History of Soil Research in Bangladesh

2

On the basis of the report of the Famine Commission of 1901, set up by the Viceroy Lord Curzon, research in agriculture was initiated in what was then called Bengal around the beginning of the nineteenth century. Agricultural Research Laboratories and an experimental station at the periphery of Dhaka were established in 1905 when Dhaka was the capital of East Bengal and Assam. It is thus assumed that soil investigation in this part of British India started around 1905. Soil science as an academic discipline and as a strong arm of the process of agricultural development had its humble beginning during the early 1940s. During the British India period research on soils was carried out in the chemistry department of the University of Dhaka and in the agricultural chemistry section of the Agricultural Research Laboratory under the Directorate of Agriculture of Bengal. At the University of Dhaka, research on soils was initiated by Professor and later Sir G. C. Ghosh under the chemistry department with the occasional grant from the Imperial Council of Agricultural Research as part of different research projects. Students could carry out research in soil-related problems for their MSc degrees in chemistry. At a later stage soil science was included as one of the fourth papers for the BSc (Honors) examination in chemistry. By 1938, the University of Dhaka had a number of famous soil scientists including Dr. P. K. Dey, Dr. S. P. Roy Chowdhury, Dr. M. O. Ghani, Dr. A. T. Sen, Dr. J. N. Chakraborty, and Dr. T. P. Banerjee as teachers, and Dr. B. C. Dev, Dr. M. Sulaiman, and Dr. M. K. Mukherjee as doctoral research students (Islam 1995).

Many fundamental contributions to the development of soil science were made by the University of Dhaka. Some of these contributions include N_2 fixation by BGA in paddy fields, biochemistry of water-logged soils, red lateritic soils of India, methods for dispersion of soils for mechanical analysis, base exchange, phosphate fixation, clay colloids, and the like. The flourishing condition of soil investigation work at the University of Dhaka continued up to 1947, when after the partition of India, senior Hindu teachers left the country and teaching and research in soil science in the chemistry department met a serious setback.

An important development during the early Pakistan period was the creation of the Department of Soil Science at the University of Dhaka in 1949 at the initiative of Dr. M. O. Ghani who was serving as agricultural chemist to the government of what was then East Pakistan. The department soon became one of the major departments of the university and students were admitted to 2-year BSc and 2-year MSc courses. At that time this was the only full-fledged department of soil science in any university in the whole Indian subcontinent. The 3-year BSc (Honors) and 1-year MSc courses started in 1963. Most of the soil-related activities in Bangladesh (then East Pakistan) until the 1963 creation of a soil science department at the Agricultural University have been contributed by the soil scientists produced from the Department of Soil Science of the University of Dhaka. Later on, since the independence of the country, in addition to the creation of a few agricultural universities, a number of general universities opened their own departments of soil science. Most of the soil-related research carried out in the university departments, particularly at the University of Dhaka, pertained to basic and quasi-basic activities. The Department of Soil Science at the University of Dhaka was renamed the Department of Soil, Water and Environment in 2000.

The research in isolated soil units that was being carried out for a long time as mentioned earlier was mainly concerned with soil fertility and took a soil chemistry perspective. Scientific attempts to study Bangladesh soils from the pedological aspects were initiated by the middle of the last century. The history of soil genesis, soil morphology, and soil classification in Bangladesh is not very old. The legacy data on soil profiles may only be 50 years old. The main driving force for a systematic study of the country's soils was to understand the properties of soils in order to enhance their agricultural productivity to cater to the needs of the ever-expanding population with a very limited land resource. Basic information on the soils of the country was lacking in the initial stage that made the possibility of a natural classification of the soils difficult. At different times several authors attempted

S. M. I. Huq and J. U. M. Shoaib, *The Soils of Bangladesh*, World Soils Book Series 1,
DOI: 10.1007/978-94-007-1128-0_2,

classification of the country's soils on the basis of pedogenic factors that were basically technical systems. The real beginning of systematic collection of soil information was initiated in the 1960s with the Soil Survey Project of Pakistan, the predecessor of the present Soil Resource Development Institute (SRDI) of Bangladesh. The Department of Soil Survey was established in 1961 as a project under FAO/UNDP and the government of Pakistan to carry out a reconnaissance soil survey of the country. The follow-up activities of the project were continued by the Central Soil Research Institute from 1969. After the emergence of Bangladesh, the project was named the Department of Soil Survey under the Ministry of Agriculture and in 1983 the government reorganized and expanded this department into a full-fledged institution and named it the Soil Resources Development Institute (SRDI). This institute, however, is not a research institute as such but a service-oriented organization. The project activities of the Department of Soil Survey expanded to include the interpretation of soil survey data to answer the needs of various users and to study certain field properties of soils required to characterize soil behavior more precisely. The reconnaissance soil survey was completed in 1975 and from 1975 onwards, detailed soil surveys have been carried out by SRDI for various clients.

