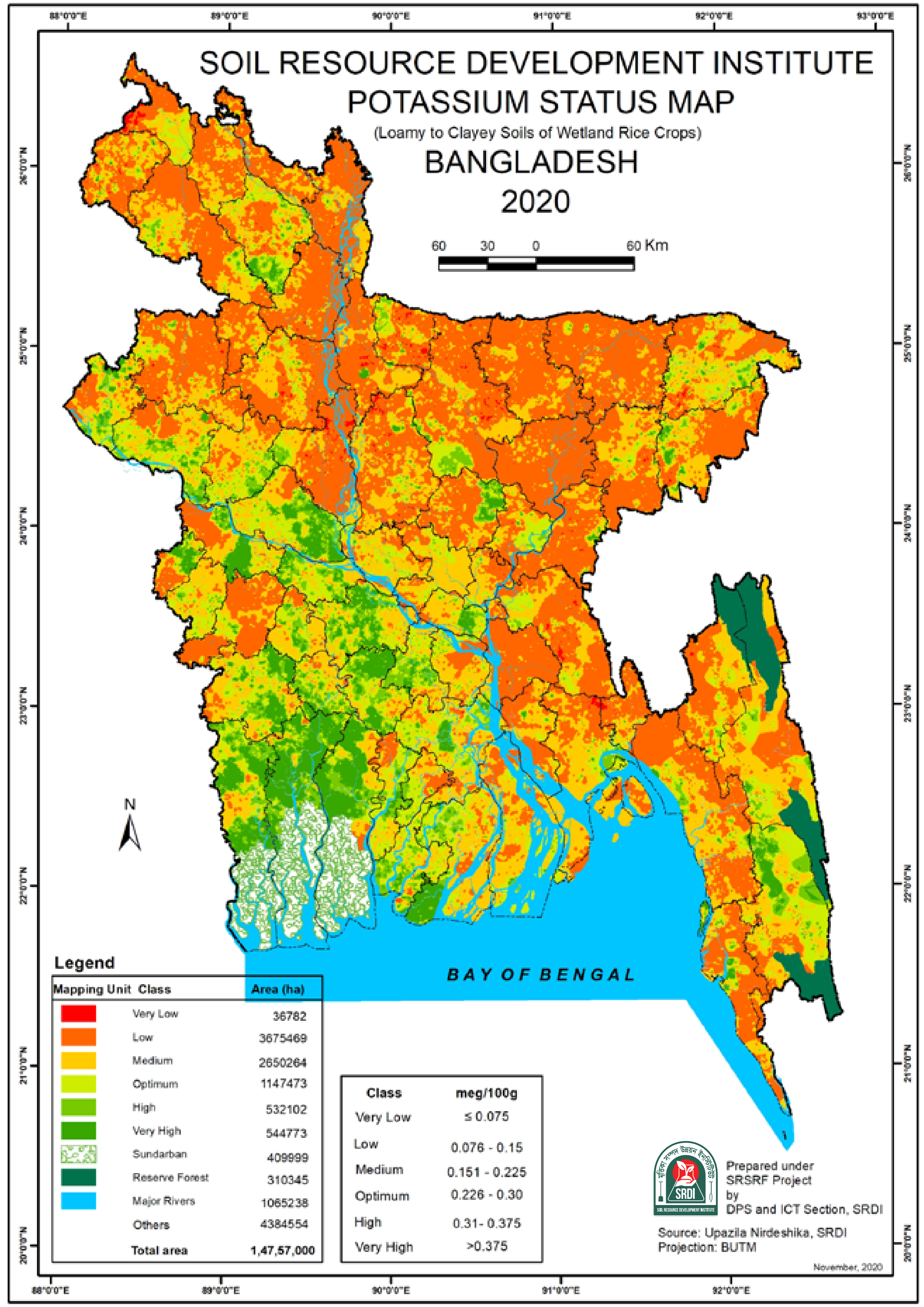

Fig. 12 Potassium Status Map for Loamy to Clayey Soils of Wetland Rice Crops, Year 2020.

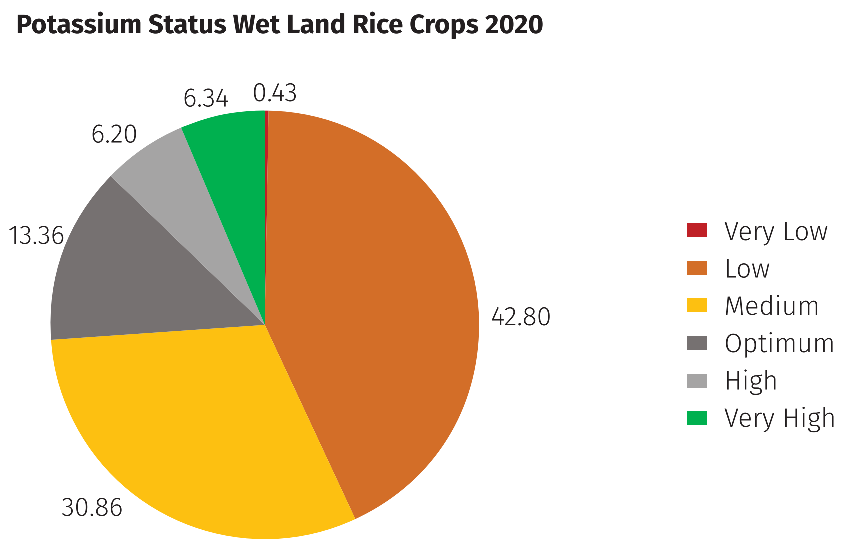

Fig. 13 Potassium status (% of arable lands) under different fertility class for loamy to clayey soils of wetland rice crops.

