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Program and Presentations

Edited by Tibor Tóth

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PROGRAM OF THE CONFERENCE

2009 September 20th Sunday. Field trip to *Eastern Hungary* with bus

07:00 Departure from the parking lot of *Nyugati pályaudvar Railway Station, Budapest, VI. Teréz krt. 55-57.*

09:30 - 10.00 Visit of *Karcagpuszta Experimental Drainage Field*

10.00 - 10.30 Visit of *Lysimeter Station of Karcag Research Institute*

10.30 - 12.00 Salt-affected soil profiles

12.00 - 13.00 Lunch

13.00 - 14.00 Travel to *Hortobágy National Park*

14.00 - 16.00 Visit of *Hortobágy National Park*

18:30 Arrival to the parking lot of *Nyugati pályaudvar Railway Station, Budapest VI. Teréz krt. 55-57.*

2009 September 21st Monday. Conference sessions at Geological Institute of Hungary, Budapest XIV. Stefánia út 14.

10:00 - 11:20 Opening Session **Hydrophysical conditions in saline and sodic areas**

-10:00 - 10:40 VÁRALLYAY, György *Salinity/sodicity as environmental stresses in the Carpathian Basin*

-10:40 - 11:00 VAN DER ZEE, S. E. A. T. M., S. H. H. SHAH, R. W. VERVOORT *An ecohydrological approach to salinity and sodicity problems in natural and agro-ecosystems*

-11:00-11:20 CHERNOUSENKO, Galina I. *Salt-affected soils in the permafrost zone of Central Yakutia*

11:20 - 11:50 Coffee break

11:50 - 12:50 Session **Advanced mapping of salt-affected soils**

-11:50 - 12:10 RUKHOVICH, Dmitry I., Polina V. KOROLEVA, Yekaterina V. VIL'CHEVSKAY Natalia V. KALININA, , Svetlana V. RUKHOVICH, Elena B. DOLININA *Methodology of the analysis of the maps of soil salinity to judge the dynamics of salinization-desalinization processes*

-12:10 - 12:30 MARLET, Serge, Fethi BOUKSILA, Wafa GHAZOUANI, Insaf MEKKI *Multi-scale analysis of soil salinization. A Case study from an oasis in Tunisia*

-12:30 – 12:50 DAKAK, Houria,Brahim SOUDI, Ahmed DOUAIK, Aicha BENMOHAMMADI, Mohamed BADRAOUI, Fatima-Zohra CHERKAOUI *Mapping the risk of soil salinization: application of electromagnetic induction and non-parametric geostatistics*

12:50 - 13:50 Lunch break

13:50 - 14:50 Session **Remote sensing of salt-affected soils**

-13:50 - 14:10 KOKOEVA, G., S. MAMYTKANOV *Integrating remote sensing, cartographical and GPS-based ground data for salt-affected soils identification, case study: Talas Valley (Kyrgyzstan)*

-14:10 - 14:30 KONYUSHKOVA, Mariya V. *Large-scale mapping of solonetzic complexes in the Northern Caspian Lowland using automated interpretation of Quickbird images*

-14:30 - 14:50 TAZEH, M., R. TAGHIZADEH MEHRJARDI, Sh. MAHMOODI *Application of remote sensing to soil salinity mapping in the arid region (Iran)*

14:50 - 15:20 Coffee break

15:20 - 16:20 Session **Groundwater problems and effects**

-15:20 - 15:40 HANSON, Blaine, Don MAY, Jirka ŠIMŮNEK, Jan HOPMANS *Salinity control under saline shallow ground water conditions of the San Joaquin Valley, California*

-15:40 - 16:00 KERÉK, Barbara, László KUTI, Ubul FÜGEDI *Groundwater under salt affected soils*

-16:00 - 16:20 LAHLOU, Mouanis, Brahim SOUDI *Diagnosis and control of salinity and nitrate pollution in Mediterranean irrigated agriculture. The case of Beni Amir (TADLA – Morocco)*

16:20 - 17:20 Poster session

-AMEZKETA, E., V. URDANOZ, I. BARINAGARREMENTERIA, L. ALBIZUA, J. DEL VALLE DE LERSUNDI *Relating remote sensing data to apparent soil electrical conductivity for assessing soil salinity in agricultural and natural fields*

-BAKACSI, Zsófia, Tibor TÓTH *The effect of changing sampling strategy on salt-affected soil profile data evaluation*

-BALOG, Kitti, Andrea FARSANG *Secondary salinization caused by used thermal water seeping*

-BARNA, Gyöngyi, János RAKONCZAI *Temporal changes of salt affected soils of Szabadkígyósi puszta*

-DEMIRKIRAN, Ali Rıza *Studies on the prevention of salinization of peat soils*

-EL-GHAMRY, A. M., A. A. MOSA, A., G. A. K. REHAM *Evaluating the ability of hyper accumulator plants for the reclamation of salt affected soils*

-FEDOTOVA, A. V., L. V. YAKOVLEVA *New approach to the ecological standardization of saline soils*

-GALLALI, Tahar *Saline water irrigation effect on soil organic carbon sequestration*

-HARMAT, Adrienn, Katalin BAA, András MAKÓ *Environmental impact of thermal water release on surface water at Kis-Balaton reservoir, in Hungary*

-HOLTHUSEN, Dörthe, Stephan PETH, Rainer HORN *Impact of different salts on the microstructural soil stability for various textures measured with a rheological test*

-KHAKIPOUR, Nazanin *Production of auxin hormone by fluorescent Pseudomonas*

-KHITROV, Nikolai, Yuri TCHEVERDIN *Regeneration and evolution of solonetz properties in soils of Kamennaya steppe for the second half or the 20th century*

-MATUS, G., O. VALKÓ, P. TÖRÖK, M. PAPP, E. VIDA, A. KELEMEN, T. MIGLÉCZ, B. TATÁR, S. KÉKI, T. TÓTH *Using propagule mimics to model seed bank formation in salinized soils*

-NOVÁK, Tibor, Kirsten BECKER, Luise GIANI *Modification of solonetz soil profile characteristics caused by organic matter influx on the livestock resting sites of Hortobágy, Hungary*

-RATHORE, Shabnam, Karl STAHR, Boris VASHEV *Monitoring and assessment of coastal saline soils in southern region (Badin) Pakistan*

-SZALAI, Zoltán, Gergely JAKAB, Klaudia KISS, Katalin FEHÉR *Vegetation induced patterns of soil redox conditions and dissolved iron*

-YAKOVLEVA, L. V., A. V. FEDOTOVA *Soil salinization in the Volga delta landscapes*

19:00 - 21:00 Conference dinner

2009 September 22nd Tuesday. Conference sessions at Geological Institute of Hungary, Budapest XIV. Stefánia út 14.

09:00 - 10:00 Session **Biomaterial production and vegetation**

-09:00 - 9:20 SINGH, Gurbachan *Biosaline agriculture for biomass and biomaterials production to generate energy from salt affected soils: Indian experience*

-09:20 - 9:40 PIERNIK, Agnieszka, Piotr HULISZ *Soil-plant correlations in native salt-affected habitats in central Poland*

-09:40 - 10:00 TÓTH, Tibor, Roger LANGOHR, Judit BECZE-DEÁK, Zsolt MOLNÁR *Two transects along the inner and outer sides of a sixty years old Tisza River dike*

10:00 - 10:30 Coffee break

10:30 - 11:30 Session **Salinization assessment and reclamation**

-10:30 - 10:50 BLASKÓ, Lajos, József ZSEMBELI *Amelioration and land use possibilities of salt affected soils with structural B-horizon*

-10:50 - 11:10 TAGHIZADEH MEHRJARDI, R., M. TAZEH, Sh. MAHMOODI *An investigation on soil salinity variability using different methods of geostatistics*

-11:10 - 11:30 MAHDI, Bashir H., János KALMÁR *Geological conditions of the salinization in case of two irrigated fields in Central and South Sahara, Libya*

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-12:50 - 13:10 LEBEDEVA (VERBA), Marina, Natalia CHIZHIKOVA *Spatial and vertical heterogeneity of the crystal chemistry and fabric of the salt accumulations in crusty solonchak of Uzbekistan*

-13:10 - 13:30 KOLESNIKOV, A. V. *Exchangeable cations of the meadow-chestnut soils at the Dzhanybek Research Station in the Northern Caspian Region*

-13:30 - 13:50 SHABANOVA, N. P., M. P. LEBEDEVA (VERBA), A.V. BYKOV *Chemical-morphological properties of salt-affected soils as affected by biogenic factor in the meadow-semidesert complex in Russia*

13:50 - 14:20 Coffee break

14:20 - 15:20 Session **Minerals of salt-affected soils**

-14:20 - 14:40 YAMNOVA, Irina A., Dmitry L. GOLOVANOV *Gypsum pedofeatures in arid soils and their transformation under the impact of anthropogenic loads*

-14:40 - 15:00 SZENDREI, Géza, Tibor TÓTH, Péter KOVÁCS-PÁLLFY, Sándor SZAKÁLL *Changes of salt minerals of soil surface efflorescences in space and time: a case study in Hungary*

-15:00 - 15:20 CHIZHIKOVA, NATALIA, MARINA LEBEDEVA (VERBA), SVYATOSLAV INOZEMTSEV *Mineralogical composition of the clay fraction and fabric of the desert soils of Mongolia*

15:20 - 15:40 Closure of the Conference

ABSTRACTS OF PRESENTATIONS

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Relating remote sensing data to apparent soil electrical conductivity for assessing soil salinity in agricultural and natural fields

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Identifying soil salinity/salinization over large areas from only on-site measurements of apparent electrical conductivity (ECa) is a demanding task. We evaluated the potential of combining remote sensing and ground geophysical data for reducing field work in identifying salt-affected soils. A comparison between ECa data collected in fields with a Mobile Georeferenced Electromagnetic Sensor (MGES) and the spectral variability of these fields in the satellite images was performed. Seven fields including the most representative landcovers/land uses of our dry-land saline area (barley, wheat, fallow and natural saline vegetation; Navarra, Spain) were selected for the study, four of them in saline areas and the other three in non-saline areas. Four spectral indices were evaluated as potential indicators of soil salinity. Two of them (Normalized Difference Vegetation Index_NDVI and Soil Adapted Vegetation Index_SAVI), as indicators of the growth of vegetation/crops, could reflect, indirectly, salts in subsurface soil solution. Then, they were evaluated for the fields with crops or vegetation. In the case of the SAVI index, the influence of soil properties on the vegetation index is reduced. The other two indices (soil-related indices such as ASTER and Salinity Index_SI), according to bibliography, could reflect salts in the surface of bare soils. Then, they were evaluated for bare soils. High values of NDVI and SAVI are associated with large ground-covering vegetation (in saline cropping fields this could be associated with low levels of soil salinity), while high values of ASTER and SI seems to be associated with high levels of soil salinity. Landsat 5/7 images from 2008 (five) and 2009 (four) were used to obtain the four spectral indices. Field survey with MGES was conducted on March 16th and 17th 2009, when the soils' water content was close to field capacity. Field conditions in 2009 were obtained from visual observations of the fields (most of them were under cropping), whereas their conditions in 2008 were deduced from the satellite images (at the dates of the images, most of the fields did not have crops, being apparently with stubble or bare). To ensure that soil-related indices were applied to bare soils, those indices were applied to fields and dates in which NDVI maximum values were lower than 0.2. Comparison between spectral indices and ECa data was performed at pixel level (pixel grids coincide in both types of data), after removing the fields' borders pixels. Most of the correlations between ECa and the spectral indices were non-significant ($p>0.05$) in the non-saline soils, whereas some moderate and significant (r up to 0.60; $p<0.05$) correlations were found for the saline soils. The best correlations with ECa were obtained with the vegetation indices (negative relationships indicating that the higher the salinity levels are, the lower the vegetation indices), while the relationships with the soil-related indices were quite inconsistent. Correlations of ECa with the vegetation indices were slightly improved when performed with the index corrected with SAVI. Further research is needed to see if those indices are useful on a wider range of fields.