Islam and Islam (1956) first tried a technical classification of the soils of this country and attempted to describe the landscape and soils by dividing the country into seven soil tracts without much field investigation. This classification scheme was subsequently known as the seven soil tracts system of classification, the basis of which was the physiographic condition and also the geological origin of the parent materials of the soil tracts. In the case of coastal soils, their chemical characteristics were taken into consideration. The seven soil tracts are as follows (the details of these tracts are described in Chap. 8).

1. Madhupur tract
2. Barind tract
3. Tista silt
4. Brahmaputra alluvium
5. Gangetic alluvium
6. Coastal saline tract
7. Chittagong hill tract

As per this classification, the Pleistocene terraces have been divided into two tracts (Madhupur and Barind) even though their materials are the same and lie mostly above the flood level. The floodplains have been divided into four tracts based on the rivers from which the materials were derived. The sediments of the Ganges River are calcareous, whereas those of the other three rivers are noncalcareous. The coastal saline tract is tidally affected and the soils are saline. This classification is a very simple and generalized one and for the first time depicted the general distribution of the soil tracts of Bangladesh that could be understood even by a nonsoil scientist. It was, however, not a natural system of classification inasmuch as it was based on pedogenic factors such as parent materials and physiography and not on soil properties. This classification scheme has been a good attempt to classify the soils of Bangladesh when practically no information on the country's soils was available (Hussain et al. 2003).

To assess the efficiency of precipitation for biological activity and soil leaching by taking into account the evaporative power of the air as measured by the evaporation from free water surface or by the atmospheric deficiency in humidity, Karim and Hossain (1957) calculated some climatic indices for the country and came out with pedoclimatic zones of Bangladesh. These are: (a) humid, (b) semi-humid, and (c) feebly arid. It was considered that climate is the most active pedogenic factor. A pedoclimatic zone was defined as representing an area where the climatic factor working on parent material has produced similar soils. The introduction of the climatic zonality concept was a new approach in distinguishing the different pedoclimatic zones occurring in the country. The division into pedoclimatic zones was an attempt to predict the probable occurrence of soils; this zoning could be compared to the much-used agroclimatic zones (Karim and Hussain 1957).

Albeit having many shortcomings, this classification was a serious scientific attempt for the delineation of the pedoclimatic regions of the country; the inherent ideas of this classification served a very useful purpose when very little field information was available (see Fig. 2.1).

Considering the fact that most of the soils in this country are relatively young and their properties are largely influenced by the nature of the parent materials and drainage conditions, in 1964 Brammer emphasized that knowledge of geomorphology of Bangladesh is essential for a proper understanding of the nature and distribution of the soils. Accordingly, on the basis of three distinct sediments—Tertiary, Pleistocene, and Holocene—that occur in Bangladesh, Brammer (1964) divided the country into 15 physiographic units and described the properties of each in relation to the soils that have formed on them. Each physiographic unit contains certain well-defined soils. As such, this division has been considered a soil classification for the country. The units are as follows.

1. *Consolidated Tertiary Rocks*
   (a) Chittagong and Tippera Hills;
   (b) Shillong plateau margins.
2. *Unconsolidated Tertiary and Pleistocene Sediments*
   (a) Mainly coarse-textured sediments
      (i) Low western ridges of Chittagong Tripura Hills;
      (ii) Lalmai Hills;