Table 6 Potassium status (area and percentage of arable lands) under different fertility class for loamy to clayey soils of wetland rice crops

Fertility Class	Area (Ha)	Percentage of arable land
Very Low to Low	3712252	43.23
Medium	2650264	30.87
Optimum	1147473	13.36
High to Very High	1076875	12.54
Total	8586864	100.00

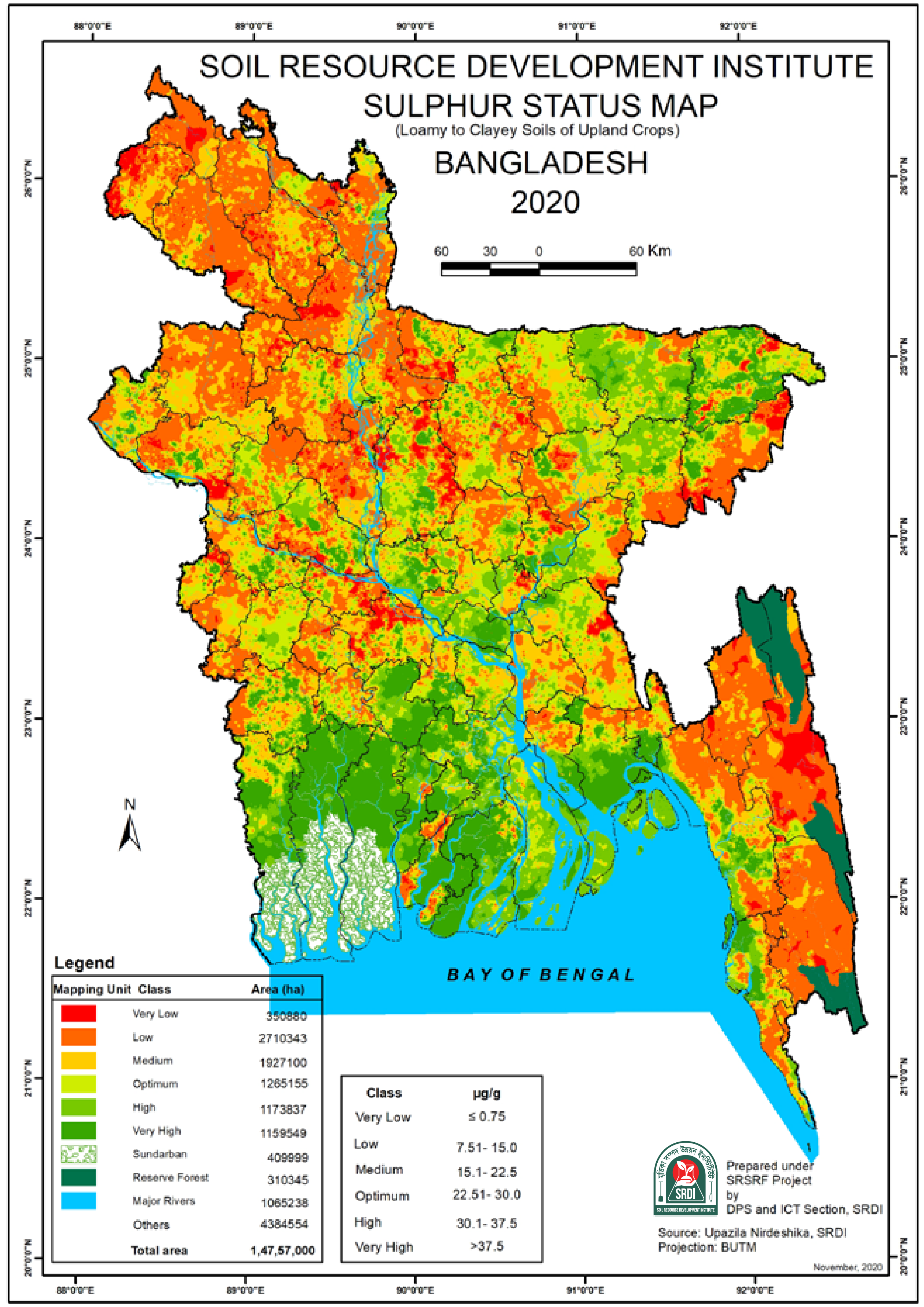

Fig. 14 Sulphur Status Map for Loamy to Clayey Soils of Upland Crops, Year 2020.