Key words: Salt-affected soils, spectral indices of soil salinity, MGES, geophysical data

The effect of changing sampling strategy on salt-affected soil profile data evaluation

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The Hungarian Soil Monitoring system has been in existence since 1992, and characterizes 1236 soil sampling sites, representing different land use categories. From the beginning till 2000, concerning the Hungarian genetic soil classification system, the applied systematic sampling focused on the genetic soil horizons. This sampling strategy fully accepted the genetic based soil stratification, and each sample represented a genetic soil horizon. The resulted profile-data were available for detecting the changes in soil properties, but the claim to spatial correlation and international harmonization called for a new concept of sampling. According to the new method the sampling area enlarged, and focused not only the profile, but for a 50 m circle around the profile. The average samples are collected from nine boreholes, equidistantly in 0-30 cm, 30-60 cm and 60-90 cm depth intervals. In the year of the changes, because of the comparability and continuity, all the profiles were sampled with both of the methods (by horizons and equidistantly). This paper focuses on the effect of the methodological change for the salt-affected soil profile data evaluation in a dataset for the period 1992-2003.

Assumed that the characteristic salt profile was well described with the genetic soil data set, we studied whether the new dataset originating from the equidistant sampling shows the same salt profile or not. We divided the salt content data of the upper three soil horizons in 10 groups, according to the genetic types and/or subtypes of salt affected soils -determined in the Hungarian Soil Monitoring system- and compared the measured salt content data according to their sampling strategy. In the genetic based dataset the three horizons are separated sharply, and -with few exceptions- the lowest salt content occurs in the surface-subsurface layer and the salt content increases with the depth. In the equidistant based dataset the separated horizons "moved" closer to each other, the difference between the salt content of the layers decreased. In some cases the earlier order of salt content changed and the second and third layer has the same salt content value. Using the equidistant method, as a result of the overlapping sampling, the effect of the salt-content changes in the genetic soil horizons is less clear.

In each soil type or subtype that we analysed the differences between the two groups of dataset by the Kruskal-Wallis test, and in some cases the expectation for the continuity of the 1992-2003 dataset seems not to be fulfilled.

Key words: sampling strategy, salt-affected soils

Secondary salinization caused by used thermal water seeping

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In our work we present problems connected to thermal water utilization and disposal. In Hungary thermal water utilization is widespread, because its exploitation is possible on the 70 % of the area of the country. This hot water of very diverse application can be used for balneological purpose, drinking water, mineral water, agricultural, industrial or municipal heating and hot water supply. After usage the thermal water is flowing in ground channels, and infiltrates into the soil and/or reach the receptive flow, in general a river. Via a few study cases, e.g. Cserkeszőlő, Tiszakécske, we are going to show negative effect of this treatment from pedological viewpoint.
In the course of our work we have determined main risk contaminants in sewage thermal water. Then on different genetic soil types (meadow chernozem and sandy soil) and various utilization cases (balneological and energetical) we have investigated effects of used thermal water flowing in channels. The questions are as follows: can used thermal water leaking cause secondary salt accumulation and salinization, perhaps any other contaminations in the soil? How can it appear in different genetic soil types? Can contaminant seep to the groundwater or reach the receptive flow?
Our results show secondary/anthropogenic salt accumulation near to the channels. High amount of salts is typical of ground water on sandy soil site due to thermal water leaking into groundwater that enhances the salt content. Hence, salts can transport and accumulate into the lower soil horizons from which these salts are not able to remove, because sandy soil does not have capillary lift. It is a site having clay and mould in Cserkeszőlő where contaminants and salts dissolved in thermal water can adsorb on colloid surfaces, so can not contaminate ground water. Infiltration is lower, therefore soil retain both water and dissolved salts. Hereby, salt content of the groundwater has not increased by thermal water, but in soil we can find salt accumulation level. Two out of ions originating from thermal water have key role in the evolution of secondary salinization and accumulation processes: in general Na^+, but in some cases Mg^{2+} also accompany the former element and together induce physical soil degradation.
In accordance with the above-mentioned it can be claimed that in the case of used thermal water seeping we have to pay more attention to the high concentration of different salts, domination of Na^+ ions, since they can generate physical and chemical problems in surrounding soils, reducing productivity of the nearby arable lands.
Key words: thermal water, infiltration, secondary salt accumulation and salinization

Temporal changes of salt affected soils of Szabadkígyósi puszta

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During the last few decades visible landscape changes can be seen in the Szabadkígyósi puszta which is an ancient saline steppe in south-east Hungary, part of the Körös-Maros National Park and Natura2000 according to Bird Directive. In 1979 overall geomorphology, soil and botanic experiments were carried out and we have repeated them since 2005. Based on our surveys, this process can be demonstrated with the change of specific soil data: total salt content significantly decreased, Calcium took the role of the previously characteristic Sodium ion and humus content increased. Alteration of hydrological conditions generated changes in the mineral composition and chemical parameters of the soil, simultaneously, with which the vegetation of the area transformed too (species preferring saline and wet habitats appear). As a result of these factors the appearance of the landscape has significantly changed.
Key words: salt affected soils, temporal changes in landscape, soil and vegetation

Amelioration and land use possibilities of salt affected soils with structural B-horizon

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Salt affected soils (SAS) cover about 1 million ha in Hungary. SAS with structural B-horizon („meadow solonetz soils") represent the most widespread group of them. About 50 percent of these soils have been reclaimed and used as arable land until now. The practice of reclamation of SAS is two centuries old. A book by Tessedik (1804) was the first guide on this topic. In spite of this long history and the results the reevaluation of the research is important because of the changing economical and ecological situation.
For a well established land use decision – among others – the following questions must be answered:

- What is the main trend of natural soil forming processes?
- What is the degree of the soil quality changes for shorter and longer term after amelioration?
- What are the most effective means of soil improvement?
- What are the most suitable cultivated crops on the improved SAS?

As a contribution to a proper answer of the above questions, the main research results of the Karcag Research Institute on the topic of salinization and amelioration of SAS are summarized. This paper is based on the research results achieved by the following facilities:
Lysimeter experiment: the investigations are being made in containers filled with meadow solonetz soil originating from Karcag-puszta large scale experimental field.
The amelioration possibilities of salt affected soils are investigated at Karcag-puszta long term experiment.
The salt content of salt affected soil in a lysimeter experiment was decreasing both in drained and non drained soil. From the soil drained with a tube the leaching was two times greater. The greater decrease of salt content was at groundwater table of 120 cm. Leaching depended on weather conditions as well. In dry years salt accumulation, in wet years leaching was the dominant process.
On the bases of the results of the investigations carried out at the Karcag-puszta Experimental Site the following statements can be made:
Solonetz soils with A-horizon deeper than 20 cm can be used as grain producing fields, but without subsurface drainage they are not suitable for crops with deeper root system even in case of chemical soil-amelioration.
Chemical reclamation of sodic soils with deeper leached upper horizon must be preferred if drainage can not be applied. According to our results a 10 cm increase of the fertile top layer can be expected in these soils in a ten-year-long period.
Key words: salt affected soils, land use

Salt-affected soils in the permafrost zone of Central Yakutia

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Yakutia occupies 3 103 200 km^2 in the permafrost zone of Central and East Siberia. The permafrost thickness in Central Yakutia is about 400 m. Salt-affected soils occupy only 0.13% of the total area of Yakutia. In the agricultural zone of Central Yakutia, their role is more significant: 421 600 ha (38.4%), including 56 600 ha (50.3%) of cropland. They are developed in thermokarst depressions (alases) within the ancient alluvial plain and on river floodplains and low terraces in the area of 60º–64º N and 120º–135º E. This is the area of sharply continental and arid climate. Annual precipitation is about 200–250 mm, and the potential evaporation reaches 350–450 mm/yr. The mean January temperature is –43.2ºC, and the mean July temperature is 18–19ºC.

The chemistry and genesis of salinization in river valleys and alases of Yakutia are different. In alases within the ancient alluvial plain, the accumulation of salts took place in the Early Pleistocene with water flows from the adjacent denuded plateaus composed of the Palaeozoic calcareous rocks with interlayers of gypsum and soluble salts. In the middle Pleistocene, these salts were immobilized in the frozen deposits of the Ice Complex. Permafrost in this area contains 0.1–0.3% of salts with a predominance of sulphates and bicarbonates of sodium and magnesium. The development of thermokarst is accompanied by the release of relict salts from thawing rocks and their concentration in the water of thermokarst lakes upon drying of the latter. At a certain stage of lake drying, the talik zone beneath it is subjected to freezing. The migration of water to the freezing front results in the development of hydrolaccoliths (pingo). The freezing is accompanied by the differentiation of salts due to the precipitation of calcium and magnesium carbonates, so that sodium salts remain in the solution. In mature alases, an association of specific alas soils is formed, including salt-affected soda-sulphate and soda-saline solonchaks, solonetzes, and mucky gley solonchakous soils.

Within river valleys, salt-affected soils—solonchaks, solonetzes, and various variants of solonchakous soils (meadow-chernozemic, meadow alluvial, and meadow-swampy alluvial soils) occur on floodplains and on the first and second terraces. The chloride-sulphate and sulphate-chloride salinization predominates; in some soils, soda is also present. River valleys are the areas of recent salt accumulation. Salts are delivered with floodwater; partly, they originate from anthropogenic wastes. Several factors favour soil salinization: (a) the lack of drainage because of the presence of permafrost; (b) evaporative concentration of flood water under arid climate conditions (the moistening factor is 0.44); (c) the presence of mesodepressions, in which the stagnation and evaporation of flood water occurs, (d) the widespread development of technogenic cryopegs in the alluvial deposits of the Lena River terraces with the salt content of 3–25 g/l and with a predominance of sulphates and chlorides of magnesium and sodium; and (e) the presence of outcrops of saline Lower Cambrian rocks at the flanks of the valley.

Thus, the geography and genesis of salt-affected soils in Central Yakutia are related to the local climatic, palaeohydrological, lithological and geomorphic conditions and to the presence of permafrost.

Key words: soil genesis, soil geography, salt-affected soils, permafrost zone, Yakutia

Mineralogical composition of the clay fraction and fabric of the desert soils of Mongolia

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Lately, due to global problem of desertification there is urgent need to diagnose the soil formation within the desert zone as necessitated by a search of indicators of this adverse phenomenon, and soil indicators in particular. The study of zonality of desert soils in Mongolia allowed recognizing the following soil types – brown, pale-brown, gray-brown and extreme arid ones (Evstifiev, 1976). The strongly saline soils are usually confined to paleogenic deposits of Cretaceous period (Pankova, 1992).

