Research Journal of Earth Sciences 1(1): 01-06, 2009
ISSN 1995-9044

Analysis of the Physical Characteristics of Bris Soil in Coastal Kuala Kemaman, Terengganu

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Abstract: This article discusses the results of the physiographical analysis of BRIS soil in the district of Kuala Kemaman, Terengganu. For the purpose of this study, four different land uses from three *mukims* were chosen. These *mukims* were Kijal, Telok Kalong and Chukai. The main objectives of the study were to classify the soil taken from these land uses and analyse its physical and chemical characteristics and nutrient content. More than 90% of the composition of BRIS soil is sand and the soil is considered practically worthless for agricultural purposes. The study showed that there were two main series of BRIS soil, namely Rudua and Rusila. Using temperature and moisture content as the main variables, it was shown that there was a significant relationship between sand and clay in the composition of the soil of land designated as agricultural (0.822), swamp (0.946) and industrial (0.974). Factors such as depth, drainage and profile development affected the composition of BRIS soil. In the analysis for nutrient content, all the plots where soil analysis was conducted showed the presence of sodium (N), zinc (Zn), iron (Fe), lead (Pb), copper (Cu) and manganese (Mg), albeit in small quantities. To summarise the findings, although BRIS soil is sandy and nutrient deficient, it is possible to improve its quality by means of up-to-date methods.

Key words: BRIS, Soil, Sediment, Soil series

INTRODUCTION

BRIS (Beach Ridges Interspersed with Swales) soil is a problematic soil in Malaysia. It lacks in many aspects. Previous studies [1-3] showed it to be too sandy, weakly structured, nutrient deficient, having low water retention capacity, limited ability to support plant growth and having a relatively high soil temperature. BRIS soil originates from sediment or sand from the sea that accumulated from the erosion of layers of steep cliffs by the sea during the monsoon seasons and has a coarse sand component [4]. As such, BRIS soil is distributed generously along the east coast of Peninsular Malaysia, from Kelantan (17,806.2 hectares), Terengganu (67,582.61 hectares), Pahang (36,017.17 hectares) right down along the coast to the west coast of Johor. The Department of Agriculture of Malaysia has identified and recommended seven types of BRIS soil based on depth, drainage and serial profile, namely Rusila, Rhu Tapai, Rompin, Rudua, Baging, Jambu and Merchang [5]. The classification system of the American Department of Agriculture divides BRIS soil into two orders, namely Entisol and Spodosol. Entisol is a young soil without a podogenetic horizon. It is found near the sea and has a high sand content. Spodosol, on the other hand, is acidic soil with a sandy texture but unstructured with a mor humus (acidic humus) content. This is what differentiates soil types in a BRIS soil series [6]. The BRIS soil series of Rompin, Rusila, Baging and Jambu are classified as sandy Entisol with a quartz composition, whereas only Rudua is included in the Spodosol order.

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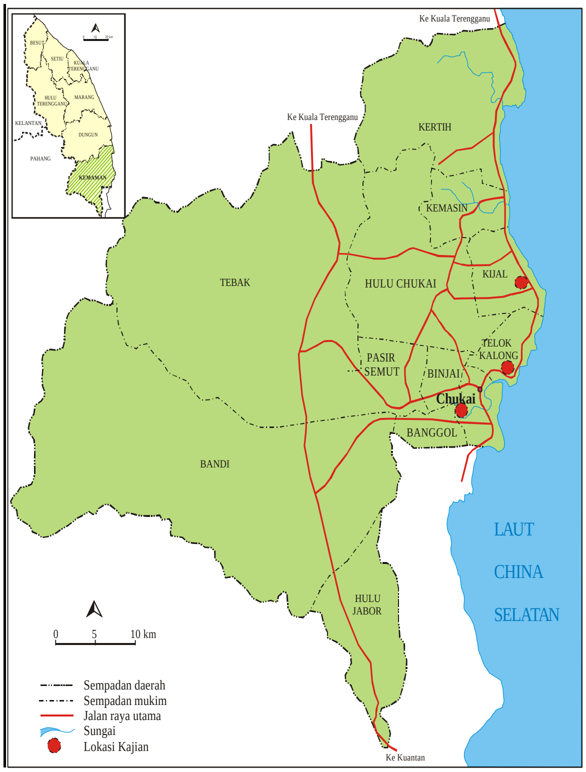

Fig. 1: Location of the study area

Study Area: The area where the study was conducted was located on the coastal area of Kuala Kemaman. It borders Dungun to the north, the South China Sea to the east and Pahang to the south and west. Kuala Kemaman has the co-ordinates of latitude 4° 16' and 4° 38' N; longitudes 103° 23' and 103° 31' E (Fig. 1). Kuala Kemaman is one of the seven districts of the state of Terengganu with an area of 2,535.60 square kilometres or 19.57% of the total area of the state.

