# CONNECTIONS BETWEEN THE DISTRIBUTION OF PRECIPITATION, THE LANDSCAPE MOSAIC, AND SOIL AMELIORATION WITH ARTIFICIAL MATERIALS

BY

J. JUHÁSZ–M. DZUBAY

The exploitation and amelioration of natural resources is an important task of both this country and the whole Socialist camp.

An important part of the agriculturally used territory of this country can be classified on the theoretical basis of landscape researches, so that soils in need of amelioration are determined.

It is commonly known, that about 50 per cent of the agriculturally used territory needs amelioration on account of its unfavorable properties and is in addition poor in precipitation (10). Accordingly, we attempt to demonstrate on the basis of new theoretical and methodological principles — besides the traditional theories — the usefulness of artificial materials in soil amelioration.

According to Kalesnik's definition the landscape is a relatively homogeneous surface area of 2000—50 000 square kilometers which developed in a natural way in the course of its paleographic and territorial evolution and differs from other landscapes in its structure, in the composition of geographical factors, and in special features (1).

The difference between landscapes is determined by their geographical character and geographical unity. This classification according to character is the result of the differences of surfaces climate, soil types, water, vegetation, and fauna. The geographical unity, on the other hand, is the result of the inseparability of the various factors.

According to Sontsev the above-mentioned factors can be classed in two large groups: in the first belong the lithogenic and hydroclimatogenic factors which have a great power of resistance, in the second belong the biogenic factors with their smaller power of resistance (2).

According to Gerenchuk the chief lithogeomorphological complexes manifest themselves through the vegetation. He proposes that the differentiation of the landscapes should be made on the basis of the boundaries of the spread of the overlying rocks (3).

Of primary importance for agriculture is the favorable or unfavorable quality of the overlying rock, the soil, which may constitute the basis of a possible classification. It was on the basis of this idea that classification we divided those agricultural areas of our country which, on account of their unfavorable properties, need amelioration in the interest of greater production.

The possibility is given to us to deal comprehensively, according to our aim, with the artificial materials that can be used for amelioration of the acid, sodic, sandy, and bog soils in our country. In the majority of cases, the amount and quality of the agricultural yields, the efficiency of production, is determined by the suitability of the soil for cultivation and by the conditions of precipitation. As some relief forms disappear or change in the course of long periods of time under the influence of external forces, within each landscape smaller areas differing in soil kind or appearance and dimensions develop as morphological systems. Since the morphological units occur in different proportions in different landscapes or micro landscapes, it is possible to show the areas cartographically by means of surveys or photos. At the same time we can categorize and examine the acid, sodic, sandy, and bog soils as constituent part, that is basic landscape units or landscape mosaic, of the agriculturally used area of this country.

In connection with our theme either form of classification can be used, though the latter method seems more suitable for our viewpoints. Detailed characterization of the landscapes is at this moment not our primary task; thus according to our aim, soil amelioration is given attention from the point of view of artificial materials that can be used for the poorer soils under given precipitation conditions.

Over the territory of our country the climatic elements satisfy more or less the needs of plant cultivation. At the same time it is a long-known fact that the yield is in very many cases a function of the conditions of precipitation.

In the middle of the last century, then after the foundation of the Hungarian Meteorological Institute, many Hungarian climatologists studied the conditions of precipitation in the basin of the Carpathians on the basis of the collected material. With a view to recording the great variability of precipitation the then existing observation network was developed further. Hajósy and his contemporaries (4—5) had already the data of the enlarged observation network at their disposal for evaluation. The old data, however, were, on account of their sporadic and unsystematic nature, only good for finding out general regularities.

We show the territorial distribution of the 50 year average (1901—1950) of the yearly total of precipitation in mm on a map made after Hajósy (Fig. 1)

The western territories of our country represent abundance of precipitation, and the areas of the Great Plain around the middle section of the river Tisza scarcity of precipitation. The driest areas of our country are the regions of Hortobágy, Szolnok, and Kunszentmárton, where the yearly amount of precipitation does not reach even 500 mm. The larger part, about 70% of the territory, however, gets a yearly amount of 500—600 mm. To this latter type of area belongs the largest part of the Great Plain, the Small Plain, and Mezőföld. In most parts of Sopron, Vas, Veszprém, Zala, and Somogy counties in Transdanubia (the part of Hungary west of the Danube) and in the parts of the northern mountains above 400 m the yearly amount of precipitation is over 700 mm. In the south-western part of Vas, Zala, and Somogy counties the yearly amount is over 800 mm.