The objective of this research is to study peculiar mineralogical composition of clay fractions and the specific features of micro-and sub-micromorphological fabric of desert soils. Mineralogical composition of the clay fraction (<1 micrometer) in desert soils is extremely diverse what is characteristic of such an orographically and geologically complicated country as Mongolia. The parent materials reveal peculiar associations of minerals; each of them is confined to definite types of deposits. In proluvial deposits of Quarternary magnesium-iron chlorites and hydromicas of two types (biotite and muscovite) are dominant, and also fine-dispersed quartz and an admixture of kaolinite are present. In more arid regions this mineral association is enriched with some amounts of palygorskite. The paleogenic salt-and gypsum-bearing deposits of Cretaceous display a monomineral palygorskite or smectite composition. A number of deposits characterized by more complicated genesis has a polymineral composition: palygorskite-smectite or chlorite-smectite. An analysis of the mineralogical composition of aeolian sediments shows that they are palygorskite-hydromica by nature.

The pattern and degree of structural differentiation of the upper soil horizons are quite different in different soil-geobotanical subzones of the desert. The higher is the climate aridity, the more distinctly are manifested such morphological features of arid soil formation as desert rind, clearly recognized crust and subcrust horizons (vesicular porosity in the first and micro-layered structure of the second horizons) and solonized surface caused by aeolian factor (Golovanov, 2005). The amorphous minerals occur in the upper soil horizons what is fixed by X-ray analysis showing a decrease in the intensity of mineral reflexes, low orientation of layered silicates due to a great amount of X-ray-amorphous components. The amorphization process in the mineral part of soils is conditioned by the fact that the minerals are destroyed without any intermediate transformation stage. The structure and amount of palygorskite are changed in the clay fraction to a considerable extent; smectite is destroyed to a lesser extent. In soils developed on parent materials of Quarternary the clay fraction reveals a higher amount of hydromicas and chlorites. The mineral distribution throughout the soil profile well agrees with structural peculiarities of dominant minerals. When the hydromicas of biotite type are dominant, the genetic horizons are recognized in the soil profile more distinctly as compared to those where micas-hydromicas of dioctahedric type are prevailing. In all the gypsum-bearing horizons the structure of minerals displays different stages of disarrangement. At the micromorphological level the above horizons reveal a salt destruction of clay paleocutans. Thus, with increasing climate aridity the diversity of soil-forming deposits is increasing as well and different criteria appear to

diagnose elementary soil formation processes in desert automorphic soils developed on deposits, which are different in their salinization.

The research was supported by the Russian Foundation for Basic Studies (project 08-04-01333).

Key words: salinization of desert soils, mineralogical composition, micro-and submicrofabric

Mapping the risk of soil salinization: application of electromagnetic induction and non-parametric geostatistics

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For a better management of salt-affected soils, the knowledge of the magnitude, the spatial extent and the evolution with time of soil salinity is required. Soil salinity is determined, conventionally, by measuring the electrical conductivity of a saturated past extract (ECe). However, given the spatio-temporal variability of the salinity, numerous samples are necessary, which makes the conventional procedure laborious and expensive. As an alternative, the apparent electrical conductivity of soil (ECa) can be measured in the field by the use of the electromagnetic induction (EMI). This procedure is fast and allows making an extensive sampling in space and monitoring in time. The study area covers 2060 ha in the irrigation district of Tadla, central Morocco. Twelve samples were taken for the determination of ECe while about hundred ECa measurements were realized with the EM38 instrument of Geonics. The pairs of ECe-ECa values allowed establishing the calibration equation permitting to convert the ECa into ECe values. This equation was used to convert the other ECa values for which there was no measure of ECe. Then, geostatistics was used for the establishment of the maps of the risk of soil salinization. First of all, a threshold for risk of soil salinization was determined and indicators were built. Then, the spatial variability of these indicators was described and modeled using the variogram. Finally, the maps were generated based on a non-parametric method of geostatistical interpolation, i.e., indicator kriging. The results showed that the study area presents various degrees of soil salinization risk. In the centre of this area, the risk is low; the major part of the study area has a moderate risk while the south and northwestern parts have a high risk. In conclusion, the combined use of the electrical conductivity, electromagnetic induction and geostatistics allowed establishing a reliable soil salinization risk map. This information could serve as a basis for any rehabilitation effort of salt-affected soils, in the future, according to their actual risk of salinization and not by considering the average risk of the whole study area.
Keywords. Electrical conductivity, indicator kriging, salinization risk, variogram.

Studies on the prevention of salinization of peat soils

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The addition of organic matter, such as peat, intends to optimize the production of plants, including crops, flowers, and young tree saplings and to maintaining soil fertility. It is also important to prevent soil salinization and high soil pH levels in the soil. Peat organic matters have been used as nutrient sources since ancient times; and the use of organic matter also contributes to good soil till and structure, but many peat soils have salts and it can cause salinization. Different materials and methods can be used to minimize the risk of salinization. Our invention seeks to provide a multi-step process in which the quality of peats and their effifcient application to farmland is maximized, so that peat organic matter will be provide as much benefit as can reasonably be achieved for the farmland.

Evaluating the ability of hyper accumulator plants for the reclamation of salt affected soils

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Reclamation of salt affected soils requires huge amounts of water for alleviation of soil salinity, but the problem is the supplies of good-quality water are falling short of demand for intensive irrigated agriculture in many arid and semi-arid regions. The judicious selection of salt tolerant plants, which are able to grow successfully on saline soils to remove enough amounts of salts to reduce salinity may improve or bring easily such soils under cultivation, among these plants kochia and barnyard grass could be ideal plants.

For this purpose two pot experiments were conducted at the experimental greenhouse of the Faculty of Agriculture, Mansoura University, Egypt, to estimate the ability of kochia *(Kochia scoparia)* and barnyard grass *(Echinochloa crusgalli)* on salt affected soils reclamation. Soil salinity was decreased after cultivation of kochia and barnyard grass under both clayey and sandy soil conditions, and kochia was more efficient in decreasing soil salinity as compared with barnyard grass. Soluble cations (Na^{+}, K^{+}, Ca^{++}, and Mg^{++}), and anions (CO_3^{-}, Cl^{-}, and $SO_4^{=}$) were decreased after cultivation of kochia and barnyard grass under clayey and sandy soils, whereas (HCO_3^{-}) anions were increased. Nutrients concentration in kochia and barnyard grass were varied according to soil salinity in both soil types, and it is cleared that concentrations of N, P, K, Ca and Mg were decreased, whereas Na was increased.

Keyword: Kochia , Barnyard grass, Salt affected soils, Reclamation

New approach to the ecological standardization of saline soils

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The new approach to an ecological standardization of soil is proposed, where the main criteria for the assessment of the condition of saline soils are the physical properties of soil. The quality of soil is defined as "ability of soil to execute its functions" (Karlen, 1997). The disruption of ecological functions of saline soils is due to the disruption/change of their physical properties. In spite of quite a number of works and broad popularity of the studies about the standardization of soil, including different degree of salinity, there is no description of the role and quantitative standard of the disruption of physical function of soil (the filtration ability, hydrotermic processes, water - and salt transport and others) up to now.

For the first time the system of scientifically based classifying features and standards of assessment of the physical processes, defining “biospherical functions” of saline soils and the quantitative standard of their breaches is worked out. The development of the evaluation criteria of the physical foundation of “biospherical function” of the saline soils, in the processes of water- and salt transport, water, air and thermal diffusion rates, permits, besides the assessments of the condition, to forecast further evolution of saline soils and their role in the biosphere.

For the first time the proposed approach will permit the assessment of the ecological importance of saline soils in the ecological functioning of salt-affected territories and their role in the soil-related processes which affect the “biospherical functions”. This will in turn permit to assess the intensity of the soil degradation processes, and the direction of the evolution of saline soils.

Keywords: ecological standardization, salinity, physical properties

Saline water irrigation effect on soil organic carbon sequestration

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In arid zones, low precipitation combined with very high evapo-transpirations are expressed, on a pedogenetic level, by organic matter-depleted soils. The use of irrigation to compensate the high water demand does only aggravate the organic stock. In fact, the highly mineralised water induces a solubilisation of the SOM as fulvates or even as sodium humates.
In this paper, we propose to study the balance of organic matter in terms of increased salinization. This is an open field experiment undertaken in the alluvial plain of the Medjerda Valley (Northern Tunisia) on a clay- silty soil with irrigation waters varying from freshwater (EC = 0,3-0,5 mmhos /cm at 25°C, SAR= 1,1-1,6) to mineralized waters (EC= 4,7-5,4 mmhos/cm at 25°C, SAR= 7,0- 9,0). After twenty-five years experiments, the organic matter balance carried out on 1.5 m soil depths is established as follows:
-Organic Carbon: 148.5 Tons/ha in the freshwaters irrigated soils against 139.6 Tons/ha in saltwater irrigated soil.
-Organic nitrogen: 18.1 Tons/ha against 16.8 Tons/ha respectively.
In effect, the increase in salinity results on one hand, in less important long-term organic restitutions, and on the other hand, by an increased solubilisation as hydro-soluble carbon.
Key words: Salinization, organic matter, arid zone, Tunisia.

The use of the halophyte salt marsh plant species *Kozteletskya virginica* for removal of heavy metals from contaminated waste water

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Metals are ubiquitous environmental pollutants that can arise from a variety of sources in an industrialized society. Salt marshes are among the most productive natural ecosystems of the world but are often considered sinks for pollutants. The capability of salt marsh plants to accumulate heavy metals is advantageous as it reduces the level of those metals in sediments and water and they could thus be used in either phytoextraction or phytostabilization processes. *Kozteletzkya virginica* (L.) Presl is a perennial dicot native to brackish portion of tidal marshes of the mid-Atlantic in United States and is considered as an obligate wetland species. It contains high amounts of mucilage consisting mainly in polysaccharide. Although such kind of polymer was reported to sequester both monovalent and divalent cations in some plant species, these properties were never analyzed in *K. virginica*. Moreover, chloride salinity has been reported to interact with heavy metal absorption but this aspect was never considered in this species.

Plants were grown in hydroponic system in the presence or absence of 100 mM NaCl and regularly harvested for growth parameter assessment and mucilage analysis by gas chromatography-mass spectrometry methods. Qualitative and quantitative data from control and salt-treated plants were compared. Salt treatment stimulated shoot growth and induced a gradient of growing mucilage content from the roots to the leaves, as well as mucilaginous precipitates on the leaf surface. Mucopolysaccharides were detected in the xylem vessels. Mucilage composition drastically differed between organs but salt stress had only a marginal impact on the composition. A high proportion of rhamnose and uronic acid in stem mucilage suggest that those pectic polysaccharides could be involved in Na^+ fixation but only a minor fraction of accumulated sodium appeared to be tightly bound to mucilage.