A study on the climate of Kemaman district for the period 1991-2000 was conducted at the Kemaman Hospital. It was found that the yearly rainfall averaged 239 mm with a maximum rainfall amount of 757 mm and a minimum of 50.7 mm. The yearly temperature was about the same for the years during the period and averaged 27°C with a uniform comparative humidity average at 81%.

The geological structure of Kuala Kemaman is made up of rocks formed during the Quaternary Period. The main rocks are multi-layered comprising clay, silt, sand, pebbles and peat. In the hilly areas, the rocks comprise phyllite, slate shale, sandstone and also argillaceous rock from the Carboniferous Period. Approximately 70% of the hilly areas are made up of these types of rocks while the other 30% are acidic intrusive rocks.

The Rudua-Rusila series, which has a loose soil structure and is deficient in nutrients, is widely found in Kuala Kemaman. In the hilly areas, the soil is made up of the Kuala Berang-Kedah-Serdang series, while the Renggam-Jerangau series can be found west of the Tebak River, Marang-Apek series in the mid-areas of the Cherul River, alluvial soil of the Telemong-Akob series at the main plains of the Jabor River and Kemaman River and peat soil in the wetland areas of the flood plains.

Study Methodology: In analysing the physiography of BRIS soil, a number of studies were carried out including library research and fieldwork. The fieldwork was carried out in a number of *mukims* in the Kemaman district, namely Kijal, Telok Kalong and Chukai. A total of 20 plots of varying land use such as swamp area, settlement area, industrial area and agricultural area were selected.

Laboratory tests were performed on BRIS soil samples taken from the plots. Among the laboratory tests conducted on the soil samples were the dry sieving process, soil colour, soil pH, soil plasticity and Atomic Absorption Spectrometer (AAS) to determine the chemical contents of the soils.

RESULTS AND DISCUSSIONS

Based on the study and land use map, it was found that apart from peat soil, the most dominant series in the study area was the Rusila-Rudua series (Table 1). In this study, BRIS soil series were categorised on the basis of the varying land use, i.e. settlement, swamp, industrial and agricultural.

Table 1: BRIS soil series for each land use

Land Use	Plot	Soil Colour	Soil Series
Settlement	1	Brownish yellow (10YR 5/8)	
	2	Brownish yellow (10YR 5/4)	Baging
	3	Brownish grey (10YR 5/1)	
	4	Brownish grey (10YR 5/1)	
	5	Brownish grey (10YR 5/1)	Rudua
Swamp	6	Blackish brown (10YR 5/6)	
	7	Blackish brown (10YR 5/6)	
	8	Yellowish dark-brown (10YR 5/6)	
	9	Brownish grey (10YR 5/2)	Rusila
Industrial	10	Brown (7.5YR 5/2)	Rudua
	11	Pale brown (10YR 7/4)	Rusila
	12	Pale grey (10YR 6/1)	
	13	Pale grey (10YR 6/1)	Rudua
Agricultural	14	Grey (5YR 5/1)	
	15	Brownish grey (10YR 5/2)	
	16	Grey (7.5YR 6/0)	
	17	Light grey (10YR 7/1)	Jambu
	18	Yellowish brown (10YR 6/6)	
	19	Yellowish brown (10YR 6/8)	
	20	Yellowish brown (10YR 5/8)	Rudua

Source: Fieldwork, 2004

Table 2: Correlated Coefficient R and Regression R2

	Sand				Silt				Clay			
	Temperature		Moisture		Temperature		Moisture		Temperature		Moisture	
Land use	r	r2	r	r2	r	r2	r	r2	r	r2	r	r2
Settlement	0.275	0.076	0.049	0.002	0.711	0.505	0.389	0.151	0.735	0.541	0.364	0.133
Swamp	0.095	0.009	0	0	0.624	0.389	0	0	0.946*	0.894	0	0
Industrial	0.974*	0.948	0.266	0.071	0.402	0.162	0.774	0.600	0.914*	0.836	0.231	0.053
Agricultural	0.056	0.003	0.337	0.114	0.270	0.073	0.601	0.361	0.599	0.359	0.822*	0.675