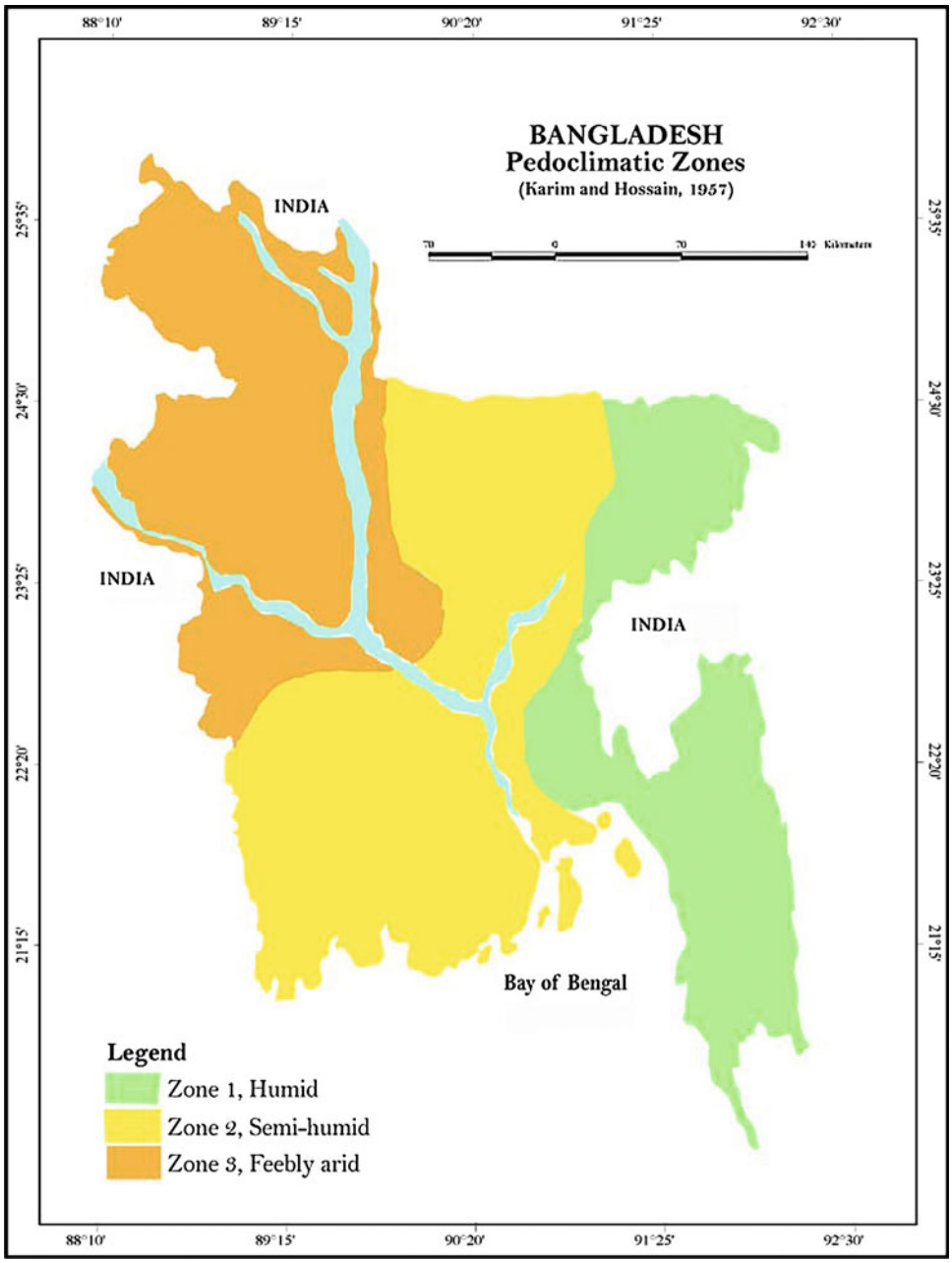

Fig. 2.1 Pedoclimatic zones of Bangladesh (*Source* SRDI)

(iii) Sylhet and Chattak Tillas;
(iv) Shillong Plateau Piedmont Hills.

(b) Mainly fine-textured sediments
(i) Madhupur Jungle Tract;
(ii) Barind Tract.

3. *Recent Alluvial Deposits*
(a) Himalayan piedmont alluvial plain;
(b) Tippera surface;
(c) Moribund Ganges delta;
(d) Recent deltaic flood plain;
(e) Sylhet basin;
(f) Coastal saline zone;
(g) Tidal mangrove swamp.