The plant was able to cope with 10 µM Cd^{2+}, 10 µM Cu^{2+} and 100 µM Zn^{2+} in the nutrient solution and to accumulate up to 0.2% Cd^{2+}, 0.25% Cu^{2+} and 0.6% Zn^{2+} in the roots (on a dry weight basis). Heavy metals also accumulated in the shoots, although to a lower extent (0.07%, 0.02% and 0.08% for Cd^{2+}, Cu^{2+} and Zn^{2+}, respectively). The presence of heavy metals in the leaf tissues decreased osmotic potential and stomatal conductance but had only a minor impact on net photosynthesis. The presence of NaCl in the heavy-metals containing nutrient solution reduced pollutant accumulation in relation to a salt-induced decrease in heavy metal bioavailability. Since NaCl increased plant growth, the total amount of pollutant removed from the solution was however higher in the presence of salt than in its absence. A consistent portion of heavy metal was bound to mucilage which remained similar whatever the salinity level, thus suggesting that Na^+ and heavy metals are fixed at different binding sites. It is concluded that *K. virginica* is a promising species for phytoextraction and rhizofiltration purposes.

Key words: halophyte, heavy metals, phytoremediation, pollution, salinity

Salinity control under saline shallow ground water conditions of the San Joaquin Valley, California

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Shallow saline ground water conditions have caused soil salinity problems along the west side of the San Joaquin Valley, California. Subsurface drainage systems cannot be used to control soil salinity and water table levels because even after more than 30 years of research, no suitable method of drainage water disposal exists. Thus, improved irrigation practices must be used for salinity control.

Research has shown that under furrow, border, and sprinkle irrigation, soil salinity near the ground surface depends mainly on the salinity of the irrigation water, but soil salinity at deeper depths increases as the ground water salinity increases. Soil salinity increases during the crop season. A pre-plant irrigation in the early spring is used to leach salts that accumulated during the previous year. About 25 mm of water per 30 cm of soil depth in addition to that needed to replenish the soil moisture depletion are needed to reduce the soil salinity and to prevent ground water intrusion into the root zone.

Field studies have shown drip irrigation of processing tomatoes under shallow saline ground water conditions to be highly profitable compared to furrow and sprinkle irrigation, As a result, drip irrigation has increased in the saline soils of the valley. These studies revealed that soil salinity in the soil profile depended on the amount of applied irrigation water and its salinity and depth to the shallow ground water and its salinity. Highly concentrated or localized leaching occurred near the drip line with the zone of highly leached soil increasing as applied water increased. Yield also increased as applied water increased due to both the larger volume of low salt soil and higher soil moisture content near the drip line. A seasonal water application about equal to the seasonal crop evapotranspiration provided sufficient localized leaching, yet prevented intrusion of saline ground water into the root zone. However, it was found that the water balance approach underestimated leaching fractions under drip irrigation.

The HYDRUS-2D computer simulation model revealed a leaching fraction of about 25% for a water application amount equal to seasonal evaporation, whereas the water balance frequently showed no leaching. Simulated salt patterns around drip lines were similar to those found in the field studies. Reclamation of drip-irrigated saline soil occurred faster for relatively large applications applied two to three times per week compared to smaller applications applied daily. The initial soil salinity conditions affected the rate of reclamation.

Both field and simulation studies indicate that subsurface drainage systems and drainage water disposal facilities may not be needed under properly managed drip irrigation.

Key words: soil salinity, drip irrigation, ground water

Environmental impact of thermal water release on surface water at Kis-Balaton reservoir, in Hungary

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The two major direct and indirect receptive medium of percolating water that arises in the course of the utilization of thermal water are soil and surface water (desiccating lakes, natural streams). The high total salt and sodium content of percolating water arose in the course of plant operation may cause the direct and indirect damage of ground water and surface water. Percolating to the ground it may change the physical and chemical features of the soil. The resulting environmental damage can be very serious if it takes place in an important sensitive area.
We examine the environmental effects of percolating water emitted by Zalakaros Thermal Spa at our university since 2003. The surface streams of the sample field are collected and led by Kiskomáromi-channel to the most significant nature reserve of the Kis-Balaton reservoir. To our current survey we marked out six sampling and checking points in the territory of Kis-Balaton Minor and along receptive channels. We took water samples once per month, on the same days and we determined the most important water quality parameters on the basis of Hungarian standards. We present the total salt, sodium and chloride ion content of the analysed water samples and their spatial and time changes in our poster.
Key words: environmental impact of thermal water, Kis-Balaton reservoir

Impact of different salts on the microstructural soil stability for various textures measured with a rheological test

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In humid climates salinity due to fertilization is seldom a threatening problem for agriculturally used soils. However, the advantages of fertilizers are not only restricted to their contribution to soil fertility. Rheological examinations showed a positive effect of fertilizers, as for instance, potassium depletion decreased microstructural stability. To distinguish between the effects and interferences of different nutrients on soil stability we measured the impact of several salts in varying concentrations with a method useful to determine microstructural strengthening of soils from the micro-aggregate down to the particle to particle level. We conducted an amplitude sweep test with a plate-plate system, where the lower plate is fixed whereas the upper plate is oscillating with an increasing deflection angle. The soil sample between the two plates is exposed to deforming forces and reacts with a defined resistance, recordable via the torque. The rheological parameters storage modulus G' and loss modulus G" can be derived, which represent the elastic and the viscous or plastic behaviour of the sample, respectively. During the amplitude sweep test the ratio of storage and loss modulus is changing. At the beginning, the deformation caused by a small deflection is reversible and G' is exceeding G". This range therefore is called linear viscoelastic (LVE) range. Further increase of the deformation, given by increasing deflection, causes both G' and G" to decrease. The deformation is no longer reversible, but still the behaviour of the sample is mainly elastic. As the loss modulus G" is decreasing to a lesser extent than G' the two moduli will intersect at a specific deformation value. The intersection point is referred to as the yield point indicating a structural breakdown of the sample and subsequent yielding. To identify the influence of a factor, the end of the LVE range and the yield point are used as characteristic values.
To detect the impact of salt, soil specimen of defined bulk density were prepared of different textures and saturated with solutions of different salts in varying concentrations, namely potassium, sodium and magnesium chlorides and sulphates. The samples then were rheologically measured with a rheometer MCR 300 (Anton Paar, Stuttgart, Germany) and the parameters described above derived. Considering the influence of the kind of cation, potassium showed the most distinct effect. Compared to samples saturated with deionized water, a molar concentration of 0.25 M potassium chloride doubled the stress necessary to exceed the yield point. Further increase of the concentration led to even higher stress values. Sodium chloride instead decreased the stress values and therefore the microstructural stability. Only very high concentrations of 1 M caused the yield point to reach a level similar to that of pure water. Magnesium chloride showed a slight tendency to increase stability with increasing concentration. The anion also had an effect as sulphates generally caused lower values and therefore lower microstructural stability than chlorides.
The results are evidence for the sensitivity of the method to salt influences on the stability of soil samples on the microscale. In our investigations potassium showed a stabilising effect whereas sodium destabilised the soil.
Keywords: amplitude sweep test, rheology, microstructure, soil stability, shear strength

Biogenity of the irrigated meadow grey soils of Azerbaijan dry subtropics

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The process of biogenic transformations of soils is closely associated with organic matters (vegetative residuals, etc.) and microbiological activities (Agayev U. 1975; Gresta J., Olszowskij. 1999). The role of the soil microflora in the current soil processes taking place in the irrigated meadow grey soils is barely studied.

In this connection, the study of the microflora and the state of the mineral part (sulphate, alkaline-earth metal carbonate, solubility of which depends on the partial pressure of CO_2) of the irrigated meadow grey soils in Azerbaijan arid zone under fodder crops is actual.

The purpose of the research is to study biogenic transformations of mobile forms of the mineral fraction of soils under fodder crops subject to species of plants and types of their sowings, numbers of microorganisms and particular physiological groups.

The researches were conducted in the territory of Azerbaijan Shirvan steppe (2000-2007). According to the data obtained from climatologists, agroecologists, physico-geographists, the climate of the territory has some features of the Mediterranean climate (Salayev, etc., 2004). The climate is warm, the average temperature in January is 0.2-2.2^0 C, in July – 27.7-28.9^0 C; the accumulated temperatures make >10^0 C – 4349-4472^0 C; the annual precipitation is 263-300 mm (Salayev M., Babayev M., Jafarova Ch., Hasanov V., 2004).

Soil characteristics are the following meadow grey, low-humic (1.3-2.3%), carbonate, solonetzic, clayey, clayey loam. Soil exchange capacity is high (25-30 mg-equiv.) with an increasing fraction of Mg and Na cations among absorbed bases; the ratio of Ca:Mg is narrower (1-2). The soil develops in leaching irrigation regime. The ground waters depth is from 2.5 to 3.1m. The ratio of C:N with regard to virgin lands is larger 8-10. Water pH is 8.0-8.2.

Agrotechnology is standard. 20 t/ha of organic (in autumn while ploughing) and mineral fertilizers ($N_{90}P_{120}K_{60}$ kg/ha of an active substance, fractionally – 20% in autumn before sowing, 50%- in spring during a tillering phase, 30%- during a budding and booting phase) was introduced. Variants for the experiment: virgin lands, lucerne (12 kg/ha), sainfoin (80 kg/ha), rye (180 kg/ha), rye (40 kg/ha) +vetch (60 kg/ha) + rape (4 kg/ha). The type of sowing: for lucerne, sainfoin, rye – full sowing, for rye +vetch (full sowing) + rape (full and cross sowing). Watering: 1 after sowing (280 m^3/ha) and 3 irrigations during vegetation period (per 350-400 m^3/ha).

Soil samples for microbiological analysis were taken seasonally from the depth of 0-25, 25-55, 55-100 cm from under each variant. Group analysis of the soil microflora was performed by the method of Valkov V.F., Kazeev K. (1999).

Solonetzic meadow grey soils of Shirvan steppe in their natural state are characterized by low biogenity. Long-term researches indicate that sowing of fodder crops (vegetative residuals remaining in the soil contain 1.0-2.16% of N, 0.20-0.69% of P_2O_5, 0.56-2.62% of K_2O) favours the improvement of properties of the meadow grey soils. However, the influence of each crop or type of sowing differs. It was established that the sowing of lucerne, sainfoin, rye+vetch+rape are most effective: salt sum is decreasing from 0.23 to 0.11%, the content of the absorbed Ca is increasing from 79 to 81%, the content of Mg

and Na is decreasing up to 6-8% and 1-1.8%, the indices of pH environment and total alkalinity decreased to the side of soil neutralization (pH 7.8-8.4), the content of calcium carbonate increased (6.2-7.9%).

Vegetative residuals favoured intensive development of the main physiological groups of microorganisms (see Table). Their stimulating effect is especially seen in the soil under lucerne (4820 ths/g), sainfoin (4694ths/g), rye+vetch+rape (4517ths/g). But in the soil under wild vegetation and pure rye sowing, the stimulating effect of vegetative residuals is lower.