*Significant at plausibility level of 95%

Source: Statistical Analysis, 2000

BRIS Soil Distribution and Classification: It was found that on land designated for settlement land use, marked on the map as plots 1 to 5, there were different series of BRIS soil at two different locations: one near a beach and the other a new settlement area. Plots 1 and 2 had the Baging series, which was found along the new track near the beach. The soil there was almost 90% sand. At the new settlement area, marked on the map as plots 3, 4 and 5, the soil was identified as belonging to the Rudua series. In general, the Rudua series has more than 95% sand in the composition of its soil. This series can be identified by its grey to brownish colouring. It differs from the other series because of the presence of spodic horizons at a depth of 50 to 100 cm, a complex layer of organic matter bonded together with chemical elements resulting from the leaching process of organic matter from the soil surface [7].

Swamp land use is marked on the map as plots 6 to 9. The Rusila soil series is prevalent in these plots. The soil of this series can be recognised as being slightly dark in colour considering that it is found in the wetlands. It is blackish on the top-most surface owing to the presence of a large quantity of humus. The composition of organic matter of the soil in this series was high with a thickness of 10 to 15 cm and the plants which could adapt themselves to this watery environment were of the *Melalueca leucodendron* species [8].

In the case of industrial land use which encompassed a number of *mukims,* the studies found that in any one area there could be a number of different soil series present. In plot 11, the BRIS soil was of the Rusila series owing to the plot’s proximity to a waterlogged area. The soil is blackish in colour. Plots 10, 12 and 13 contained soil of the Rudua series. The identification was based on the kinds of plants found growing on them.

Agricultural land use is represented by plots 14 to 20. These were areas where the land was heavily utilised. This was understandable considering the fact that the main occupation of the people living in the area was farming, as could be seen by the variety of crops grown there. Only two soil series, Jambu and Rudua, were identified in the plots.

BRIS soil has a high percentage of sand and this hinders the growth of plants. The lack of plants growing on BRIS soil in turn causes the temperature of the soil to remain high. In addition, the constant leaching process reduces the moisture content of the soil. Based on the measurement of moisture temperature conducted *in situ* at the time plotting works were carried out, it was found that the average temperature of most BRIS soils was 31.2°C. The maximum temperature was found to be 36°C and the minimum 24°C. High soil temperature causes the speedy vaporisation of moisture and nitrogen on soil surfaces. It is for this reason that BRIS soils have a low moisture content since the high sand content does not allow the soil to retain water for any length of time. An exception is the Rusila series which is usually found in lowland areas that are often waterlogged.

Statistical Results: From the statistical analysis (Table 2), it can be seen that the temperature and moisture content of a soil have a significant relationship to the texture of sand and clay soil with a level of plausibility of 95%. In the case of swamp land use with a significance level of 0.05 between clay and soil temperature, that is, r = 0.946 and regression coefficient value of r^2 = 0.836, it is clear that there is a high correlated relationship between the two. This is due to the fact that a waterlogged area under certain conditions will experience an increase in soil temperature. This is in turn due to the ongoing bacteria cycle as well as decomposition processes. Although the composition of clay in the soil is not high, it acts as a temperature moderating agent within the soil. In the case of industrial land use, it was found that there was a relationship between sand and the temperature with a correlated coefficient value r = 0.974 at a significance level of 95% and r^2 = 0.948. This confirms that 94.8% of the temperature plays a role in causing BRIS soil to lose soil moisture through the evaporation process, especially in places where the ground lacks plant cover.

In the case of agricultural land use, the significant relationship at 95% level is the one between clay and moisture content with r = 0.822 and r^2 = 0.675. This is because agricultural activities require water resource for growth. The presence of clay helps to retain water for a certain period of time and helps prevent the leaching process from happening actively. Other land uses which have a weak relationship with the stated variables could be owing to other factors. In any case, temperature and moisture content are not the main factors that give BRIS soil its physical characteristics. According to studies carried out by the Department of Agriculture, the sand content percentage of BRIS soil depends on depth, drainage and profile development of the BRIS soil.