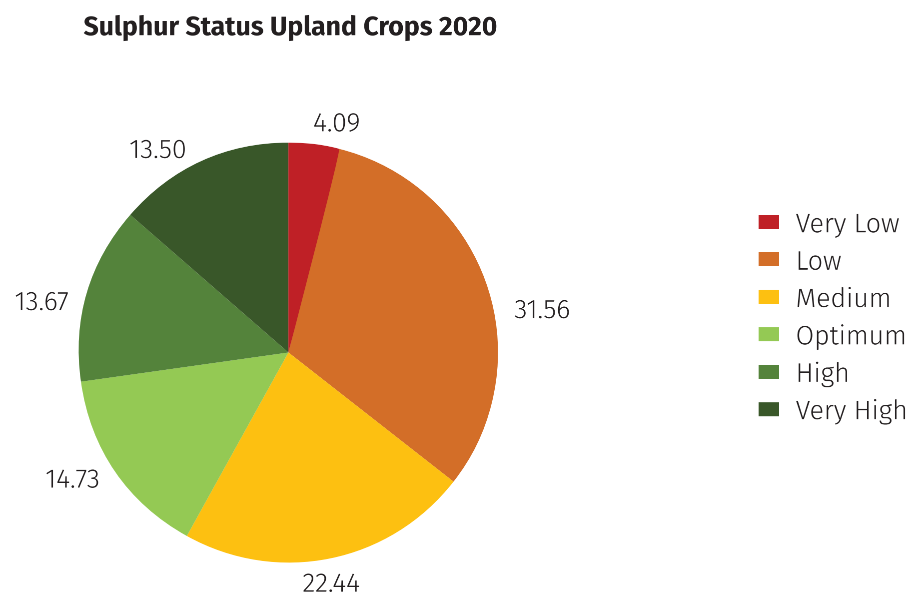

Fig. 15 Sulphur status (% of arable lands) under different fertility class for loamy to clayey soils of upland crops.

Table 7 Sulphur status (area and percentage of arable lands) under different fertility class for loamy to clayey soils of upland crops

Fertility Class	**Area (Ha)**	**Percentage of arable land**
Very Low to Low	3061223	35.66
Medium	1927100	22.44
Optimum	1265155	14.73
High to Very High	2333386	27.17
Total	8586864	100.00

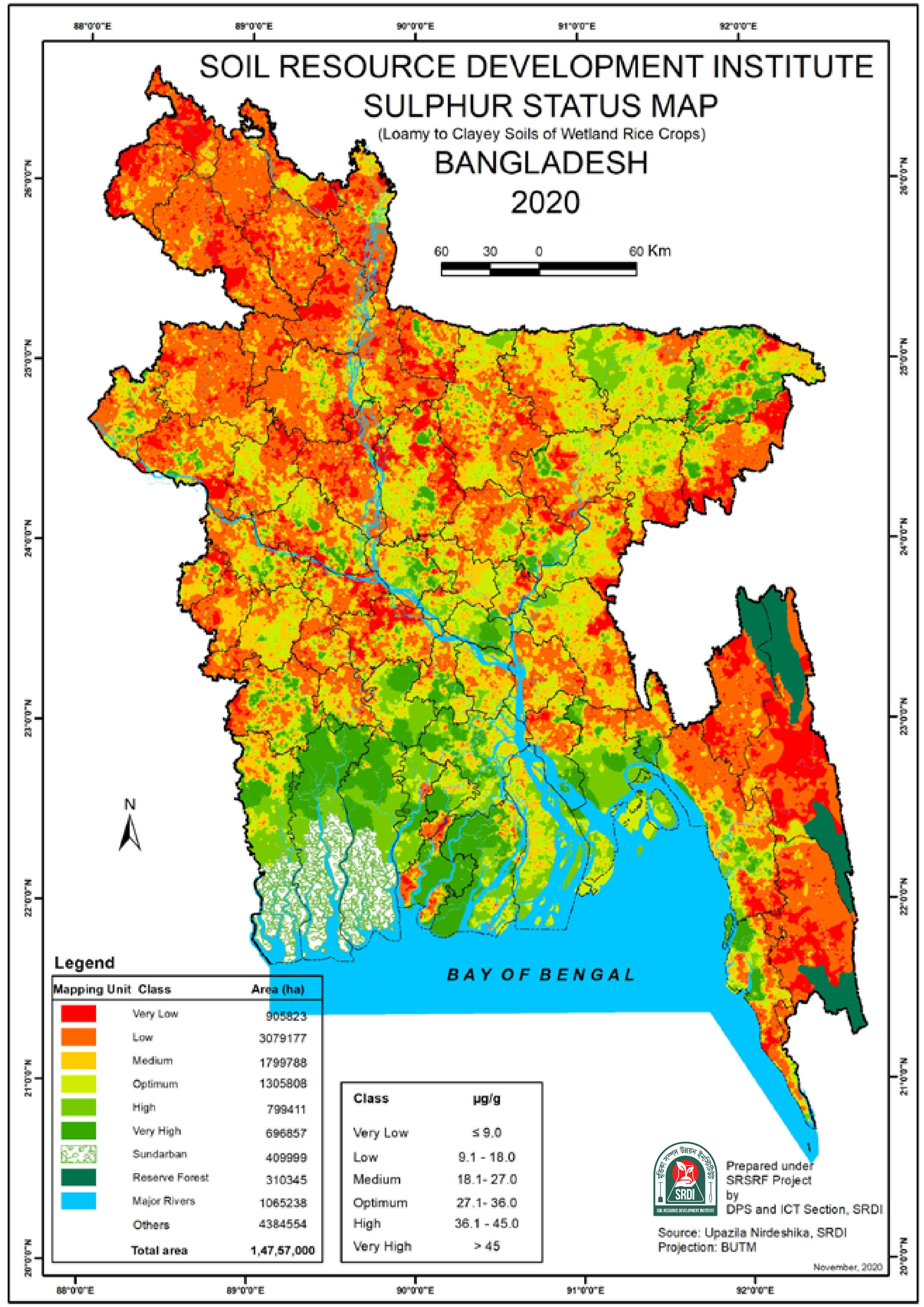

Fig. 16 Sulphur Status Map for Loamy to Clayey Soils of Wetland Rice Crops, Year 2020.

