

# SOIL CONDITIONS IN THE KHULNA DISTRICT

(East Pakistan)

by

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## 1. INTRODUCTION

The Khulna District is a part of the Ganges delta area in East-Pakistan and is subjected to influences of the tides. The difference between low and high tide amounts to ca. 3–3.50 metres. Human occupation is found on the levees of ancient rivers which in places rise above the brackish water clay, or on the levees of tidal channels and tidal rivers (fig. 1).

For the protection of land and dwellings the area has been embanked thus giving rise to the existence of a very great number of small polders. In most cases, however, the dikes are not capable to their task consequent of insufficient height, too steep slopes, lack of maintenance and undermining by a very great type of crab. Therefore dike-bursts are manifold causing flooding of the land with brackish to salt water from the tidal streams and inflicting great damage to the crops. Moreover water control in the small polders is very defective because of leaking sluices by which water streaming forth at low tide, flows back equally rapid at high tide in various places.

Permanent ricegrowing is the prevailing cropping system. Rice is sown at the beginning of the wet monsoon (May-June), planted out afterwards and is harvested, dependant on the kind, from mid-October to the middle of January.

Water supply of the rice crop depends on the beginning, the proceeding and ceasing of the rainy season in which many variations occur, thus causing many risks for the one and only crop on account of drought on the one side and drowning on the other side.

The purpose of the soil survey in the area was to draft plans, in co-operation with agriculturists and rural- and civil engineering specialists, to remove the mentioned difficulties and to create possibilities to obtain two harvests a year instead of one by improvement of dikes, effective control of drainage and drafting an irrigation system.

## 2. SOIL CONDITIONS

The Khulna District is a part of an extensive declining area situated at the Bengal Gulf. The thickness of the alluvial sediment layers (alternating fluvial and marine deposits) amounts to some hundreds of metres. Generally the depositing power of the rivers is such, that in most cases a fluvial subsoil is found.

During the last centuries the transgressive force of the sea appears to have increased through which a topsoil of brackish water sediments, overlying a transitional peat layer, has been formed. Sedimentation took place in the normal way by a system of creeks, levees and basins. This system is characterized by some circumstances which greatly influence soil quality.

a. Conditions during sedimentation were of a nature that the swamp soils have a  $\text{CaCO}_3$ /sulphides ratio to such a degree that cat clay formation