The ratio of the main physiological groups of microorganisms in the irrigated meadow grey soil (layer-0-25cm, ths/g of soil) in spring

Plant	Total number of microorganisms	Percent of the total number of microorganisms			Spore forming bacteria as percent of total number of bacteria
		Bacteria	Actinomycetes	Microscopic fungi	
Wild vegetation	1489	58	42	0.09	15.0
Lucerne	4820	76	24	0.19	9.8
Sainfoin	4694	75	25	0.18	9.4
Rye	2849	68	32	0.11	13.9
Rye+vetch+rape	4517	75	25	0.18	9.7

In the composition of microflora, the number of nonspore-forming bacteria increases, but that of spore-forming bacteria decreases. In the virgin soil, the content of actinomycetes is higher (up to 50% out of the total number of microorganisms), but the number of spore ammonifiers is lower (up to 10-19% out of the total number of bacteria).

The qualitative composition of microorganisms in the soil under lucerne and rye+vetch+rape is rich compared to the soil under rye and wild vegetation. Here among the ammonificating bacteria the representatives of *Bacillus prevail. Bac. mesenteicus* multiplied intensively (38-45%). The number of bacilli was at its highest point in rhizosphere close to the flowering period.

The number of microscopic fungi in the virgin soil is low and they are only from Aspergillus genus. In the soil under lucern and rye+vetch+rape there are an increasing number of microscopic fungi and enrichment of their qualitative composition (*Aspergillus, Penicillium, Trichoderma*, and *Alternaria*). The appearance of the representatives of *Penicillium, Trichoderma*, and *Alternaria* along with *Aspergillus* indicates the formation of favorable environmental conditions in the soil under lucerne, rye+vetch+rape. The vegetative residuals of these plants have a stimulating effect on the intensive development of the main physiological groups of microorganisms.

In the soils under all the variants, we could observe seasonal fluctuation of the number of the particular physiological groups of microorganisms as well as their total number (maximum exceeds minimum 2-2.5 times as much).

While observing the soil profile under all the crops downwards, it was found that the absolute and relative number of microorganisms decreased drastically. It was also found experimentally that correlation coefficient among the number of microflora, and the total reserve of vegetative residuals of lucerne and rye+vetch+rape is 0.127-13, together with living roots – 0.380-0.401, together with dead roots- 0.680-0.715.

The sowing of lucerne and rye+vetch+rape and the application of organic and mineral ($N_{90}P_{120}K_{60}$ kg/ha) fertilizers, improving physical and chemical properties of meadow

grey soils, favours soil desalinization, the growth of microflora number, and the increase in soil fertility.

References: **Agayev U.B. (1975)**: The influence of cultivation on morphological, physico-mechanical and chemical properties of light-chestnut soils in Kirovbad massif / area. // Report. Conference on cultivation and recultivation of soils of Transcaucasia, Kirovbad, p.46. **Babayev M.P., Ramazanova F.M. (2004)**: The soil protective role of fodder crops in the irrigated soils of Azerbaijan dry subtropics. // Report. Forum "Let's preserve the planet Earth", St. Petersburg, p.317. **Gresta J., Olszowskij. (1999)**: The effect of fertilization on the biological activity of the soil of former open casts/ Ecol. Pol. Vol. 22, № 2. **Valkov V.F., Kazeev K.SH., Kolesnikov S.I., (1999)**: The methodology of the research of soil biological activity by the North Caucasus example.//The scientific idea of the Caucasus, Rostov-on-Don, № 1, pp.32-37. **Salayev M.E., Babayev M.P., Jafarova Ch., Hasanov V. (2004)**: Morphogenetic profiles of Azerbaijan soil // "Elm" Publishers, Baku, pp. 155-159.

Groundwater under salt affected soils

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The project on studying changes in groundwater chemistry started in 1995 at the Nyírőlapos model area, Hortobágy. After the first results, it became clear that the regular observations have to be extended to other model areas. Between 1995 and 2004 new observation wells were located in different parts of the Great Hungarian Plain (in two bigger salt-affected plains: Hortobágy and Apajpuszta; others in the smaller saline lakes at Fülöpszállás, Fülöpháza, Bugac, Csólyospálos, in the Danube-Tisza Interfluve). At some locations the observation is available from different depths at the same place.
Wells are monthly sampled and groundwater level, conductivity and pH are measured in the field. Water samples are filtered and conserved, then they are analysed in the Water chemistry Laboratory of the Geological Institute of Hungary. Total water analysis (Na, K, Ca, Mg, Fe, Mn, NH4, Cl, SO_4, HCO_3, NO_3, NO_2, hardness, alkalinity, total soluble salt content), and microelement determination (Cr, Zn, Co, Ni, Ba, AL, Cu, Sr, Mo, B, Pb, Cd, Li) are completed on every water samples. Based on our results, in some extremely salt affected areas not just the concentration of the groundwater changes, but its chemical composition too.
Precipitation has a great importance in the changes of the salt content in the groundwater. Rainwater, fallen on the surface, infiltrate into the geological media and going through the layers above the groundwater, can dissolve significant amount of soluble salt and transport them to deeper layers. Poorly permeable layers on the surface hinder or slow down the filtration of precipitation into the groundwater, so the leaching effect of percolating rainwater cannot or just partly can predominate. Evaporation clearly increases salt concentration in groundwater, and if the groundwater becomes saturated in any compound, its precipitation alters the chemical composition of the groundwater.
Changes in groundwater chemistry could also be caused by lateral water movements and inflow. Groundwater level above see level in wells at Nyírőlapos-model area shows that lateral groundwater flow has to be taken into account even in absolutely flat areas. The flow direction can sometimes reverse. The groundwaters of the areas close to each other have different chemical composition and concentration, so they can be mixed up by lateral water flow.
The composition of the groundwater is influenced by meteorological factors, the thickness-, the rock development-, and the quality of the layers above the groundwater level. These factors influence the chemistry of the infiltrating rainwater and the chemical composition of the groundwater changes, too.
Key words: groundwater, salt affected soils, changes in chemical composition

Production of auxin hormone by fluorescent *Pseudomonas*

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Plant growth promoting rhizobacteria (PGPR) are considered to promote plant growth directly or indirectly. *Pseudomonas* bacteria, specially *P. fluorescens* and *P. putida* are the most important kinds of PGPR. Production of auxin is one of the main reasons to promote yield because of inoculation with this bacteria. In this research fifty strains of Fluorescent pseudomonads belong to microbial bank of Soil and Water Research Institute, isolated from Iran soils, selected and evaluated about secretion of auxin compounds.
In HPLC device,72% of the strains exuded at least one type of indolic auxin composites.The amount of exuded IAA by *P. fluorescens* strains was varied from zero to 31.6 mg/l while it was producing from zero to 24.08 mg/l in *P. putida*.
The amount of exuded IAM by *P. fluorescens* and *P. putida* was between 0-16.2 mg/l and 0-17.2mg/l, respectively. Also these strains exuded 0-7.2 mg/l ILA for *P. fluorescens* and 0-10 mg/l for *P. putida*.
Neither of experimental strains exuded the IBA. The results showed that 65% of the studied *P. fluorescens* used IAM pathway to synthesize IAA and 35% used the IAM and IPyA path, while 48% of the *P. putida* through IAM, 41% through both paths and 7% used the only IPyA path towards IAA synthesize. But 78% of the strains studied in spectrophotometery exuded auxins with their amounts were producing between 0-7.09 mg/l for *P. fluorescens* and 0-4.40 mg/l for *P. putida* strains.
Key words: Auxin, *Pseudomonas*, HPLC, Colorimetric Method.

Regeneration and evolution of solonetz properties in soils of Kamennaya steppe for the second half or the 20th century

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In the context of intensive human interventions on soils and expecting global climate changes the concern has been growing about the study of soil processes that take place in soils, determine the trend in their development or maintain the available quasi-stationary status of these soils now.
The aim of this paper is to show the investigation results obtained in the study of spontaneous regeneration and evolution of solonetz properties in soils of solonetz complexes after stopping their amelioration and annual ploughing. The objects of research are the soils of two solonetz experimental stations located in Kamennaya Steppe (Talovsky district, Voronezh region, Russia). Before trial establishment in the 1950s the soil cover was represented by a combination of ordinary and broken-up chernozems on convex relief elements, solonetzic chernozems on gentle sloping hollows, meadow-steppe chernozemic sodium-sulfate solonetzes and leached (non-solonetzic) chernozems on hollow bottoms. Within 1952-1954 the ameliorative measures have being taken in different combinations: (1) ploughing at a depth of 30-40 cm, (2) gypsum application (10 t/ha), (3) fertilization (40 t/ha of manure) and (4) earth mulching – creating a humus horizon of 20 cm thick.
As seen from the long-term observations, within the second half of the 20th century the soils retained physico-chemical conditions for the development of the solonetz process (low concentration of salts combined with exchangeable sodium above 5-10% of CEC) in the presence of the groundwater table at a depth of 1-1.5 m, the salt content (1.4-2.2 g/l) and the sulfate-hydrocarbonate-sodium composition with soda in ground waters. 55 years later the present soil-forming factors continue to maintain and support the soil processes in chernozems and solonetzes taken place before their amelioration and ploughing. After stopping the effects of human activities they enable to be conducive to regeneration of morphological differentiation of solonetzes into eluvial and solonetz illuvial horizons. At present, the humus horizon of chernozem that has been created above the solonetz soil as resulted from earth mulching reveals morphological and physico-chemical solonetz properties under hydromorphic conditions (prismatic structure, skeletal grains, humus-clayey pendant cutans, alkaline pH, a higher concentration of sodium salts in the soil solution, accumulation of exchangeable sodium).
The work was supported by the Russian Foundation for Basic Research (project No. 08-04-01195).
Key words: solonetz, solonetz process, amelioration, spontaneous regeneration

Integrating remote sensing, cartographical and GPS-based ground data for salt-affected soils identification, case study: Talas Valley (Kyrgyzstan)

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The natural environment of Kyrgyzstan and climatic conditions, where evaporation rate during the summer period is much higher than the rainfall rate, in combinations with human-induced processes, such as intensive or inappropriate irrigation and poor water management have led to the extension of salt-affected soils. Soil salinity has reduced soil quality, by affecting agricultural crops decreased its production and leads to the abandonment of agricultural lands in Kyrgyzstan. Between 1985 and 1990, the area of salt-affected soils in Kyrgyzstan increased from 666 300 to 1170 300 ha (Mamytov, 1995).

Monitoring and mapping of soil salinity is one of the main challenges in Kyrgyzstan. The traditional method is time consuming and requires considerable resources for field sampling and laboratory analysis. The availability of multispectral satellite data of Landsat series allows for wider opportunities of using Remote Sensing and GIS techniques for salt-affected soils monitoring and enables us to detect temporal changes for over 40 years. The objective of this study is to identify salt-affected soils by integrating satellite derived data with existing soil maps and GPS-based ground-collected data. In order to achieve this goal, the Normalized Difference Vegetation Index (NDVI), the Transformed Vegetation Index (TVI), the Salinity Index (SI) and the brightness parameter of Tasseled Cap transformation have been applied to distinguish salt-affected soils from none-affected bare and vegetation-covered soils. The best algorithms of a supervised classification have been chosen on the basis of overall accuracy and Khat statistics of classification. In order to achieve this goal, the best algorithms of a supervised classification have been chosen on the basis of overall accuracy and Khat statistics. The extraction of relevant geomorphologic parameters from SRTM data plays also a significant role in soil salinity identification.