- This classification is in fact an elaborative version of the seven soil tract classification system. However, the introduction of a few new names made it a newer classification. Like the previous classifications, this classification also focused limited attention on soil properties. The information on land and soils of Bangladesh published from 1956 to 1964 were of no significance in practical use because these were produced without much field investigation. Systematic generation of primary data regarding land and soil resources started during the early 1960s by undertaking the Reconnaissance Soil Survey (RSS) program under the Soil Survey Project of the then East Pakistan with

the active cooperation of the FAO. The information contained in the RSS reports, a comprehensive classification of Bangladesh soils was carried out by Brammer in 1971. Through this descriptive classification, the classification of the soils in Bangladesh was made understandable to the layman. Brammer called it the General Soil Type (GST) system of classification (FAO 1971). A GST was defined as a "group of soils formed in the same way and having a broadly similar appearance."

- The RSS was based on intensive aerial photo interpretation followed by field examination of soils made along planned traverses across the landscapes. A total of 465 soil series (taxonomic units) were identified, described, and classified particularly for the agroservice purpose through the RSS from 1965 to 1976. Soil series were identified on the basis of differentiating characteristics such as texture, nature of the horizon developed, soil reaction, and consistency, among others. The physical and chemical properties of 465 soil series were determined in the laboratory and all the analytical results were subsequently published in 33 RSS reports. Soils were mapped at the scale of 1:125,000 in terms of geographical associations or complexes of soil series and phases. A total of 1,034 soil associations (groups of soils that occur together within part or all of a physiographic unit or subunit) were mapped. The smallest soil series has an area of only 11 ha and the largest one has an area of 486,493 ha. The average area of a soil series is 23,989 ha. The total covered area in the RSS was 11,466,913 ha. Forests occupying 15 % of the land in Bangladesh have not been covered by RSS. The RSS in Bangladesh successfully filled the vacuum that had existed for a long time. Through the RSS people could get first-hand information about the soils of Bangladesh. Through their characterization in soil taxonomy, everybody could have some knowledge of the nature of Bangladesh soils. Some basic soil properties such as their morphological, physical, and chemical properties were made available (Imamul Huq and Hoque 2012).
- The GST system offers a single category of 21 soil types with no higher or lower category. Originally 17 GSTs were proposed but the number was increased to 21 in a subsequent revision (FAO-UNDP 1988; see Chap. 5). The information contained in the RSS reports was utilized in making the AEZ map of Bangladesh (FAO-UNDP 1988). Soils (taxonomic units) were classified according to two international soil classification systems: the US soil taxonomy and the FAO-UNESCO legend based on RSS data. RSS-based information has been used as the baseline data to conduct the semi-detailed soil survey of the country from 1986 to 2001 and the publication of the *Land and Soil Resource Utilization Guide* for upazilas (subdistricts) of the country.
- FAO-UNDP developed a General Soil Map on the basis of Brammer's classification at the time of making a "Land Resource Appraisal for Agricultural Development of Bangladesh" in 1988. This map is shown in Fig. 2.2.

Later in 1997 SRDI developed another General Soil Map of the country on the basis of RSS data and further field verification (See Fig. 2.3). For details see Chap. 5.

The land resources appraisal (LRA) for agricultural development in the country was published in 1988 (FAO-UNDP 1988). Based on the RSS data on land types and soils, physiography, and climate, a database for the land resource appraisal was prepared with the objectives (a) to compile a national computerized land resources database; (b) to develop and establish a computerized land and climate resources appraisal system; (c) to differentiate and delineate agroecological regions (see Chap. 3); (d) to assess the crop production potential of the land and climate resources under rain-fed conditions; and (e) to make the land resources database and crop suitability assessments available to agricultural and forestry researchers and extension and development planners. The LRA has been published in the form of seven reports including an executive summary. The soil series identified through RSS, according to the US soil taxonomy, comfortably fit into five orders, including: Inceptisols, Entisols, Ultisols, Histosols, and Mollisols. There were 12 suborders, 21 great groups, and 56 subgroups in this country (Hussain 1992). According to the FAO-UNESCO soil classification system, the soil series identified through RSS has been categorized mainly into 35 FAO-UNESCO soil units. These occur mainly as Fluvisols, Gleysols, Leptosol, Arenosol, Cambisol, Luvisol, Planosol, Alfisol, Histosol, and Anthrosol. The soils of Bangladesh have never been classified at the "Family Level."