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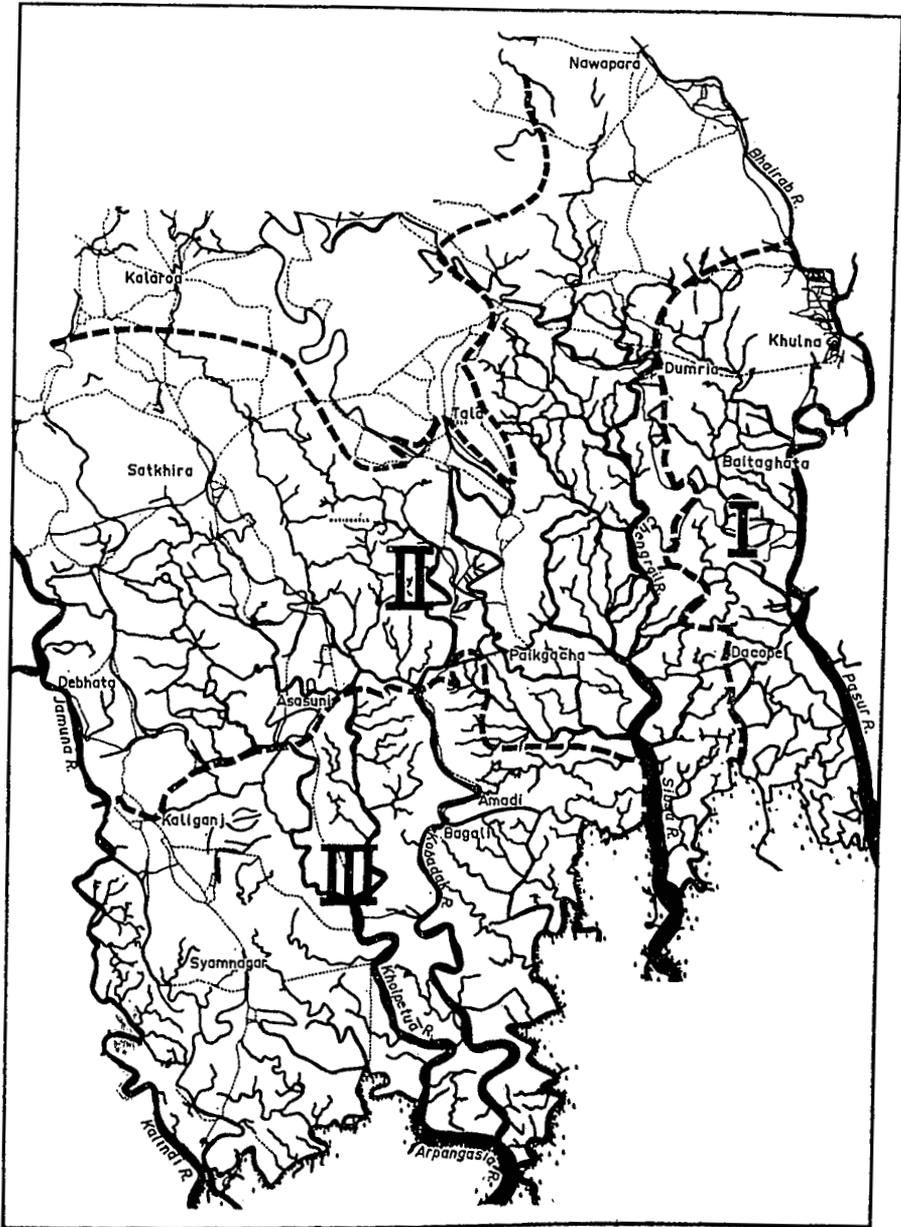


Fig. 1. Map of the Khulna District, East Pakistan.

I Fresh

II Fresh-brackish

III Brackish-saline

(By courtesy of the F.A.O. Agric. Div. Land and Water Use Branche, Rome).

may start easily. In the southern part of the area this has already taken place showing the well-known yellow spots in the profile accompanied by a low pH.

In the north, where drainage conditions are such that the subsoil is not yet aerated, pH values are not yet as low, but from analyses may be taken that this will also be the case after aeration has set in.

*b.* In the greater part of the surveyed area the topsoil has been subjected during centuries, and still up to the present day, to regularly occurring flooding with brackish to salt water.

As a consequence the soil adsorption complex has a very high degree of saturation with Na and Mg, giving rise to the well-known problems on soil structure and permeability. Naturally flooding is also reflected in a lower or higher salinity of the soil, the degree of which varies greatly in connection with duration, frequency and intensity of flooding and salt content of the flood water. High salinity figures may occur in an area periodically flooded with salt, tidal water as well as in an area with permanent salt water. In the last case, however, the intensity of occurring of high salinity figures is greater than in the first one. In the survey under review, however, not much attention was paid to salinity as its occurrence is not systematically connected with soil differences but is accidental. Furthermore the salinity will disappear after a short period of desalinisation after finishing the improvement works so that no more harm can be done to the crops, such in contrast to the influence of sodium and magnesium. In the course of time every polder has been flooded many times and is in a more or less advanced stage of desalinisation but the influence of sodium and magnesium is still undiminished.

*c.* At present a part in the east of the surveyed area is still under the influence of fresh water from the rivers Ganges and Brahmaputra. This is the cause that brackish or salt water influences are unknown here in spite of the occurrence of considerable differences in high and low tide. In this area fresh water tidal sediments are found showing a tidal sedimentation pattern without the occurrence of cat clay. Furthermore difficulties with brackish and salt water flooding do not occur and consequently no structure and permeability problems exist. Therefore the soils belong to the best in the district seen from an agricultural point of view.