The depth factor that influences sand, silt and clay contents is true only for certain BRIS soil series. This is because depth influences the profile development of soils. The profile development of BRIS soil in certain areas may cause it to have a 100% sand content. BRIS soils that are located along coastal areas have large-grained sands owing to wave actions that bring in such type of sand.

The next Factor Is Drainage: Most BRIS soils have good drainage. This is due to the high sand content which allows water to seep through quickly. In certain BRIS soil series, the Rusila in particular, the drainage is poor, owing to the presence of a high content of silt and clay at lower depths. The mixing of organic matter with silt and clay gives the soil a high water retention capability.

Profile development is considered a strong factor that influences the sand content of BRIS soils. Each BRIS series started off with a development profile that differs from one series to the other. This differing development profiles more or less determine the sand content of each soil series, which in the case of BRIS soils is high. BRIS soil is also known as sandy alluvial or coastal alluvial, which again emphasises the high sand content. Although BRIS soils may be located in places as diverse as along the coastal area and inland, their sand content remains high, that is, more than 90%.

In the analysis of the relationship between pH and moisture content, it can be seen that moisture content does not influence the pH of BRIS soil. From the analysis, the correlated coefficient value of r = -0.149 and regression coefficient value of r^2 = 0.022 at a significance level of 95%. The relationship that exists, therefore, is one that is inverse and weak. This confirms that moisture content contributes only 2.2% towards change in soil pH while the rest is influenced by other factors.

Aside from moisture as an ancillary factor, the main factor that has a direct influence on soil pH is base deficiency and low cation exchange capability (CEC) in BRIS soil. BRIS soil has a low pH (less than 5) indicating that it is acidic. Studies showed the existence of a strong relationship between soil pH and base saturation percentage in the soil [9]. The base percentage in BRIS soil is very low, in particular potassium (K) and calcium (Ca), the two main chemical elements found in soils. The same applies to the CEC of the soil. The sandy and loose individual grains permit an active leaching process of the soil, especially during heavy rainfalls where nutrients which act as soil pH binders are washed away. The CEC too is closely associated with organic elements of the soil, where soils absent in organic matter such as BRIS soil will have a reduced CEC value. The soil runs the risk of being infertile.

By using the dry sieving technique in the laboratory, it is possible to separate the soil particles according to pre-determined classes. In general, the percentages of sand, silt and clay in BRIS soil for different land uses do not show much variation. BRIS soil is sandy soil and the percentage of sand in the soil composition is always higher than that of silt or clay. In all the plots under study, which encompassed all four categories of land use, were found a high sand (coarse as well as fine sand) percentage in the soils in comparison to percentages of the other components of the soils. On the average, the percentage of sand exceeded 98%, whereas in the cases of silt and clay, it was 1-2% only. Nevertheless, the studies showed that there was a difference in the sand percentages of a number of BRIS soils, in particular those of the Rusila series which registered less than 70% sand content[1]. However, in the current study, it was found that the sand percentages were almost the same for identified soil series.

In the aspect of soil plasticity, BRIS soil generally has low plasticity. The reason is that physically, soil with high sand content is unconsolidated and crumbles easily on attempts to mould it. Only BRIS soils found in waterlogged or swamp areas (Rusila series) have plasticity. This is due to the presence of a high mixture of organic substances, silt and clay. Nevertheless, soils in agricultural areas too show plasticity. The reason could be the addition of foreign soil and fertiliser to the BRIS soil to prevent leaching and to make the land suited to agriculture. The plasticity of a soil, including that of BRIS soils, depends on the mineral content of the soil. These minerals form the soil itself. Examples of such minerals are mica, kaolinite, feldspar and gibbsite found in clay [9].

Studies carried out found that the content of the main nutrients in BRIS soil, that is, nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg) and calcium (Ca), is low[5]. This is due to the sandy structure of the soil which causes rapid leaching of these nutrients.

In analysing nutrient content, the Atomic Absorption Spectrometer (AAS) was used on soil samples to test for seven types of mineral. These were sodium (Na), zinc (Zn), iron (Fe), lead (Pb), copper (Cu), manganese (Mn) and magnesium (Mg). However, copper content findings were discarded for this mineral was not present in all the samples from the four land uses. The minerals were found in small quantities in all BRIS soil series.