In connection with the territorial distribution of precipitation we show the soils needing amelioration in the agriculturally used areas. The territorial distribution of the acid, bog, sandy, and sodic soils is classi-

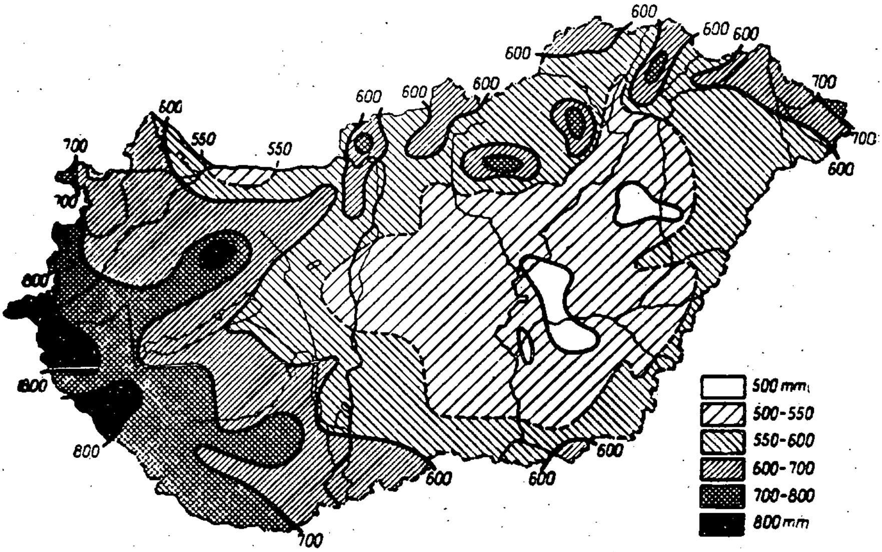


Fig. 1. The territorial distribution of a 50 year average (1901—1950) of the yearly totel of precipitation (after Hajósy).

fied on the basis of the precipitation map of Hajósy and the soil map of Mattyasovszky, Görög, and Stefanovits.

1. To the areas with less than 500 mm of yearly precipitation belong the cultivated, occasionally cultivated, and uncultivated areas with sodic soil in the region of Hortobágy, and the weakly and strongly acid, strongly bound mud soils between Szolnok and Kunszentmárton.
2. To the areas with 500—600 mm of yearly precipitation belong among the lowlands the weakly or strongly acid form of poor sand, weakly and strongly acid, strongly bound mud soil and clay, the areas of cultivated and uncultivated sodic soils in the region of the Körös rivers, and the acid bogs along the northwestern border and in the region of the Körös rivers.
3. To the areas with 700—800 mm of yearly precipitation belong the weakly and strongly acid sand soils the weakly and strongly acid sandy mud soils, and medium bound mud soils of Sopron, Vas, Veszprém, Zala, and Somogy counties.

4. To the areas with more than 800 mm of yearly precipitation belong the weakly and strongly acid medium bound mud soils of the south-western parts as well as the weakly and strongly acid sporadic sands and mud soils of Vas, Zala, Somogy, counties.

Knowing the territorial distribution of the yearly precipitation we wish to remark that the ratio of the amounts of precipitation in each area in given months and seasons is similar, and differs hardly from the yearly ratios. Generally the air-lifting effect of hills and high lands, as for instance in Transdanubia, increases the amount of precipitation in the highest spaces above sea level.

The heights of the relief are such important factors that yearly variations of the precipitation conditions could be established with minimal discrepancies in terms of altitudes above sea level, i. e. contour lines, contour line maps. But the altitude above sea level is not the only factor which influences the precipitation conditions, but, together with the inflowing air masses, it ensures the supply of precipitation for the areas. The precipitation conditions in our country are controlled by the complex effect of these two factors.