Although RSS was conducted to generate land and soil data for agroservice purpose, the use of these data was limited only to planners and researchers. RSS data could not be widely used at the farmers' level. Considering this issue, Soil Resource Development Institute (SRDI) undertook the program of a semi-detailed soil survey particularly to publish the *Land and Soil Resources Utilization Guide* for different upazilas of the country in 1985. Through the semi-detailed soil survey a huge database of information on land and soil resources of the individual upazilas was collected, soils were mapped at the scale of 1:50,000 and grouped in terms of their similarities in physicochemical properties and physiographic and AEZ-based distribution. About 50,000 topsoil samples collected for 324 soil groups during the semi-detailed soil survey were analyzed in the laboratory to

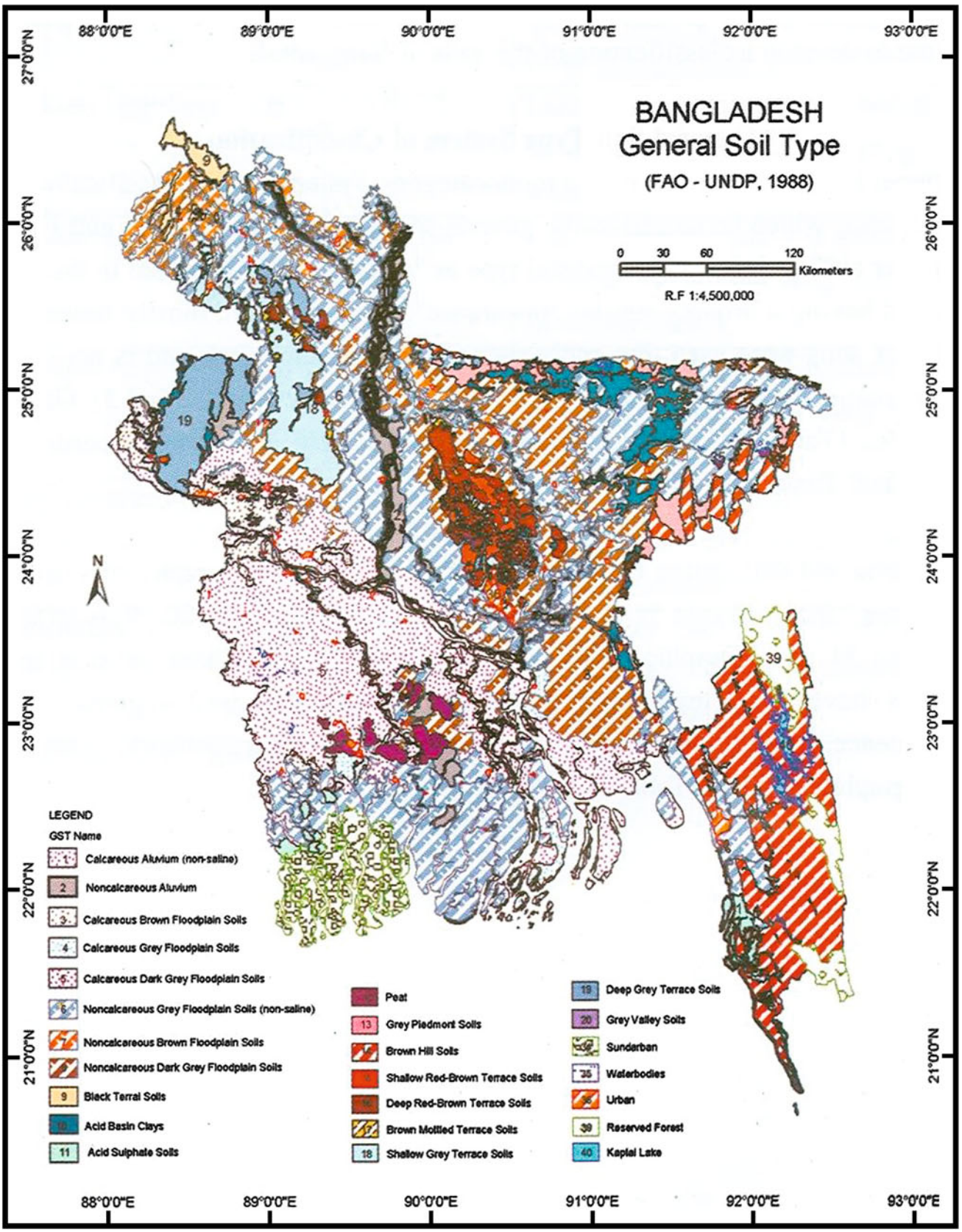

Fig. 2.2 General soil map of Bangladesh done in 1988 (*Source* SRDI)