Exchangeable cations of the meadow-chestnut soils at the Dzhanybek Research Station in the Northern Caspian Region

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The predominance of exchangeable Ca^{2+}, Mg^{2+}, and Na^{+} in soils of arid regions is a well-known fact. The relationship between these cations in the soil adsorption complex (SAC) is determined by the content and chemical composition of soluble salts in the soil solution and by the values of the selectivity factors. This general regularity is well seen in the studied soils of solonetzic complexes in the semidesert zone of the northern Caspian region. The soil cover differentiation is related to the microtopography: microhighs are occupied by solonchakous solonetzes, and microlows are occupied by nonsaline meadow chestnut soils. In the solonchakous solonetzes, the portion of exchangeable Na^{+} reaches 30 – 40% of the cation exchange capacity (CEC); in the meadow-chestnut soils, it does not exceed 1 – 2% of the CEC.

The studies of the composition of the SAC in the soils of solonetzic complexes at the Dzhanybek Research Station were mainly focused on the solonchakous solonetzes, as the high percentage of exchangeable sodium in them was one of the factors exerting a negative effect on forest shelterbelts and crops grown in the course of the agroforest amelioration of this area. The SAC of meadow-chestnut soils was studied to a lesser extent.

Our work is aimed at studying the composition of the SAC and the nature of the CEC in the meadow chestnut soils located in the microlows under virgin herbaceous vegetation and in the analogous soils located under artificially planted forest shelterbelts

Taking into account that the main carriers of exchangeable cations are the organic matter and clay minerals, the humus content, particle-size distribution, and the mineralogical composition of the clay and fine silt fractions were determined. We made approximate calculations to estimate the contribution of these factors to the value of the effective CEC in the soils. The activity of Na^{+} and the salt reserves were determined to characterize the level of the soil salinity

The meadow-chestnut soils of the Dzhanybek Research Station are characterized by the eluvial-illuvial textural differentiation of the solonetzic type. It is supposed that solonetzic process took place in these soils at the earlier stages of their development. Later, the excessive salts and the adsorbed sodium were removed from these soils by the fresh water supplied with the snowmelt.

In the virgin and ameliorated meadow-chestnut soils, the portions of exchangeable calcium and magnesium in the CEC reach 70–80 and 13–30%, respectively. The composition of exchangeable cations remains relatively stable in the entire profile. The exchangeable sodium percentage is less than 1%, and there are no indications of the current activity of solonetzic process in the profiles of meadow-chestnut soils.

The research was supported by the Russian Foundation for Basic Studies (project 09-04-00030).

Key words: salt-affected soils, soil salinization, soil adsorption complex, cation exchange in soils.

Large-scale mapping of solonetzic complexes in the Northern Caspian Lowland using automated interpretation of Quickbird images

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The goal of this study was to develop a procedure for large-scale mapping of solonetzic complexes using automated interpretation of very-high-resolution space-borne images.
Solonetzic complexes are widespread in the northern part of the Caspian Lowland. They include the soils with different degrees of salinization: strongly saline Solonetzes (SN), slightly saline light chestnut soils (Kastanozems, KS) and nonsaline Chernozem-like (CL) soils replacing one another at distances of about 5–30 m. Dark-coloured CL occupy microlows with a relative depth of 10–30 cm, SN occur on microhighs, and KS occupy slopes. The portion of SN in the soil complexes varies from 25 to 75%.
Earlier, large-scale soil maps of solonetzic complexes were developed on the basis of detailed surveys at key plots with a further extrapolation of the obtained data. The reliability of such extrapolation is low, because the proportions between different soils in the complexes may change considerably at distances of about 500 m. High-resolution (<5 m) space-borne images allow us to obtain more accurate large-scale maps. However, their visual interpretation is an extremely labour-consuming process. A semiautomated mapping of solonetzic complexes with the use of 2.4-m resolution multispectral Quickbird imagery was set as the goal of this study.
The test area at the Dzhanybek Research Station is 65 km^2; one-third of it is occupied by shelterbelts and fallow land. Our approach was developed for virgin soils and natural pastures. The computer-based image analysis was performed with the help of ILWIS Academic 3.4 Open GIS. The major results are outlined below.
I. The use of a supervised classification (discriminant analysis) made it possible to delineate the areas of CL soils on the basis of the NDVI values and brightness values in the near-infrared band with high level of cross validation (88%). An automated separation of the remaining two soil types by this method proved to be of poor quality. A map of soil areas with different portions of CL soils was obtained at this stage.
II. To estimate the portions of SN and KS, a visual interpretation of the image was performed for 20 test plots (200x200 m). The portions of different soils in the complexes were tightly interrelated. Two groups of test plots with different portions of CL were specified: (1) CL 0–15% and (2) CL 15–30%. No complexes containing >30% of CL were identified. In group 1, the portions of KS and CL were interrelated: $K1(\%) = -4.17CL(\%) + 86.8$ (R^2=0.94). In group 2, the area of K1 is about 20% (15–25%).
III. These regularities were used to develop the soil map of the test polygon (scale 1:25000) with the following mapping units (solonetzic complexes): (1) CL 0-5%, KS 70-80%, SN 20-30%; (2) CL 5-10%, KS 50-70%, SN 30-40%; (3) CL 10-15%, KS 35-50%, CN 40-50%; (4) CL 15-30%, KS 15-25%, SN 50-75%.
Thus, this method ensured an automated delineation of the areas with CL with high (90%) reliability, on the basis of statistically reliable (R^2=0.94) relationships, the portions of SN and KS were determined in each mapping area. This study was supported by the Russian Foundation for Basic Research, project no. 07-04-00136a).
Key words: Solonetzic soil complexes, Caspian Lowland, Quickbird imagery, image interpretation, large-scale soil mapping.

Diagnosis and control of salinity and nitrate pollution in Mediterranean irrigated agriculture. The case of Beni Amir (TADLA – Morocco)

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Agricultural productivity may be constrained by limited water resources and soil and water quality degradation. In Moroccan conditions, the main degradation processes occurring under intensive cultivation in the irrigation schemes are: (i) soil salinization, and alkalinization, soil compaction and ("on-site" impacts) and increased salt and nitrate loads in irrigation return flows (IRF) ("off-site" impacts) and groundwater nitrate pollution. A subsequent revision of agricultural practices should be established and an Integrated Agro – Environmental Management of these constrains is essential.

In order to reinforce scientific, technical and socio-economic investigations and findings on salt and nitrogen contamination and on pollution control measures in Mediterranean irrigated agriculture, seven research partners and ten stakeholders in six countries have collaborated during four years (2006-2009) in the framework of a project called "QUALIWATER: Diagnosis and Control of Salinity and Nitrate Pollution in Mediterranean Irrigated Agriculture INCO-CT-2005-015031".

In Morocco the Academic institutions are represented by the "Institute of Agronomy and Veterinary Medicine Hassan II", and stakeholder by the "Regional Office of Agricultural Development-Tadla" where hydraulic unit covering 2600 ha was selected as study area. The result of the two hydrological years 2007 and 2008 show that the District Irrigation Efficiency was about 56% and 52% respectively in 2007 and 2008; the Water Use Efficiency is about 60% and 59% respectively in 2007 and 2008; the mass of salts that percolate to the water table (Mg/ha) is about 5.3 and 4.8 respectively in 2007 and 2008; and the mass of NO_3-N that percolate to the water table (Kg/ha) is about 137 and 117 respectively in 2007 and 2008.

In addition a simulation studies has been carried using a set of calibrated and validated water, salt and nitrogen models to analyze the effectiveness of best management alternatives for off-site pollution control.

Spatial and vertical heterogeneity of the crystal chemistry and fabric of the salt accumulations in crusty solonchak of Uzbekistan

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The studies of mineral associations in salt crusts have been performed in many parts of the world (Mermut, 1986; Mees and Stoops, 1991). In this paper, we consider the results of special investigation into the composition and properties of different types of salt accumulations sampled from the surface salt crust of a crusty solonchak in Uzbekistan. The main goals of our study were to (1) typify the morphologically different parts of the salt crust, (2) determine the chemical properties of different types of salt accumulations, (3) determine the mineral composition of salt crusts using mineralogical and submicromorphological analyses, and (4) give a comprehensive characterization of the diversity of crystal chemistry features of salt minerals. The soil profiles were dug in the dry delta of the Zeravshan River in Uzbekistan. The mean annual air temperature is +15.1°C; the mean January temperature is –0.6ºC, and the mean July temperature is +29.6ºC. The annual precipitation averages 125 mm, with only 2.0 mm in June–August. Morphologically different parts of the salt crust were sampled hermetically sealed in glass tubes. The particular minerals were diagnosed with a help of X-ray diffraction and thermogravimetric (TG) methods using an XZG-4a diffractometer (Carl Zeiss Jena, Germany) and a Q-1500 D derivatograph (F. Paulek &t K˚). The samples were also analyzed under a scanning electron microscope (SEM); X-ray diffraction patterns of separate crystals were obtained using a Camebax (Cameca, France) microprobe. The analysis of water extracts (1:5) from salts crusts was performed to determine the chemical type of salinity. The surface salt crust of the crusty solonchak can be differentiated into three major morphological types. Chemical analyses of water extracts from these types of the crust suggest that all of them consist of a mixture of sodium and magnesium sulfates and chlorides with somewhat different Cl/SO_4 ratios. The specificity of the predominant first type of the crust consists of its high alkalinity (both total and bicarbonate), which is absent in the other two types confined to microhollows and microelevations of the surface. The appearance of high alkalinity in the first type of the crust might be related to the activity of microbiota concentrated in certain microzones in the lower crust layer. Micromorphological and mineralogical investigations showed that each morphological type of the salt crust is characterized by its own paragenetic association of mineral salts with a predominance of sodium and magnesium sulfates: thenardite, mirabilite, and bloedite (astrakhanite); more careful examinations with the use of TG and SEM techniques have shown the presence of glauberite, polyhalite, and gypsum. Different morphological forms of thenardite and mirabilite have been registered. The possibility of the presence of small amounts of trona cannot be excluded judging from chemical data, though we failed to detect this mineral by mineralogical methods. It is important that only a combination of different investigation techniques makes it possible to identify different minerals of salts in their mixture and suggest a reliable interpretation of the obtained data. The research was supported by the Russian Foundation for Basic Studies (project 08-04-01333; 08-04-90266Uzb.).
Key words: salt minerals, micromorphological and mineralogical investigations.