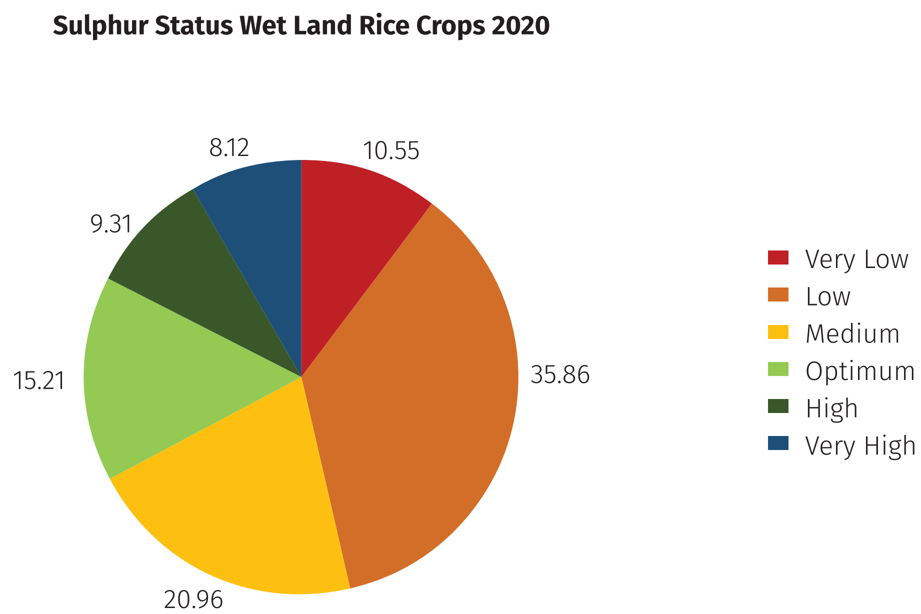

Fig. 17 Sulphur status (% of arable lands) under different fertility class for loamy to clayey soils of wetland rice crops.

Table 8 Sulphur status (area and percentage of arable lands) under different fertility class for loamy to clayey soils of wetland rice crops

Fertility Class	Area (Ha)	Percentage of arable land
Very Low to Low	3985000	46.41
Medium	1799788	20.96
Optimum	1305808	15.21
High to Very High	1496268	17.43
Total	8586864	100.00