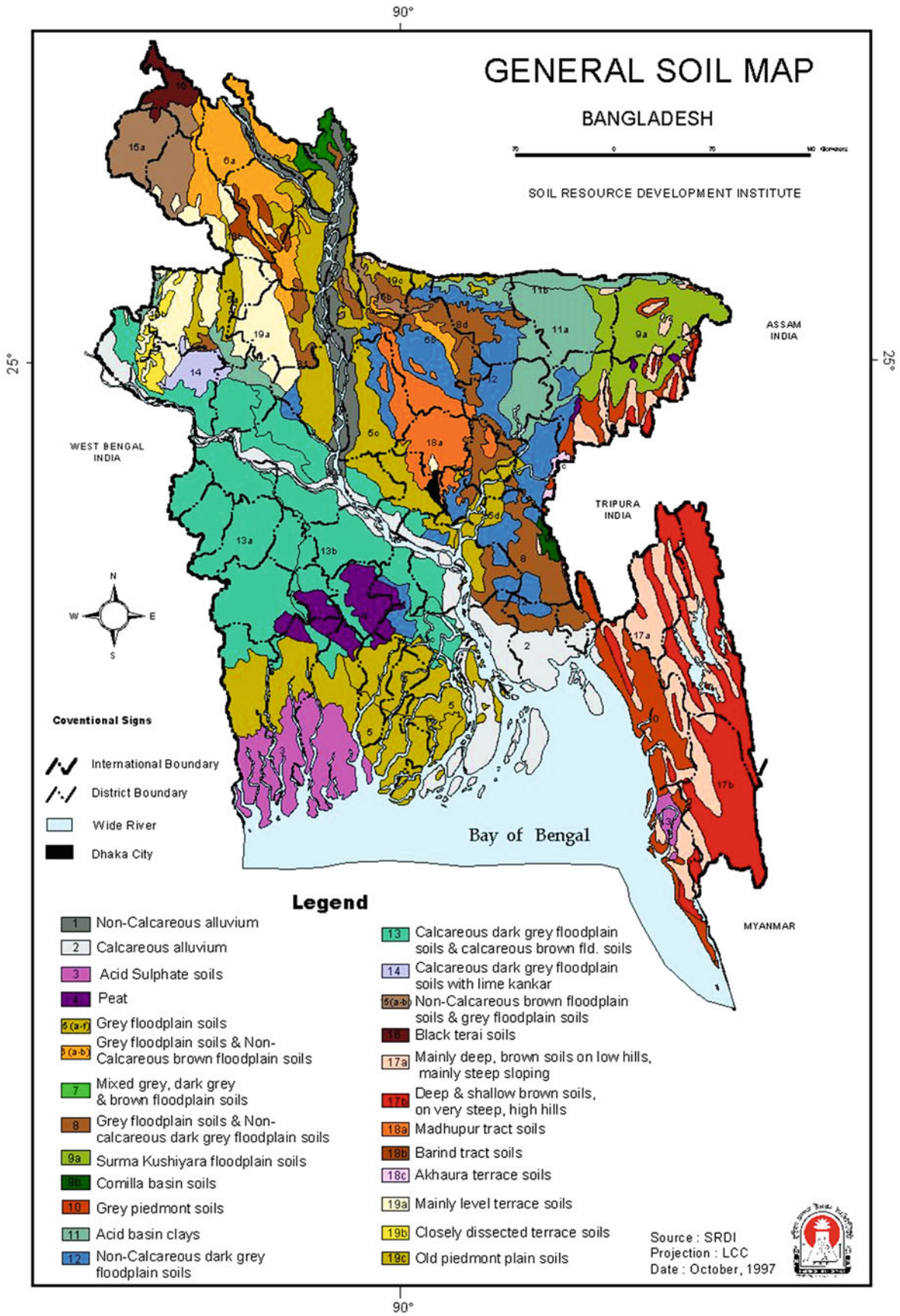

Fig. 2.3 General soil of Bangladesh done in 1997 (*Source* SRDI)