Geological conditions of the salinization in case of two irrigated fields in Central and South Sahara, Libya

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Presenting the environmental problems of the mapped Saharian region, two significative areas were studied: the first area, situated in Wāw al Kabir oasis (NG 33-12 sheet) and the second one, near to Rabiyanah village (NG 34-15 sheet). Both areas are located in the driest zone of the African continent, consequently plant production is possible only by irrigation, in so called Agricultural Projects.
In Wāw al Kabir, an ancient Islamic eremite site, during a long historical time the sandy soil was irrigated from 5-8 m deep wells, using with care the groundwater found in disaggregated Paleogene rocks and in the gravels from the base of the Quaternary deposits, with ~2000 mg/l total salinity. Boring a few hydrogeological wells, an artesian water, below 500 mg/l was obtained, but because of the accidental mixing with groundwater in the northern part of the oasis, in a few years the soil became saline, with 2-5% NaCl.
In Rabiyana, a large Pleistocene proluvial fan, with silty-sandy or clayey-silty deposits were irrigated with low saline (500-700 mg/l.) water from the Cretaceous aquifer. Unfortunately, the clay retained more and more salts, resulting, after 15 years of irrigation, the total salinization of the soil, with 2-10 mm thick halite lenses, in which all of vegetation has disappeared.
The paper is illustrated with tables and graphics of analytical data, with X-ray diagrams and optic and SEM micrographs of the salinized soil samples as well.

Multi-scale analysis of soil salinization. A Case study from an oasis in Tunisia

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Soil salinization results from a combination of hydrological processes operating at different time and space scales. Thus effective salinity control measures should recognize the natural processes that operate in irrigated systems as well as on-farm processes, and understand how they affect the long-term quality of soil and water resources.
A multiscale analysis was developed and applied in Fatnassa oasis (Nefzaoua, Tunisia). The approach combined a water and salt balance model at irrigation scheme and yearly time scales, spatial variability of the shallow groundwater, and the influence of the shallow groundwater and some farmers' practices on soil salinity at field scale. The salt balance model accounts for input by irrigation, export by drainage and groundwater flow, the influence of biogeochemical processes and variations in the resident amount of salt for each chemical component in the soil and shallow groundwater. The groundwater was monitored and sampled from a network of 27 observation wells. Soil salinity was calculated from electro-magnetic conductivity (EM38) on 416 fields.
From a salt input of 39 Mg ha^{-1} $year^{-1}$ by irrigation, 21 Mg ha^{-1} $year^{-1}$ (54%) and 10 Mg ha^{-1} $year^{-1}$ (26%) were exported by groundwater flow and drainage, respectively. 7Mg ha^{-1} $year^{-1}$ (18%) were removed from groundwater by geochemical processes, while a non significant 2 Mg ha^{-1} $year^{-1}$ were estimated to have been stored in the soil and shallow groundwater where the residence time was only 2.7 years. The current extension of date palm plantations and salinization of groundwater resources are expected to significantly increase the salinity hazard while the degradation of the drainage system is of lesser impact. Groundwater salinity ranged between 5.8 and 18.5 $dS.m^{-1}$. Whereas salinity increased with the decrease in groundwater depth, their spatial distributions were partly different and evidence for dissimilar causes between waterlogging and salinity. They pointed out a need for reinforcing drainage in the lower part of the oasis. Soil salinity ranged between 3.7 and 46.2 $dS.m^{-1}$. This resulted from a combination of the groundwater depth and salinity, the yearly irrigation amount and the magnitude and frequency of sand application by the farmers.
The results did not show any rapid salinization process but a progressive evolution of salinity depending on the management of soil and water both at the irrigation scheme and the farmers'fields scales. The farmers can, to certain extent, control salinity at field scale but don't clearly grasp the root causes of salinization related to the current extension of date palm plantations and salinization of groundwater resources. The combination of various approaches was essential to identify measures for controlling salinity in the long term.
Key words: salinity, irrigation, drainage, oasis, Tunisia

Using propagule mimics to model seed bank formation in salinized soils

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Studying soil seed banks is among the research highlights in plant ecology, especially in ecological restoration. Several attempts were made to reveal correlation between size and shape vs. vertical distribution of seeds in the soil. Based on empirical data from natural seed banks, the generally accepted assumption among plant ecologists is that species with small and spherical seeds are more likely to build up dense and deeply penetrating soil seed banks than species with large and flattened seeds. It was, however, not known how long does it take for a seed to travel to certain depths in the soil. Without this information the vertical distribution and seed age can hardly be compared.

The aim of our study was to provide a reference by giving statistical description of the movement of non-decomposing propagule mimics, the size and density of which falls into the range of naturally occurring Central-European plant species. Granules made of high-density polyethylene (HDPE, specific gravity ρ=0.95) and of different sizes and shapes were applied as propagule mimics. The selected study sites are located in the Bihar Plain in the vicinity of Derecske (East-Hungary). on meadow solonetz soils of silty loam texture covered with differently degraded stands of traditionally managed pastures (*Achilleo-Festucetum pseudovinae* and *Cynodonti-Poetum angustifoliae*). The impact of grazing (cattle and/or sheep) on vertical and horizontal dispersal of propagule mimics is to be assessed by comparing fenced and unfenced plots. Results collected on the sodic soils are compared to a similar dataset on non salt-affected soils in order to show how special physical conditions of sodic soils affect seed bank formation.

Basic soil characteristics in the uppermost 10 cm of the studied soils have been analyzed (particle size distribution, sum of exchangeable cations and CEC values, pH-H_2O, soil organic matter, $CaCO_3$, AL(ammonium-lactate extractable)-Ca, AL-K_2O, AL-P_2O_5, NH_4-N, NO_3-N, exchangeable Al, Ca, Fe, Mg, Mn, Na and K). Movement of granules is also to be correlated with penetration resistance determined by a drop hammer penetrometer.

Altogether 160,000 granules were placed to 400 spots in October 2008. In the project (OTKA 67748) planned for 5 years, recollection of small soil monoliths (15x15x7.5 cm) is scheduled twice a year (April, October) in five replicates per plot in each date. Granules resting on soil surface are collected first then monoliths are cut into slices of 12.5 mm width. Granules are separated through soaking in water then washing over a series of sieves. Coinciding with former observations, our first results suggest that smaller granules traveled to deeper layers in a larger portion.

Key words: soil seed banks, propagule size, propagule shape, physical soil type, grazing

Modification of solonetz soil profile characteristics caused by organic matter influx on the livestock resting sites of Hortobágy, Hungary

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Extensive livestock grazing is a traditional way of using the solonetz grasslands of Hortobágy (Eastern Hungary). This way of use results in livestock resting places developed around the shepherds lodging places and wells. Since these sites are situated on the highest elevations of the landscape (87.5-89 m a.s.l.), their soil characteristics differ slightly from that of the surrounding surfaces (86-87 m a.s.l.). However, the original "deep meadow solonetz" or "meadow solonetz turning into steppe formation" soil types of these places were modified by the effects of livestock trampling and organic matter influx due to muck accumulation and straw and hay input as well. The degree of modification seems to differ by the intensity and the length of use.
We investigated soil characteristics of 4 profiles from 3 locations modified by effects mentioned above and compared their characteristics with 2 reference profiles situated very close to these places but not modified in this way.
The profiles were sampled every 10 cm to 70 cm depth. Thickness of accumulation horizon, morphologic properties of the sampled layers, particle size fractions, pH, carbonates, EC, ESP, CEC, organic matter (via ignition loss), total amount of C and N, C/N ratio were measured and taken into consideration by the evaluation process. In one case the organic matter of the anthropo-organic accumulation layer was also analyzed with IR spectroscopy.
Organic accumulation layers reached a thickness of 3-18 cm. Under the accumulated organic matter compacted soil layers were found with laminated structure. The characteristics of the accumulation layers could be summarized as follows: lower pH and higher EC values, higher cation exchange capacity (CEC: 20-75.5 mg.eq/100 g) but lower ESP (5.7-28%) values in comparison with the topsoil of control profiles. The amount of organic matter reaches up to 22.3%. C:N ratio was higher than 11% in the accumulation layers. IR-spectroscopy showed that the material of the organic accumulations is mostly decomposed, dominated by cellulose compounds and it is in reactive form. The degree of humification is very low and probably blocked by the cold winter, the dry summer periods and the particularly high salinity of the soil as well.
Based on the properties and the thickness of the accumulation layers these soils do not satisfy the criteria of an Anthrosol of WRB, because the thickness of the accumulation horizon does not reach 50 cm in any case, given in the definition. However, based on the physical and chemical characteristics of the topsoil these soils differ significantly from undisturbed meadow solonetz soils.
Key words: livestock resting sites, solonetz, anthropic soil, organic horizon, C:N ratio

Soil-plant correlations in native salt-affected habitats in central Poland

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The natural inland saline areas in central Poland are connected with the occurrence of the geological structure of the Zechstein salt-bearing formation. In addition inland halophytic vegetation may occur as a result of soda industry. This research aimed at describing differences in soil-plant relations on natural and anthropogenic stands. Three types of habitat were investigated: 1. natural saline grasslands in the villages Jacewo, Turzany and Słonawy and meadows in the valley of river Zgłowiączka, 2. anthropogenic saline meadows next to the sediment traps of two soda factories in town Inowrocław and Janikowo and 3. halophytic vegetation along brine pipelines connecting salt mains with soda factories and pipelines providing saline wastes of soda production to the adjacent rivers. In total 76 phytosociological relevés and soil samples from the root zone (0-25 cm) in each plot for chemical analyses were taken. In the natural stands soil salinity was characterized by $Na^+ > Ca^{2+} > K^+ > Mg^{2+}$ cations and by $Cl^- > SO_4^{2-} > HCO_3^-$ anions. Spearman rank correlations demonstrated high significant correlation between Cl^- and Na^+, SO_4^{2-} and Ca^{2+} and Mg^{2+} cations and high correlation between HCO_3^- and K^+. Next to the sediment traps $Ca^{2+} > Na^+ > Mg^{2+} > K^+$ and $Cl^- > SO_4^{2-} > HCO_3^-$ ions dominated. Only Cl^- was significantly correlated with all cations. Along pipelines cations and anions dominancy in the extract was similar like in the natural stands, but only Cl^- was significantly correlated with Na^+ and Ca^{2+}. After discriminant analysis (CVA) including all measured soil properties high pH values were identified as significant for pipeline habitats, high electrical conductivity of saturation extract (EC_e) together with high Ca^{2+} concentrations and the highest Ca^{2+}/Na^+ ratio for the sediment traps surroundings and finally relatively high K^+ concentrations as characteristic for natural stands. CCA analysis, Monte Carlo permutation test and forward selection of all species and environmental data demonstrated that significant in species-environment relations model were EC_e values connected with sediment trap habitat, K^+ characteristic for natural habitats and total nitrogen together with organic matter content. Vegetation of the natural habitats differed significantly from the vegetation of sediment traps and pipelines surroundings. More species were frequent there, as well halophytes: *Glaux maritima, Festuca arundinacea, Trifolium fragiferum, Melilotus dentata, Carex distans*, as glycophytic species. There were not significant differences in vegetation between sediment traps and pipelines stands. For these two anthropogenic habitats presence of obligatory halophytes i.e. *Salicornia europaea, Aster tripolium, Atriplex prostrata* and *Spergularia marina* was typical. Considering communities distribution results of CVA analysis identified natural stands as significantly different from two other categories. There were more frequent *Scirpus maritimus* community, *Glaux maritima-Potentilla anserina-Agrostis stolonifera* and *Triglochin maritima* community. *Salicornia europaea, Puccinellia distans-Salicornia europaea, Puccinellia distans* and *Atriplex prostrata* communities were typical for anthropogenic stands. Differences in soil condition in sediment traps and pipelines surroundings didn't reflect as well species as community's distribution.