When the productive part of the soil is in the center of investigation and becomes connected with precipitation, the humidity of the soil of the examined area acquires a decisive importance.

On the basis of the yearly and monthly amounts of precipitation and the average of 50 years it has been found that from the beginning of May to the end of July as well as from the beginning of September to the end of November, i. e. in two periods, we have to reckon with larger amounts of precipitation than in other months. The summer rains generally control the temperature conditions in the country with the influx of the cool Atlantic air masses. Rainfall are frequent along the front of influx of the oceanic air masses. The little precipitation in winter, the precipitation minima, are due to the influx of continental air masses; in these continental air masses humidity is always lower than in the oceanic air masses; thus the former cannot supply as much precipitation as the latter.

In general it can be established, that in the territories east of the Tisza the continental character is predominant, west of the Danube the Atlantic character prevails with a maximum in June or July and a weaker second maximum in autumn. In the land between the Danube and the Tisza the continental and Atlantic air masses mingle, mostly under the control of the continental current.

In the common work of Kéri and Kulin very detailed information can be found on the probable values of the yearly, seasonal, and monthly amount of precipitation (9). From their discussion in connection with the graphic representation of the values to be expected with a 25 and 75 per cent probability it can be deduced for the summer half-year that in any planning connected with the planting of some crop a much smaller amount of precipitation must be taken into consideration than that shown on the precipitation maps of the 50- year averages. In our opinion only 75—80 per cent of the 50 year average of precipitation can be taken into consideration for planning in connection with the vegetation period.

Thus it is more probable that the production targets can be achieved. (The results can be improved by irrigation).

In connection with the territorial distribution of the total yearly precipitation the scattered bogs, acid sandy, and sodic areas can be regarded as landscape mosaics even if the agricultural areas of our country are divided by a threefold classification. Thus we can define the landscape unit of Transdanubia, that of the land between the Danube and the Tisza, and that of the land east of the Tisza with their characteristic microlandscapes, landscape mosaics, and basic landscape units.

I. Division of *Transdanubia* as a landscape on the basis of the distribution of the average precipitation: the acid sand soils of Sopron, Vas, Veszprém, Zala and Somogy counties, their acid sandy mud soils and medium bound mud soils and bogs may be regarded as LANDSCAPE MOSAICS.

II. According to the soil units of *the land between the Danube and the Tisza* as a landscape: a considerable part of the limy, poor sand is scattered over the area; acid mud soils and clay are to be found immediately beside the Tisza; these areas may be regarded as LANDSCAPE MOSAICS.

III. According to the soil units of *the land east of the Tisza* as a landscape: the sodic lands of Hortobágy, the sodic areas between Szolnok and Kunszentmárton, the cultivated and uncultivated sodic areas and sporadic acid bogs, mud soils, and clay may be regarded as LANDSCAPE MOSAICS.

It can be said of all landscape mosaics that they are forms of mesorelief which besides a given rock composition possess nearly similar productive soils and complex plant associations.

According to many experts Gerenchuk's view of the landscape mosaic is correct: „the urochishche is nothing else but the combination of genetically similar facies evolved in mutual connections" (7).

In the division of the above three landscapes I. II. III. into landscape mosaics Solntsev's method (2) can be used on the basis of which from the landscape mosaic of the land between the Danube and the Tisza as a morphological unit the weakly and strongly acid sandy soils may be taken out and examined as dominant factors is the landscape mosaic. The less common acid mud soils and clays can be examined as subdominant components of the landscape mosaic.

On the basis of any classification of a similar nature the use of suitable artificial materials in the areas can be determined in advance according to whether we want to preserve the structure of the soil with polyelectrolites, artificial foams, emulsions, or true solutions, or else we want to influence the air, water, and heat balance of the soil.

We have made such a classification on the basis of biogenic factors in the area of Csévharaszt in the land between the Danube and the Tisza. We delimited the basic landscape units in the territories of the landscape mosaics; at the same time we described the flood-basin microlandscape as the genetic unit of several landscape mosaic components.