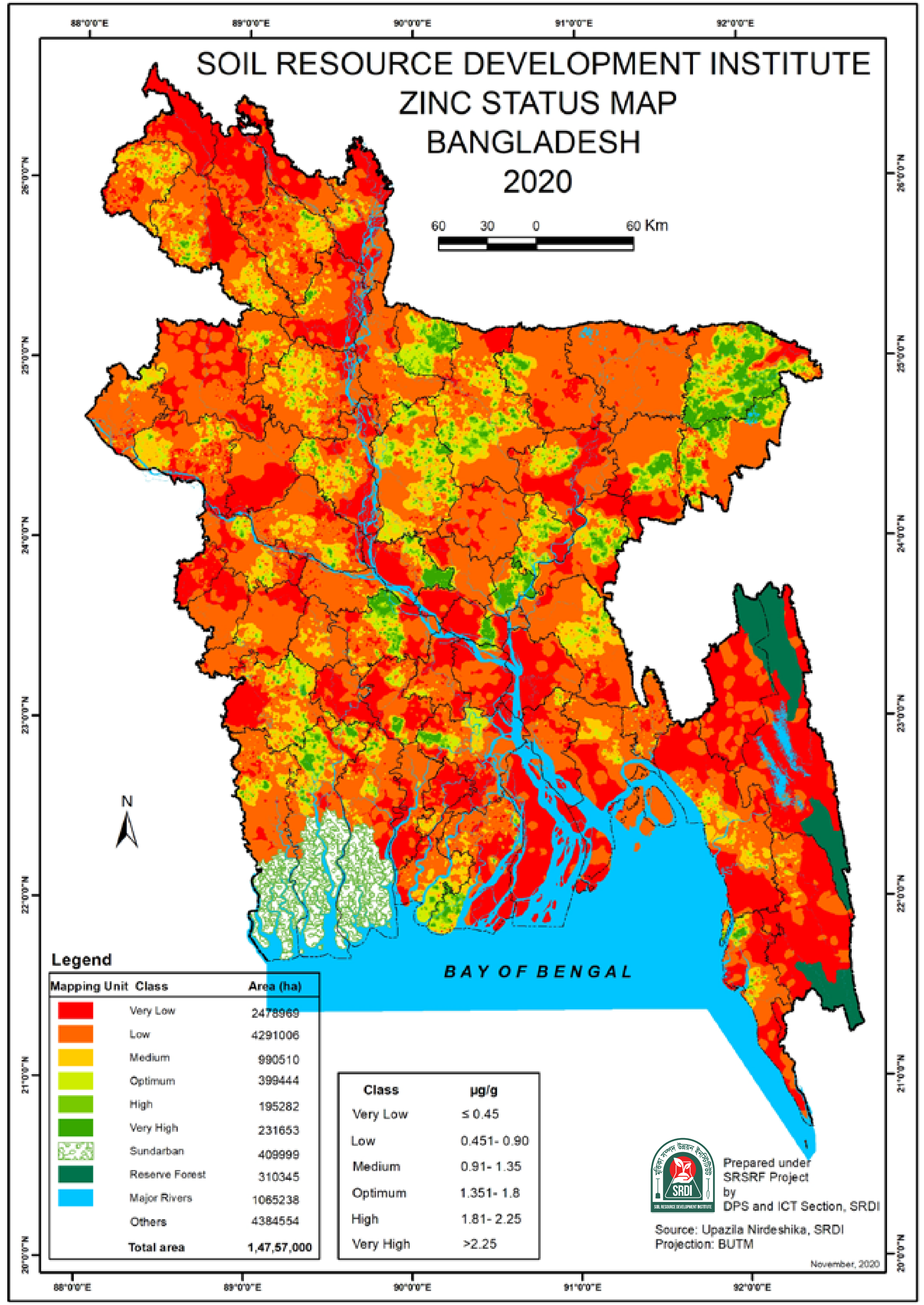

Fig. 18 Zinc Status Map, Year 2020.

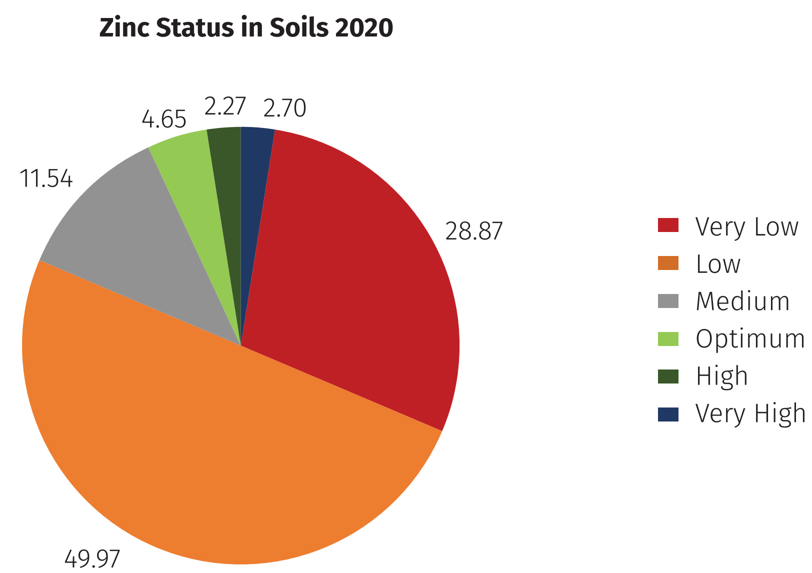

Fig. 19 Zinc status (area and percentage of arable lands) under different fertility class.

Table 9 Zinc status (area and percentage of arable lands) under different fertility class

Fertility Class	Area (Ha)	Percentage of arable land
Very Low to Low	6769975	78.84
Medium	990510	11.54
Optimum	399444	4.65
High to Very High	426935	4.97
Total	8586864	100.00

