Differences in Salinization Between the Mesopotamian Plain and the Nile Delta

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When I visited the United Arab Republic (Egypt) in the spring of 1964 I studied a number of soils in the Southern part of the Nile Delta. It was quite remarkable to learn that, except for a few minor areas, the soils in the Central and Southern part of this Delta were almost non-saline. In comparison with similar soils of the Tigris and Euphrates plain in Central Iraq (BURINGH [1]), which are very saline, one would expect most soils of the Nile Delta to be saline also. It therefore seems to be worthwhile to study the soil salinization processes and factors involved in Lower Mesopotamia and to compare these with the Nile Delta, in order to obtain valuable information that can probably be used when reclaiming alluvial soils in arid regions.

According to ELGABALY [4] the main source of salinization of soils in the Nile Delta is the replacement of the very old system of basin irrigation by the perennial irrigation system. This system was introduced about a century ago and gradually expanded over the whole Delta.

HULSBOS [5], who is working in practical tile drainage pilot schemes in the Nile Delta, is also surprised that salinization is not a serious problem. He points out that in the Southern and Central part of the Delta practically no soils exist with a high salt content in the surface layer or with a high water table. He concludes that this is caused by the typical aspects of the hydrological profile. Soils are very homogeneous, heavy, compact clay soils (40—60% smaller than 2 micron, and 90% smaller than 20 micron), with an extremely slow permeability in the substratum (average 5 mm/day). This heavy clay layer (thickness 7 to 25 mm) overlies very permeable sands, through which percolation water is transported to the northern part of the Delta, where salinization is a real problem. Although these factors mentioned by HULSBOS certainly contribute to the almost non-saline status of soils in the Central and Southern Nile Delta, we found that some other factors, explaining the high salinity in Mesopotamia and the relative low salinity in Egypt, should also be mentioned. These are listed below.

1. *Soil parent material*

The origin, properties and substrate of the soil parent material in both countries are quite different. In Soils of Iraq (BURINGH [1]) I already mentioned that for these reasons soils cannot be similar. The Nile sediment originates from tropical regions, partly with igneous rocks (Blue Nile), whereas the Tigris and Euphrates sediments are weathering products of mainly calcareous rocks of marine origin in the temperate mountain regions of Iran, Turkey and Iraq.

Besides differences in clay minerals there also is a great difference in soil texture and lime content. In Mesopotamia lime content varies from 25—35%, whereas in the Nile Delta lime content is about 6%. This and the coarser soil texture in Mesopotamia are the reasons for the much higher permeability and capillary rise of soil water in most alluvial soils of Iraq. The coarse, sandy layer in the deeper underground in the Nile Delta is absent in Mesopotamia.

2. *Hydrology*

The flood period differs in the two countries. The maximum discharge of the Tigris and Euphrates rivers is in April, but that of the Nile in September-October. This leads to an entirely different agricultural management system. In Central Iraq dykes along both rivers are built for flood protection. In Egypt there was no need for flood protection, almost all land was flooded (basin irrigation) and winter crops could be grown.

3. *Irrigation and sedimentation*

Due to the hydrological conditions and the very great distances in Mesopotamia, irrigation canals and diversion works were made since the beginning of irrigation some 6.000 years ago. As a result of irrigation sedimentation the land has a typical meso-relief consisting of irrigation levees and depressions. The levees are higher and much lighter-textured than the depressions (BURINGH [1, 2]). In Mesopotamia there is almost no large-scale land levelling. Irrigation depressions have no natural drainage. The water tables rise after irrigation and soils become saline, often even saline-alkali. All irrigation levees are highly saline (puffed solonchaks, sabbagh) mainly as a result of seepage of irrigation water and the very high capillary rise of the soil-water (medium textured, hot climate, rapid supply of ground-water).

In the Nile valley, which has also been cultivated for about 6.000 years, the flood irrigation has not built up a meso-relief of irrigation levees and depressions. Moreover the Egyptian farmers have levelled all the land. They also used much more irrigation water per ha and their agricultural system has been much more intensive. In Mesopotamia the irrigation works were often destroyed in war time. This has contributed to the salinization of extensive areas.

The much simpler basin irrigation system in Egypt could be repaired much more easily if anything was destroyed.

4. *Ground-water conditions*

As a consequence of seepage from rivers and canals and the method of irrigation the water tables are high in irrigated areas in Mesopotamia. In addition the soil water is highly saline. The sandy underground, the basin system of irrigation, the slow permeability of the clay soils and the absence of seepage are the main reasons why water tables in the central and southern part of the Nile valley are not high (HULSBOS [5]). Another effect is the presence of a fresh water layer in the upper part of the ground-water, due to rather heavy irrigation and intensive cultivation. All lands have been cultivated, even when the system of basin irrigation was in use.

5. *The system of agriculture*

In Iraq, where the population is relatively thin, the system of agriculture always has been a fallow one. Much idle land occurs in the Mesopotamian plain. Population centres have shifted from one part of the plain to other because of salinization or changing river courses. An extensive system of land use in irrigated arid regions causes high water tables and soil salinity. Since the system of perennial irrigation has been introduced in Egypt, a very intensive cropping system followed. Rotations with 2 and 3 crops per year are generally applied. Permanent, intensive cropping and irrigation, partly in connection with drainage and intensive land levelling in combination with the above mentioned soil and substratum conditions prevent land from salting up.