The woody steppe on sandy soil is a cultivated area interspersed with pastures; its hillock systems preserve the ancient vegetation. But the larger part of the vegetation is identical with the vegetation of the sandy areas between the Danube and the Tisza. The continental Pontic and the Pontic Mediterranean elements give the woods and moorland greens an eastern and southeastern character, although southern elements, as for instance Diarthus diutinus, are also represented (8).

The flood-basin microlandscape examined is a genetically homogeneous area characterized by a uniform geological base, a peculiar plant association, and a local climate. The soil surface both on the pastures and on the cultivated lands needs quick and effective amelioration.

A further aim of agricultural investigation, which serves the exploitation and amelioration of the natural resources, is to find materials similar to humus and of lasting effect. This aim has partly been achieved by the manufacture of artificial materials which preserve (condition) the soil structure.

The advantage of the artificial materials, artificial soil stabilizers, over the natural structure ameliorators (humus, clay) is partly that they do not decompose so rapidly in the soil, partly that they can be used in greater concentrations.

The artificial materials, artificial resins that can be used for soil amelioration are mainly organic or mineral, surface-active or neutral materials with generally large molecules. They possess the common property that they preserve the soil structure thus favorably influencing certain soil properties, for instance the air and water balance.

Their simplest classification is: 1. polyelectrolites, 2. artificial foams, and 3. emulsions and true solutions.

1. The polyelectrolites are artificial polymers containing electrically charged components, cations and anions, which, sticking to the surface of the soil particles in the form of string colloids, glue them together into water-resistent lasting crumbs. Their effect depends on the quality and quantity of their active groups (e. g. CH, COOH), the size of the dose applied, the mechanical and mineral composition, pH, salt content, etc. of the soil.

The salts of the soil, for instance, if they are easily soluble (Na salts), have a great effect on the hydrolyzing compounds, on the coagulation threshold of polymers. These salts hinder the formation of giant molecules, the string colloids consisting of elements with ramifying structures. Thus they hinder a lasting aggregation of the soil crumbs. Ca and Mg carbonates for example as salts not well soluble in water do not influence the structure-preserving effect of hydrolyzing polyelectrolites (11).

Besides this, as we have mentioned, the chemical effect of the soil can also influence the applicability of artificial resins, because the active groups of the latter may be different.

The pH generally has no effect on the less hydrolyzing polyelectrolites.

Hydrolyzing polyelectrolites can be effectively used for soil amelioration only in the range of, pH 4.5—9.

If the soil is strongly acid, — its pH value is less than 4.0-, the area must first be limed (11).

The effect of the polyelectrolites is that they glue the soil particles together in to crumbs with small bridges of artificial material then as string colloids they enmesh them. The latter keep the crumbs from falling to pieces and from the silting effect of water. The lasting structure so formed ensures a favorable change in the water, heat, air, and nutrient conditions of the soil (12).

The polyelectrolites are chiefly acrylic, metacrylic, and maleic acid derivatives, or more exactly, different Na, K, and $NH_4$ salts of these.

In the Soviet Union, under laboratory conditions, a kind of polyacrylamide has been produced which contains liquid nutrients — easily absorbable NPK. This material, used as base or top dressing besides ameliorating the structure of the soil ensures also the nutrient supply of the plants (13).

When we calculate for dry soil, the polyelectrolites and artificial resins must be applied in quantities between 0.02—0.2 per cent. Those in pulverized form are introduced into the soil by means of disk fertilizer spreader and those in liquid form by means of a distributor also used for spraying herbicide. Previous to introduction into the soil, a crumbly structure must be developed by suitable agrotechnics, because only structures already existing can be stabilized with these artificial materials (14).

2. The artificial foams can be loosening materials with open, hydrophilic, or closedpored, hydrophobic structures. Their primary property is that they exert a chiefly physical influence on the soil. This consists in improving the water balance properties of the soil, producing lasting looseness, and preventing a quick destruction of the soil structure so formed. The environment thus changed, the larger amount of oxygen and higher temperature, activates the life of the soil and mobilizes the nutrients.