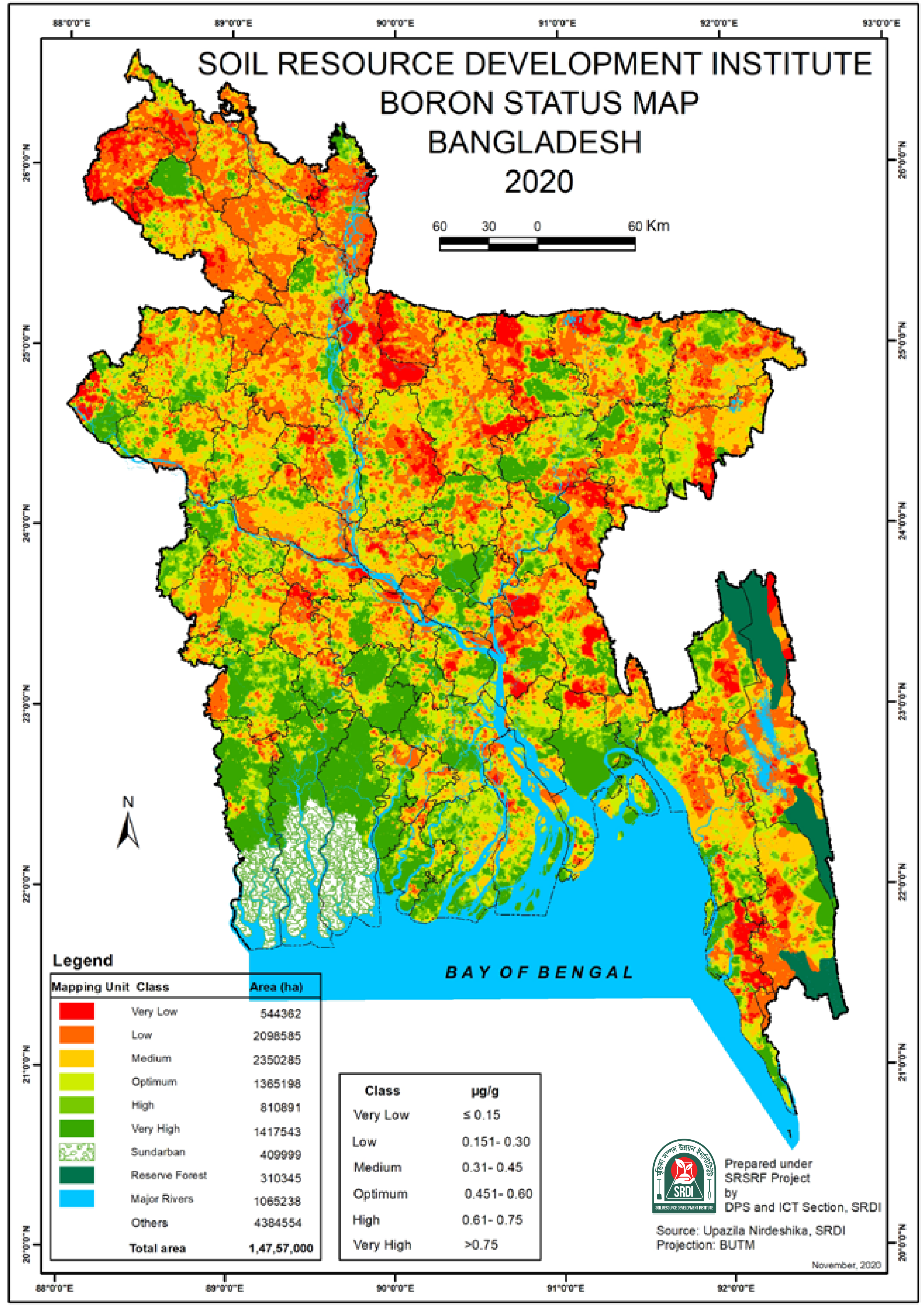

Fig. 20 Boron Status Map, Year 2020.

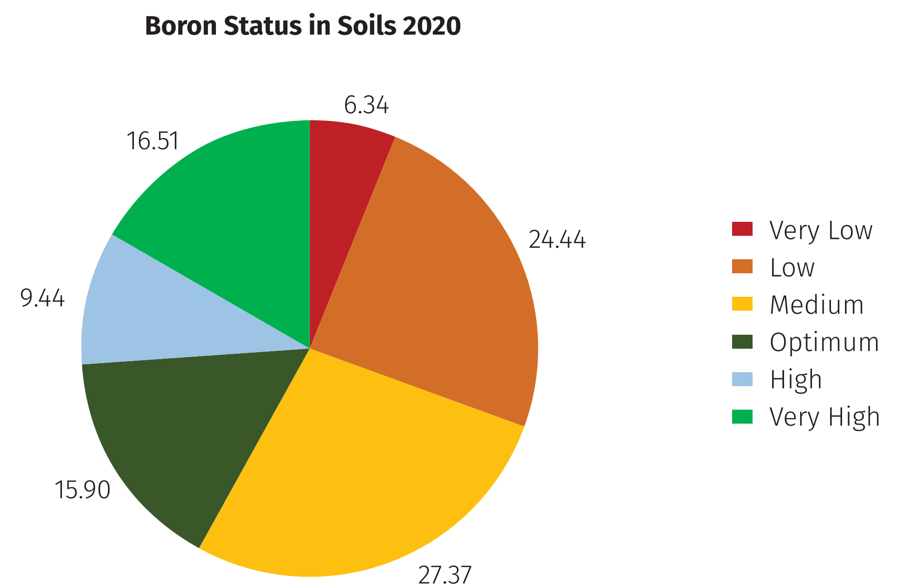

Fig. 21 Boron status (area and percentage of arable lands) under different fertility class.

Table 10 Boron status (area and percentage of arable lands) under different fertility class

Fertility Class	Area (Ha)	Percentage of arable land
Very Low to Low	2642975	30.78
Medium	2350285	27.37
Optimum	1365198	15.90
High to Very High	2228434	25.95
Total	8586864	100.00