determine their physicochemical properties. All these data thus generated concerning land quality and soil characteristics have been converted to digital format using GIS (Geographic Information System) technology (Imamul Huq and Hoque 2012). The *Land and Soil Resources Utilization Guide* is popularly known as *Upazila Nirdeshika*. This guide has been used for land-use planning, crop-specific fertilizer recommendation, and postdisaster agricultural management.

From 1974 to 1990, SRDI carried out a detailed survey of some experimental farms to generate specific information on soil properties for planning small area-development programs and the location of specific activities. Publication scales for the detailed soil surveys ranged from about 1:5,000–1:10,000. As these surveys were project bound, the use of the information thus generated was limited to the project purposes only (Islam 2003).

It was mentioned earlier that agricultural research laboratories were set up around 1905 in this part of the continent, initiating soil research to improve agricultural production. The earliest records indicate that the investigation into soil fertility on the effect of bone meal and cowdung on Aus rice was initiated in the year 1911 at the farm established in Dhaka. The experiment was popularly known as Birt's experiment and it continued until 1923. The outcome of the experiment indicated substantial yield increases over control. Later, another experiment with bone meal, lime, and green manuring alone and in combination on Aus rice was carried out during 1914–1918 and was known as Basu's experiment. The results of these experiments were not properly analyzed, interpreted, and compiled and thus remained unpublished.

Early investigations into soil fertility from 1931 to 1946 were mostly conducted at the Dhaka farm on Aus and Aman rice with lime, bone meal, rock phosphate, kossiphos, niciphos, diamophos, ammonium sulphate, sulphur, and muriate of potash as well as with bulky organic manures such as green manures, town compost, cow dung, oil cakes, fish manures, bone meal, and so on. The planning and layouts of the experiments were very simple without sufficient replications. However, these experiments provided some very fundamental information on the response of Aus and Aman paddies to soil amendments. These early experiments were extended to different soils of the country with complete soil analyses. More than 400 soil samples were analyzed that provided baseline data for nutrients including N, P, K, Ca, and organic matter. Accordingly, it was made known at the time that the soils of Madhupur Tract were deficient in N,P,K, and lime; Barind Tract soils were deficient in N, P, and lime; and the soils of the Gangetic alluvium were sufficient in K, lime, and organic matter but deficient in N and P.

Between 1953–1954 and 1960–1961, a large number of experiments were conducted to study the comparative efficiencies of different commercial fertilizers, particularly nitrogenous and phosphatic fertilizers on Aus and Aman paddies and winter vegetables. During these periods a series of more complex experiments was performed for balanced nutrient management for paddy, wheat, sugarcane, and vegetables with different combinations of N, P, and K fertilizers as well as combinations of organic and inorganic fertilizers. These experiments were the basis for formulations of different recommendations for these crops. These recommendations were considered unrealistic considering the heterogeneity of the soils. To make the recommendations more realistic, a scheme entitled "Rapid Soil Fertility Survey and Popularization of the Use of Fertilizer in East Pakistan" was implemented in 1957 with 50 experimental centers all over the country. This was later modified and expanded under the name of "East Pakistan Soil Fertility and Soil Testing Institute" in 1963 with 200 experimental centers. The field trials were carried out on farmers' field all over the country and recommendations were made on the basis of the seven soil tracts. This practice continued till 1960. When the soils of Bangladesh were later classified into 17 general soil types, it was felt necessary that fertilizer recommendations be made for these general soil types. As a result, as many as 7,105 field trials on different general soil types of Bangladesh were carried out between 1970 and 1974.