Plots 6 to 9 showed the highest presence of nutrient content in their respective soils. These were all plots located in swamp areas. Almost all the minerals could be identified as present in all four plots. In swampy areas, many processes take place as these areas contain plants and the presence of bacteria which assist in such processes as biological cycle and decomposition.

Plots 16 and 17, among the plots designated under agricultural land use, showed the most number of minerals present. These two plots were located next to each other, which explained why the minerals found on both plots were almost identical. There were no significant differences between the other plots as regards the mineral content of their respective soils. The fact that none of these plots were separated more than 1 km from any one of the others could be a reason.

Sodium (Na) is the most significant mineral found in all plots under all land uses. This mineral showed the highest amounts in plots 8 and 9 with readings of 34.8 mg/l and 36.6 mg/l respectively. Magnesium (Mg) showed the highest amount in plot 13 (36 mg/l), designated as under industrial land use because the plot was located near a steel mill, hence the possibility of a high magnesium content in its soil is high. Lead (Pb) was found with the least amount in the plots under study. It was found in only about half the samples of BRIS soils that were tested. However, lead is required only sparingly for plant growth. Too much of it in the soil will cause chemical toxicity and eventual physical and chemical deterioration of the soil.

CONCLUSION

This study was devoted to BRIS soil which has a reputation of being a problematic soil, a sandy soil which does not support plant growth. At one time, this soil was the object of research and study initiated by the Ministry of Agriculture as regards its suitability for agriculture. With modern techniques, BRIS soil, which earlier had a reputation of being useless, has had its functional diversity increased which has enabled it to adapt to all types of plants [10]. Indirectly, this will increase the fertility of sandy soils in the near future.

ACKNOWLEDGEMENT

The School of Social, Development and Environmental Studies and Institute of Environment and Development (LESTARI), Universiti Kebangsaan Malaysia.

REFERENCES

1. Abdul Wahab Nafis, 1981. Asas Sains Tanah. Kuala Lumpur: Dewan Bahasa dan Pustaka.
2. Marlia Mohd Hanafiah, Jumaat Hj Adam, Mohd Barzani Gasim, Sahibin Abdul Rahin and Nurulhuda Edy Muslim, 2004. Pengurusan dan Pemuliharaan Tanah Bris untuk Aktiviti Pertanian di Marang, Terengganu. In Norhayati Mohd Tahir, Nakisah Mat Amin and Kamaruzzaman Yunus (eds). KUSTEM Third Annual Seminar on Sustainability Science and Management 2004. pp 265-268. Kuala Terengganu. Kolej Universiti Sains dan Teknologi Malaysia.
3. Nurulhuda Edy Muslim, Jumaat Hj Adam, Mohd Barzani Gasim, Sahibin Abdul Rahin and Marlia Hj Mohd Hanafiah, 2004. Sifat dan Taburan Tanah Bris di Kemaman, Terengganu. In Norhayati Mohd Tahir, Nakisah Mat Amin and Kamaruzzaman Yunus (eds). KUSTEM Third Annual Seminar on Sustainability Science and Management 2004. pp: 265-268. Kuala Terengganu. Kolej Universiti Sains dan Teknologi Malaysia.
4. Nossin, J.J., 1964. Beach Ridges of the East Coast of Malaya. Tropical Geography Journal, 18: 111-117.
5. Shamsuddin Jusoh, 1990. Sifat Pengurusan Tanah di Malaysia. Kuala Lumpur: Dewan Bahasa dan Pustaka.
6. Shamsuddin Jusoh, 1981. Asas Sains Tanah. Kuala Lumpur: Dewan Bahasa dan Pustaka.

7. Ives, W.D., 1967. Reconnaissance Soil Survey of Southern Pahang. Kuala Lumpur: Malaysia Soil Survey Report No 4/ 1967.
8. Othman Yaacob and Shamsuddin Jusoh. 1982. Sains Tanah. Kuala Lumpur: Dewan Bahasa dan Pustaka.
9. Abdullah, C.T., 1988. Pengurusan Tanah Bris untuk Tanaman Tembakau. Teknologi, 4(1): 13-19.
10. Shamsuddin Jusoh, 1979. Tanah Bris di Pantai Timur. Mastika, May: 121-124.