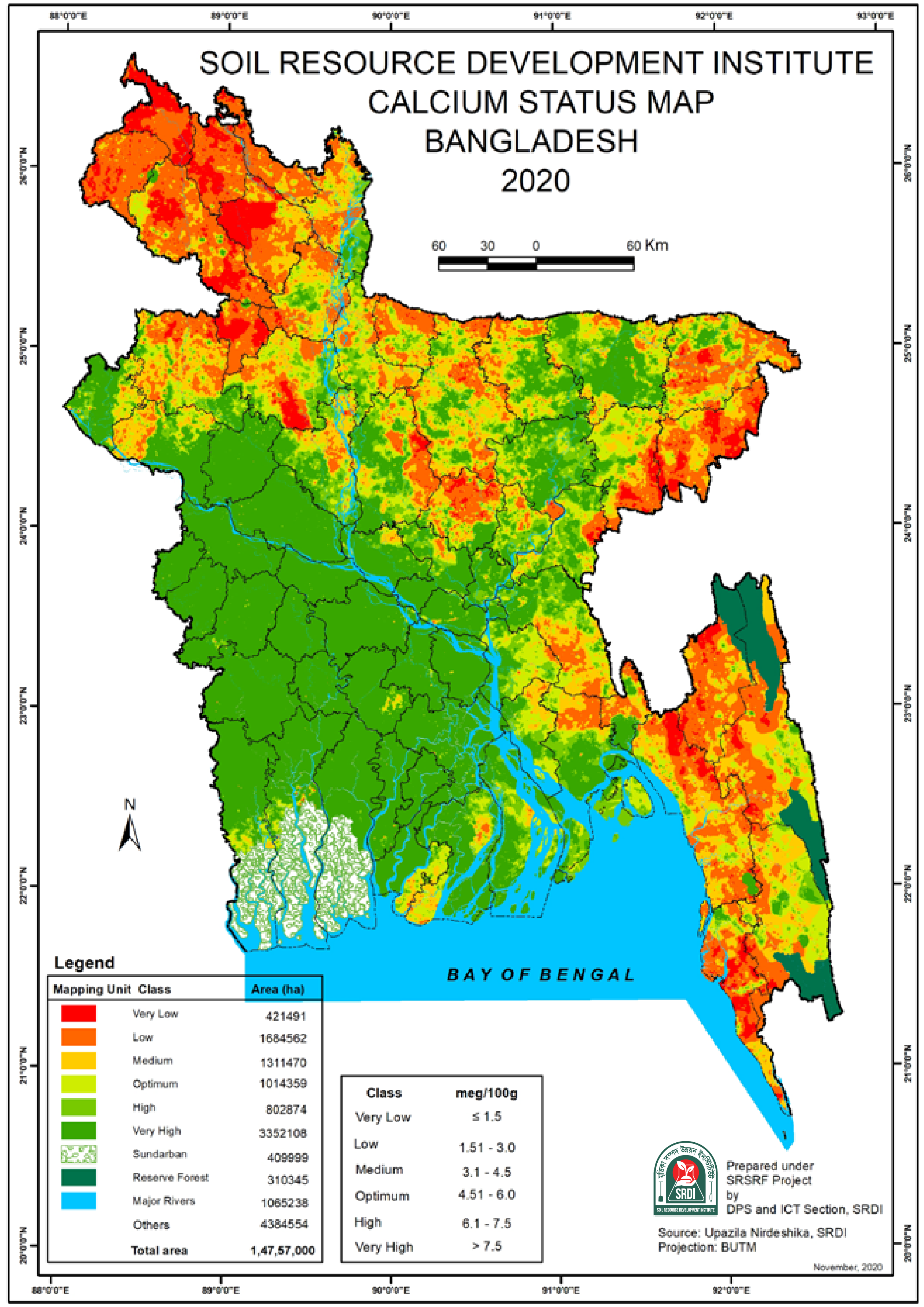

Fig. 22 Calcium Status Map, Year 2020.

Calcium Status in Soils 2020

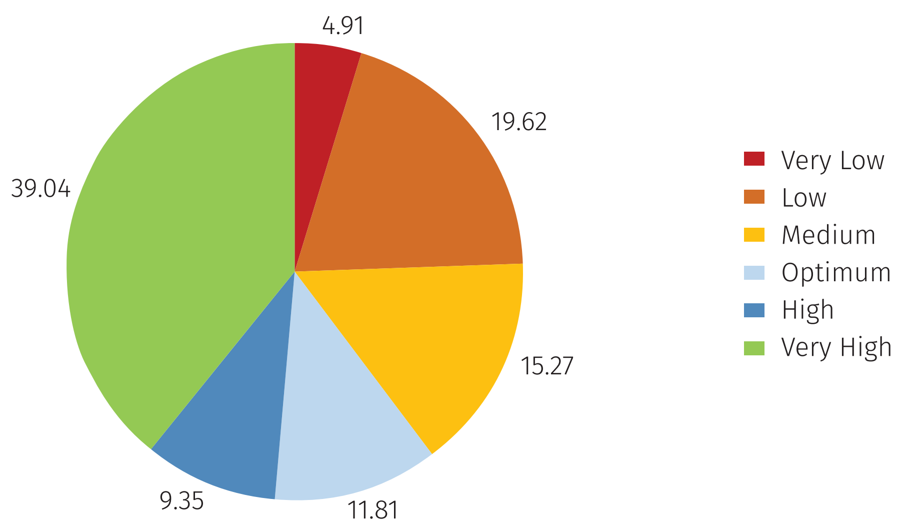

Fig. 23 Calcium status (area and percentage of arable lands) under different fertility class.

Table 10 Calcium status (area and percentage of arable lands) under different fertility class

Fertility Class	Area (Ha)	Percentage of arable land
Very Low to Low	2106053	24.53
Medium	1311470	15.27
Optimum	1014359	11.81
High to Very High	4154982	48.39
Total	8586864	100.00