With the introduction of HYV or modern varieties of crops as well as introduction of the Boro season of rice cultivation, the field trials were extended to further microlevels. The first fertilizer recommendation guide was published in 1979 by BARC largely on the basis of soil series information and the results of fertilizer trials. Coordinated soil test crop response correlation studies were conducted from 1980 to 1984 by the Bangladesh Institute of Nuclear Agriculture (BINA), Dhaka University (DU), Bangladesh Jute Research Institute (BJRI), Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI), and Bangladesh Agricultural University (BAU). Based on the recommendations of these soil test and crop response studies, in 1985 BARC updated the 1979 fertilizer recommendation guide. The concept of soil testing and yield goals for making fertilizer recommendations was introduced for the first time in Bangladesh. The guide was called *Fertilizer Recommendation Guide for Most Bangladesh Crops*, and as such, considered only a few major crops. Over the years, however, there has been a sharp rise in the use of chemical fertilizers although at the time, fertilizer use efficiency at the farm level was very low. The experts concerned thought it pertinent to update the then-current practices for fertilizer use for different crops

grown in the varied range of environment. Moreover, considerable progress was made on soil fertility research. All the data generated by different national research institutes of the country were collected by BARC and a new revised fertilizer recommendation guide was published in 1989 that included some major features such as (a) the diversity of agroecological regions, (b) major cropping patterns, (c) soil fertility levels, and (d) the resource base of farmers and yield goals. The 1989 guide was further updated in 1997. From 1997 to 2005 considerable progress was made on soil fertility and fertilizer management research and extension by the National Agricultural Research System (NARS) Institutes and the extension department. The 1997 guide was further updated in 2005 to include information on more crops and cropping patterns, updated soil nutrient status of different agroecological zones, nutrient balance status, soil and fertilizer management based on the IPNS concept, fertilizer management in multiple cropping systems, minimum tillage, hill farming, and information on the quality control aspects of fertilizer. This 2005 FRG is again being updated for publication in 2012.

References

Brammer H (1964) An outline of the geology and geomorphology of East Pakistan in relation to soil development. Pakistan J Soil Sci 1:1–23

FAO (1971) Bangladesh: soil resources. AGL:SF/AK 6, Technical Report No. 3, Rome, p 211

FAO-UNDP (1988) Land resources appraisal of Bangladesh for agricultural development. Report 2: Agroecological regions of Bangladesh. Report prepared for the Government of the People's Republic of Bangladesh by the Food and Agriculture Organization of United Nations, United Nations Development Programme. BGD/81/035, Technical Report 2, pp 1–570

Hussain MS (1992) Soil classification with special reference to the soils of Bangladesh. University of Dhaka, Bangladesh, pp 312–367

Hussain MS, Elahi SF, Eswaran H, Uddin MJ, Islam S (2003) Bangladesh: in quest of resource management domains. Publication No. 2. Department of Soil, Water and Environment, University of Dhaka, Dhaka, 1000, Bangladesh (ISBN: 984-32-0707-6), pp 83

Imamul Huq SM, Manzurul Hoque AFM (2012) Land and soil resources database for grass root agricultural development in Bangladesh. Paper presented at the international conference on advancing the science and technology of soil information in Asia—launch of the Global Soil Partnership's Asia Soil Science Network and Global Soil Map.net East Asia Node, Nanjing, China, 8–11 February 2012. Conference Handbook, pp 23–24

Islam A (1995) Review of soil fertility research in Bangladesh. In: Hussain MS, Imamul Huq SM, Anwar Iqbal M, Khan TH (eds) Improving soil management for intensive cropping in the tropics and sub-tropics. Proceedings of the inter-congress conference of commission IV of the ISSS, Bangladesh Agricultural Research Council, Dhaka (pub.), pp 1–18. ISBN: 984-30-0097-8

Islam MA, Islam W (1956) Nutrient status of East Pakistan soils. Directorate of Agriculture, Government of East Pakistan, Dacca, Bulletin No. 1, p 52

Islam MS (2003) Soil resources development institute. In: Islam S, Mia S (eds) Banglapedia—National Encyclopedia of Bangladesh, vol 9. Asiatic Society of Bangladesh, Bangladesh pp 367–368. ISBN: 984-32-0584-7

Karim A, Hossain M (1957) On the single value climatic indices and the pedoclimatic zones of East Pakistan. Orient Geogr 1:145–153

http://www.springer.com/978-94-007-1127-3

The Soils of Bangladesh

Huq, S.M.I.; Shoaib, J.U.M.

2013, XIII, 165 p. 58 illus., 57 illus. in color., Hardcover
ISBN: 978-94-007-1127-3