### 3. TECHNICAL PROBLEMS

The ultimate purpose of the survey was, in co-operation with experts in other fields, to arrive at a responsible execution of a carefully drafted and well founded plan.

In view of the special soil properties, soil conditions play an important role in the execution of the agricultural and land development plans. In this connection the following problems are to be dealt with:

*a.* The danger of cat clay formation in case of drainage

Apart from the regularly returning floods part of the district is subjected to imperfect drainage conditions. Partly, however, this is a fortunate circumstance owing to which soils susceptible to cat clay formation have not yet got acid which in future too, is to be prevented. External drainage conditions are to be put under control but internal drainage has to remain unchanged. This implies that this type of soils is only suitable for perpetual rice growing.

Drainage, internal as well as external, will render this type of soils unsuitable for rice as well as for other crops.

#### *b. Subsidence*

A part of these soils overlies a fairly thick peat subsoil of a slushy consistency. The whole of it is in equilibrium with the prevailing drainage conditions. Locally no alternations are intended in view of the danger of cat clay formation. However, peat also underlies the fresh water tidal sediments. These sediments having larger agricultural potentialities do need a better drainage and with it the problem of subsidence makes its appearance. According to the available modes of computation subsidence will amount to about 50% of the thickness of the peat layer thus bringing about a lowering of the surface of ca. 0.50 metre which locally may cause damage for irrigated dry cultures, in connection with the realization of an adequate drainage.

#### *c. Water management potentialities*

Thanks to great tidal differences and the altitude of the average surface relative to these differences, good external drainage is possible. Internal drainage conditions are varying but are well correlated with the various soil groups. In the fresh water tidal sediments, which are in need of a fairly deep internal drainage in view of the most desired agricultural use, permeability of the topsoil as well as of the subsoil is satisfactory thus giving a favourable picture.

The whole profile of cat clay soils and soils susceptible to cat clay formation is badly permeable which, in view of perpetual rice growing, is to be desired. So in this case only good external drainage must be the aim, then internal drainage is of no importance and has even to be prevented for various agricultural and pedological reasons.

Thus it appears that in special cases a combination of unfavourable soil properties may be profitable.

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#### SAMENVATTING

In het Khulna district (Gangesdelta, Oost-Pakistan) komt een groot aantal polders voor, die regelmatig door brak tot zout water uit getijderivieren worden overstroomd, hetgeen verzouting veroorzaakt. De bodemgesteldheid is van dien aard, dat de gronden gevoelig zijn voor kattenkleivorming en gedeeltelijk reeds kattenklei bevatten. De ontworpen drainage- en irrigatiewerken moeten er dus op gericht zijn, om enerzijds verdere kattenkleivorming tegen te gaan en anderzijds de zouthuishouding te verbeteren, waarbij het voorkomen van overstromingen ook een belangrijke rol speelt. Deze gronden zijn eigenlijk alleen geschikt voor continue rijstbouw. Slechts een klein gedeelte van het gebied, dat onder invloed staat van zoete getijderivieren, heeft grotere landbouwkundige mogelijkheden.

#### ZUSAMMENFASSUNG

Im Khulna Distrikt im Ganges Delta, Ost-Pakistan, befinden sich viele Polder, welche regelmässig von Brack- und Salzwasserüberschwemmungen aus Gezeitenflüssen zu leiden haben wodurch Versalzung der Böden auftritt. Die Bodenbeschaffenheit ist derart, dass die Böden sehr empfindlich sind für die

Bildung von Pulvererde und zum Teil schon daraus bestehen. Daher sollen die Entwürfe von Entwässerungs- und Irrigationsanlagen derart gestaltet werden, dass einerseits einer weitergehenden Pulvererdebildung Einhalt wird getan, andererseits aber die Salzhaushalt verbessert wird. Hierbei spielt die Vorbeugung von Überschwemmungen eine sehr wichtige Rolle. Überhaupt eignen sich diese Böden nur zum fortdauernden Anbau von Reis. Nur ein kleiner Teil, unter Einfluss süßem Gezeitenfluszwassers, bietet größere landwirtschaftliche Aussichten.