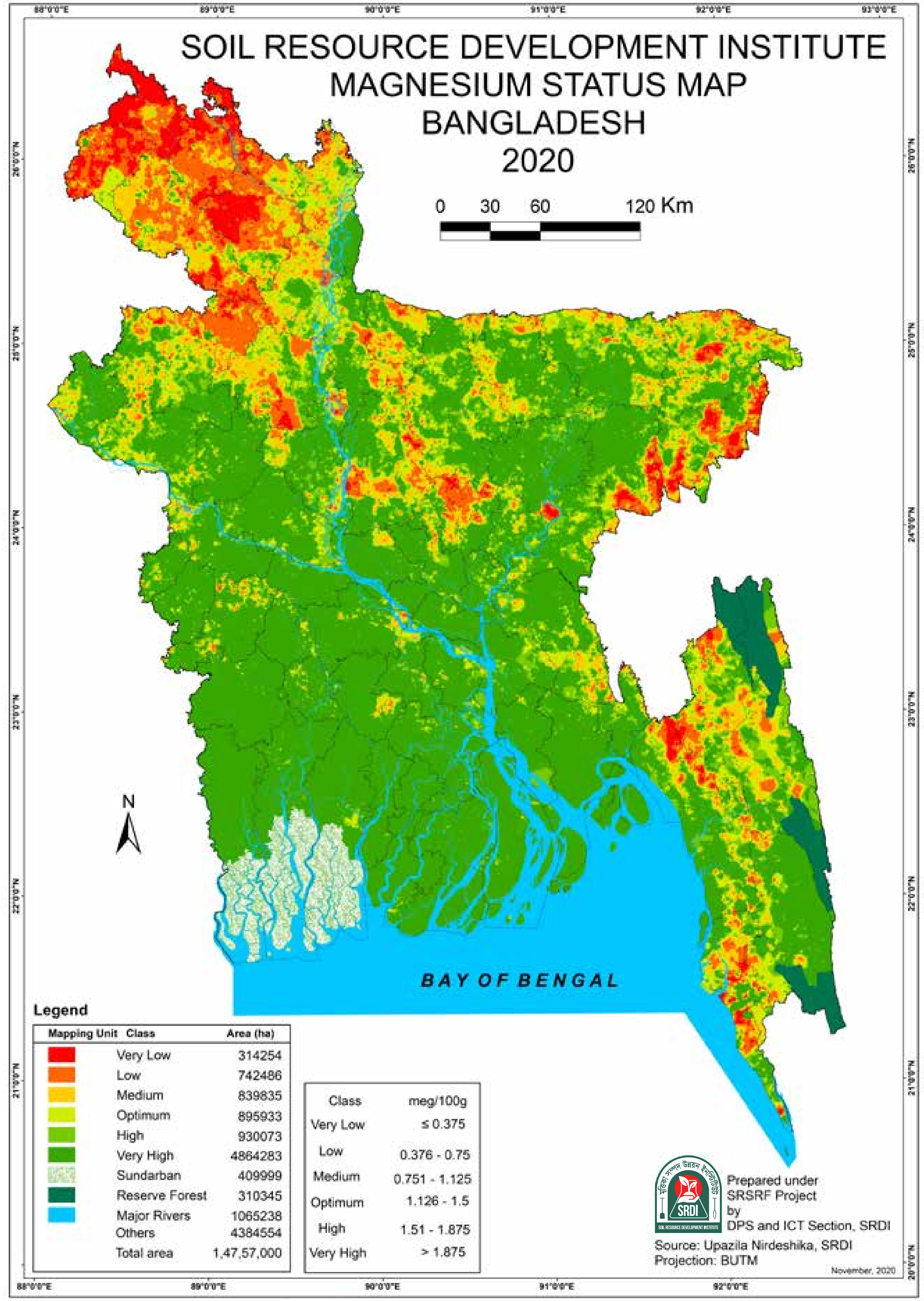

Fig. 24 Magnesium Status Map, Year 2020.

Magnesium Status in Soils 2020

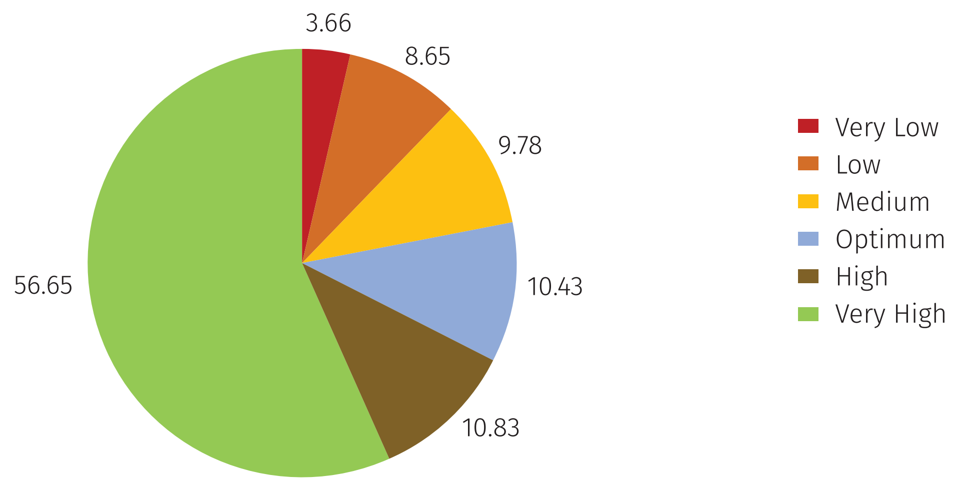

Fig. 25 Magnesium status (area and percentage of arable lands) under different fertility class.

Table 10 Magnesium status (area and percentage of arable lands) under different fertility class

Fertility Class	Area (Ha)	Percentage of arable land
Very Low to Low	1056740	12.31
Medium	839835	9.78
Optimum	895933	10.43
High to Very High	5794356	67.48
Total	8586864	100.00