The interstices of the artificial foam materials with open pores may be permeable to air up to 70 per cent. Thus their volume can be filled nearly completely with water or nutrient solution, and this is practically utilizable for the plants.

Of the type of materials mentioned above the carbamide — formaldehyde foam (in the following CF, hygromull) is the best known. Its volume weight is 8—15 kg/m. Yearly about 3—5 per cent of the foam decomposes; as it contains 30 per cent of hydrogen, the amount of liberated plant nutrient may be considerable (15).

CF foam can also be made in the form of a film coating which provides good protection against wind erosion (16).

In soil amelioration about 300—500 $m^3$ of this open-pored material is used for one hectare. As it decomposes very slowly, the duration of its effect is estimated at 10—15 years.

The CF foam is best introduced into the soil in fall, so it can have time to become saturated with humidity.

The artificial material can be used successfully also in arid regions. Besides this the area may be treated with sprinkling irrigation.

Under a ratio of 50 per cent, CF foam can well be mixed with peat, compost, mud, clay, etc. (16)

The next artificial material, polystyrol foam (in the following PS foam, styromull), has closed pores. It contains air as an inclusion. From all points of view it is a neutral material. It is incapable of binding water and nutrients. Its volume weight is also very little: 15—20 kg/$m^3$. The globules or flakes made of it and used for amelioration have a diameter of 4—12 mm. Depending on what kind of soil is to be ameliorated with it, PS foam can be applied in quantites of up to 500 $m^3$ per hectare.

Owing to its extremely large volume the foam is not transported, but like KF foam, it is made on the site.

In soil amelioration the way of introduction of the material always depends on the goal. For instance if the plowed layer is to be loosened, the PS foam must be spread on the surface, then worked in to a small depth with a disk harrow or cultivator, and then plowed in. If the aim is to improve the subsoil, then the material spread on the surface must be worked into the soil by plowing down to the required depth. If the soil is too wet and we want to dry it, the furrows made with the subsoil loosener must be filled with the artificial foam (17).

With this method the area, if it has a proper inclination, can be drained without drainpipes.

3. Emulsions and true solutions are materials which can form a chemical soil cover and a waterimpermeable layer under the root zone.

Their effect chiefly depends on their place of application. On the surface of the soil they reduce above all evaporation and weed growth. Introduced into a certain depth they retain the water in the root zone.

The above-mentioned materials are generally used on soils with a light structure. Then the film formed on the surface of the soil raising the temperature of this layer by 10 C° creates more favorable life conditions for the plants already at the beginning of the vegetation period. If an „asphalt bed" is made in the subsoil, it helps to retain the water and nutrient supply in the root zone.

These materials can be got onto the fields with the help of devices like the machines suitable for spraying plant-protecting chemicals (18).

The effect is variable and depends on the material sprayed. For instance oily latex forms a film. Not only does this film protect the surface, but it also ensures that precipitation and irrigation water get into the soil more easily, and the bitumen or emulsion introduced forms an „asphalt bed". On the other hand quaternary ammonium salt as a true solution makes the soil crumbs so water-repellent that the water does not rise to the surface through the capillaries. Evaporation is thus reduced.

The duration effect also depends on the qualities of the materials. This effect varies between six, seven, and fourteen months. It depends on how rapidly the microorganisms can decompose the film formed on the soil surface (14).

The use of asphalt in the lower layers considerably increases the duration effect prolonging it to 10—15 years. In this case the bitumenous material is introduced into the soil behind a device resembling a goose's foot shaped cultivator hoe. The thickness of the water-impermeable layer, the artificial asphalt bed" is about 3 mm.

By this method, as we have mentioned, the pore space of sand is used for storing water, and the watertight layer is formed under the root zone.

Little has been done in this country regarding the utilization of artificial materials for soil amelioration. We can say that only the first steps have been made in this direction.

Utilization of the materials described above for soil amelioration under dry conditions depends mainly on the distribution of precipitation and the type of soil in the landscape mosaic. The ways and conditions of their use is the subject of our next paper.

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Felelős kiadó: Dr. Pénzes István
71-2319 — Szegedi Nyomda