6. *Soil climate under non-irrigated conditions*

It is also quite typical that small strips of idle land along roads, canals and near houses in the Nile Delta are not saline, at least there is no efflorescence of salt. This is probably partly the result of differences in precipitation. In Central Iraq where such idle land has a salt crust on the surface, annual precipitation is 134 mm, in Cairo only 30 mm. In some periods in winter soils near Baghdad become moist to a depth of a few decimetres. As a consequence of fairly rapid evaporation of soil moisture, salinity increases in the soil surface layer. Near Cairo non-irrigated soils become moist in the upper few centimetres only. The rest of the soil is completely dry. As capillary rise of soil water is very slow the capillary water column is very short. In Mesopotamia this situation is the reverse, which is probably the main reason why non-irrigated soils are extremely saline in this area.

In conclusion, it is stated that the differences in salinization between the Mesopotamian plain and the Nile Delta are caused by a combination of various factors.

The most important factors causing high salinization of soils in Mesopotamia are:

a) the meso-relief as a result of irrigation sedimentation in a typical pattern related to the lay-out of canals and ditches,

b) the light texture of irrigation sediment in combination with an extremely high lime content, causing high capillary rise, relative high permeability and seepage,

c) the extensive fallow system of agriculture.

The most important factors preventing soils in the Central and Southern section of the Nile Delta from becoming saline are:

a) the heavy textured, very slowly permeable clay layer overlying the deeper, permeable sandy layer,

b) the very low capillary rise of soil water,

c) the intensive irrigation and cropping system and good soil management practices.

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Различие между засолением почв Месопотамской равнины и дельты Нила

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Резюме

В ходе одного из заседаний специальной комиссии F. A. O и U. N. S. F. весной 1964 года в Каире подвергли обсуждению вопрос о засолении почв дельты Нила.

К своему удивлению мы обнаружили, что процесс засоления в южной части дельты, к северу от Каира протекает не очень интенсивно. При сравнении почвенных условий этой части дельты Нила и сходных почвенных условий в районе рек Тигр и Евфрат, особенно в Среднем Ираке, что впрочем уже явилось предметом детального изучения (Buringh [1], можно было бы ожидать гораздо более сильного засоления почв в дельте Нила. Наряду с поразительной разницей в ходе процессов засоления, наблюдаются значительные отличия и в самих почвах, в отложении наносов, интенсивности использования земель, системах земледелия и орошения, обработке почвы, плотности населения и др. условий. При анализе различных факторов, влияющих на почвообразовательные процессы в аллювиальных районах Египта и Ирака, можно притти к выводу, что эти процессы значительно отличаются друг от друга, и некоторые из них играют значительно большую роль, чем остальные (Buringh [1]). Главные различия следующие:

а) Характер и свойства материнской породы. В дельте Нила материнская порода является наносом, происходящим из тропических районов, в долине же рек Тигра и Ефрата материнская порода представляет собой продукт выветривания пород с высоким содержанием извести. Эти горные породы распространены на территории зоны с умеренным климатом Турции, Ирана и Ирака. В южной части дельты Нила большинство почв имеет более тяжелый механический состав, более уплотненные и менее водопроницаемые чем подобные почвы в Ираке, которые характеризуются высоким содержанием извести (25—35% извести). В дельте Нила подпахотный горизонт характеризуется очень неблагоприятной структурой и малой водопроницаемостью. Вдоль каналов в некоторых местах наблюдаются и засоленные почвы, образовавшиеся в результате фильтрации вод. В большинстве почв дельты Нила капиллярное поднятие воды очень мало и не превышает 10—15 см.

б) Способы орошения. В Ираке уже в продолжении нескольких веков строят оросительные каналы, и проводят их очистку от ила и др. отложений. Построены оросительные плотины и водохранилища, и создан характерный мезорельеф (Buringh [1, 2]). Однако, эта система привела к возникновению проблем засоления и образования щелочных почв. У дельты Нила характер реки благоприятствует распространению орошения методом затопления, но этот метод в последние годы заменили постоянными оросительными каналами. В результате этого верхний слой грунтовой воды не является засоленным, в Месопотамии же почти все грунтовые воды сильно засоленные.

в) Система земледелия и землепользования. В дельте Нила использование земель и растениеводство весьма интенсивное. Собирают по два-три урожая в год. В Месопотамии сельское хозяйство ведется значительно менее интенсивно, исключение составляют некоторые небольшие районы на высоком берегу Тигра и Ефрата, на территории Среднего Ирака. Большинство земель обрабатывают только один раз в два-три года, в остальное время они находятся под перелогом. Землепользование, включая сюда и мелиорацию и планировку полей, значительно интенсивнее в Египте.

г) Климат сравниваемых территорий также различен. В Багдаде сумма годовых осадков составляет 134 мм, а в Каире всего 30 мм. В окрестностях Багдада в течение зимы почва увлажняется в некоторые периоды до глубины нескольких дециметров. Испарение увеличивает засоленность верхних горизонтов. В окрестностях Каира почва без орошения никогда не увлажняется на глубину более нескольких сантиметров.