Key words: halophytes, soil salinity, inland salt-marshes, discriminant analysis, CCA

Monitoring and assessment of coastal saline soils in southern region (Badin) Pakistan

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The salt affected soils in the southern region of Badin, Pakistan have been a challenge to agricultural production. In order to understand the nature and extent of these salt affected soils, a salinity study was conducted. Different profiles (0-120cm) were exposed from 16 different locations. The sampling sites were selected in such a way as to cover most of the salt-affected area. The results showed that the main causes of salinity were poor irrigation water management without having a suitable arrangement of drainage. Other causes are seepage from canals and shallow saline ground water table. However, there are several natural saline seeps in the region, which can contribute to salinization. Accumulation of salts was high on the surface soil due to capillary rise during fallow season, which resulted in secondary salinization. High free evaporation of water from the surface aggravated the salinization process. Saline and saline-sodic soils were the major salt-affected soils in the region. Most of these salts are easily soluble. While sodium was in excess in saline-sodic, calcium was in excess in saline soils. Chloride was the dominant anion in salt-affected soils. Ground water depth was shallower during the rainy months (June-August) and its salinity was lower than in dry months. Irrigation water salinity was also low from June to August. Saturated paste extracts are high in chlorides, sulfates, and carbonates in all profiles, ESP and SAR are more than 15 in all these soils studied. The average electrical conductivity (ECe) and pH values were17.2 mmhos/cm and 8.7, respectively. The results are valuable for producing a salinity map to show the areas at risk of salinization and planning the management of salinity.
Key words: salt affected soils; saline soil; sodic soil, water table depth.

Methodology of the analysis of the maps of soil salinity to judge the dynamics of salinization-desalinization processes

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Salinization is one of the most dynamic soil properties. Secondary salinization intensifies salt transfer in the soil profiles. In the newly irrigated area of the Golodnaya Steppe (Uzbekistan), the salt status of soils may change from nonsaline to strongly saline and vice versa within a year. Despite such a considerable dynamism of salinization–desalinization processes, traditional methods to assess the dynamics of soil salinity are based on the comparison of two maps of soil salinity developed at different times with an arbitrarily chosen time interval between them.

Maps of soil salinity reflect the chemical type and the degree of salinization. Nonsaline, slightly saline, moderately saline, strongly saline, and very strongly saline soils are specified. Nonsaline and slightly saline soils can be grouped in one category. Thus, for the soils with the same chemistry of salinization, four legend units characterize the degree of salinization. If two maps for different years are compared, seven combinations are possible: (1–3) soils, whose salinity has decreased by three, two and one grades, respectively (desalinization of different intensities); (4) soils, whose salinity has not changed; and (4–7) soils, whose salinity has increased by one, two and three grades, respectively (salinization of different intensities). It is supposed that the direction of salinization–desalinization processes in the particular area remains unchanged during the studied time interval.

We have developed 7 maps of soil salinity for the Usman Yusupov farm (no. 10) in the Golodnaya Steppe of Uzbekistan for different years from 1983 to 2008 on the basis of aerial and satellite images. Their analysis proved that the extrapolation or interpolation of tendencies for a period exceeding one year is incorrect. Thus, a comparison of the maps for 1983 and 1985 indicates the intense salinization, whereas the maps for 1985 and 1986 indicate the intense desalinization for the same area. If only two maps are compared, the error of the estimate of salinization–desalinization tendencies may be as high as 70–80%. To judge the dynamics of these processes, the following series of the maps is suggested. (1) Maps showing the areas with stable salinization. From year to year, their portion is about 25% for each salinity grade; for the entire period, it is only 2.5% of the territory. (2) The map showing the trend of salinization (slope of the curve approximating distribution of saline soils by years); for the studied farm (80 km^2), this map contains more than 50 000 polygons attesting to the high spatial variability of salinization-desalinization processes. (3) The map of salinization-desalinization dynamics characterizes the average amplitude (the dynamics coefficient) of salinization-desalinization processes. In our case, it was calculated on the basis of five maps for 1983–1989: $k = (|a-b|+|b-c|+|c-d|+|d-e|+|e-a|)/5$, where a, b, c, d and e are the degrees of soil salinization at a given point (or on a given plot) in 1983, 1985, 1986, 1988 and 1989, respectively. The map demonstrated that the degree of salinization changes by more than one grade on more than a half of the studied territory. Overall, a set of eight maps is suggested to judge the dynamics of salinization–desalinization processes.

Key words: soil salinity mapping, salinization–desalinization dynamics, image analysis

Chemical-morphological properties of salt-affected soils as affected by biogenic factor in the meadow-semidesert complex in Russia

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Special attention has being paid long ago to studying the impact exerted by soil animals on the composition and properties of solonetz soils in the semidesert complex and their role in the formation of peculiar microrelief (Abaturov, 1972; Gacahu, 1987**)**. However, this problem remains very acute at the relatively young territory of the Volga-Ural interfluve area because it hasn't been studied earlier. The objective of this paper is to study the genesis and properties of virgin salt-affected soils in the meadow-semidesert complex on young terraces of Khaki shor and to show the role played by burrowing animals (gopher, vole) in the formation of peculiar microrelief and properties of the soil cover. Three soil pits have been studied as confined to different microrelief elements under a great variety of vegetation. 1) The flat surface under common wormwood-grass association, which hasn't been disturbed by burrowing animals - a control variant; 2) the micro-hillocks formed by gophers under wormwood-grass association and 3) the nano-depression under grass vegetation. The control variant is characterized by the Salic Solonetz soil (WRB-2006). The groundwater samples of a higher chloride-sodium composition at a depth of 2.2m. The soils of micro-hillocks display buried horizons named as zoo-turbated ones (according to «Classification of Soils in the Russian Federation», 2008). In the nano-depression, the genesis of which is connected with solution sinkhole the Endogleyic Kastanozem occurs.
In the micro-hillocks formed by gophers the carbonate material thrown by these animals for 5-7 years reveals destroying the morphologically expressed carbonate and salt neoformations so characteristic of the subsolonetz horizon. The buried horizon (albic) displays a slighter effervescence and some compaction. The horizon (natric) retains the color, but becomes more friable and fissured, effervescence is everywhere, what is absent in the control pit. In zoo-turbated solonetz there are numerous traces of intensive activity of burrowing vertebrates and invertebrates (passages, chitin, droppings, food, litter, etc.). Among the soils under study the soil in nano-depression seems to be most washed out. The absence of soluble salts is conditioned by lower relief and burrowing activity of animals (voles), thus providing transformation of the surface runoff into subsoil one. In the zoo-turbated solonetz the upper horizons are desalinized at a depth of 35 cm (the salt sum accounts for 0.1%). In the subsolonetz horizon the amount of salts is sharply increased (to 2.8%); it is possible to observe chloride and sulfate salinization combined with gypsum to the depth of 180cm. In the soil of control variant only the albic horizon is characterized by moderate extent of salinization and chloride-sulfate composition, being increased with depth. The biological activity of burrowing animals in combination with lithological layering of lacustrine deposits is conducive to higher changes in the chemical composition of soil salinization, thus complicating the soil cover pattern. The research was supported by the Russian Foundation for Basic Studies (project 08-04-01333 and 06-05-64082).
Key words**:** genesis of salt-affected soils, burrowing animals, soil salinization.

Biosaline agriculture for biomass and biomaterials production to generate energy from salt affected soils: Indian experience

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Nearly 1000 million ha area covering about 8% of the land surface of the world in about 100 countries is affected by the twin problems of soil salinity and sodicity. Australia followed by Asia (42.3 and 21.0 per cent, respectively) had the world's largest area under salinity and sodicity. Most of the salt affected soils and brackish ground water resources are confined to arid and semi-arid regions and are causative factors for triggering the process of desertification. Recent estimates indicate that 6.74 million ha in India are affected by higher concentration of salts in the root zone soil. A brief account of the extent, nature and distribution of salt-affected soils and poor quality ground water resources in different states in the country is reported in this paper. A sizeable part of the salty lands in India is constituted by the village community lands and as such these areas are not suitable for cultivation of annual grain crops because of lack of individual property rights. Utilization of such lands abandoned due to high salinity/sodicity for growing salt tolerant trees, grasses, bushes and other high value industrial crops seems promising option. The Central Soil Salinity Research Institute, Karnal has developed and standardized several options to produce biomass and biomaterials to generate energy/electricity from such lands. A brief review of the biosaline agricultural research in India is cited in this paper. The information has been discussed under the sub-heads : (i) promising salt tolerant trees, grasses, shrubs, halophytes and medicinal/aromatic crops, (ii) agrotechniques for practising biosaline agriculture, (iii) silvipastural and agroforestry models for forage, fuel and energy production, (iv) soil amelioration by biosaline agriculture practices (v) scope and limitations of *Jatropha* and *Pongami*a as biodiesel crops, (vi) case studies of energy plantations including post harvest handling, value addition and marketing, (vii) biomass quality in relation to salinity and sodicity, (viii) socio-economic and environmental impacts of raising energy plantations in salt lands and (ix) future research, development and policy needs. Recent results from a seven country consortium biosaline agriculture programme funded by European Union and Coordinated by Organization for Agriculture in Saline Environments (OASE), Netherlands will also be shared and discussed for dissemination and upscaling.

Vegetation induced patterns of soil redox conditions and dissolved iron

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Our presentation focuses on spatial differences of soil redox condition, on causes of theses differences and on effects on seasonal dynamics of dissolved iron. Study areas are located in a hilly headwater area (Szabadszántók, SW Transdanubia, Hungary) and in a lowland area (Geje Plain, Danube-Tisza Interfluve, Hungary). Soil temperature, wind speed (at 1m), incident solar radiation (PAR), soil pH, soil Eh and dissolved iron were monitored. Measurements have been taken in four different patches in Szabadszántók, and three different patches in Gerje Plain: sedge (*Carex vulpina, Carex riparia*), horsetail (*Equisetum arvense*), common nettle (*Urtica dioica*), reed (*Phragmites communis*). Measurements focused on differences between core parts of patches and between edge and core areas. pH and Eh characteristics have been measured individually in the studied patches. Soil Eh, pH and dissolved iron have shown seasonal dynamics. Higher redox potentials and higher pH values were measured between late autumn and early spring in both study areas. The increasing physiological activity of higher plants causes (directly or indirectly) more acidic and more reductive soil environment and it leads to higher spatial differences. Iron content of soil solution also has shown strong correlation with soil redox conditions. Although temperature is an essential determining factor for Eh and pH, our results suggest that it rather have indirect effects through plants on wetlands. The spatial patterns of the studied parameters are influenced by the water regime, micro-topography, and climatic conditions and by direct and indirect effects of vegetation. The indirect effect can be the shading, which has influence on soil temperature and on the incident solar radiation (PAR).
Key words: wetland, redox, dissolved iron, *Carex, Phragmites*

Changes of salt minerals of soil surface efflorescences in space and time: a case study in Hungary

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In the European prairie ecological division (term after Bailey 1996) mineralogical investigations of soil surface efflorescences have not been published. As there are more minerals with sodium sulphate or sodium carbonate chemical compositions, more details were expected from the mineralogical study than from the chemical compositions alone.
176 spots were visited for surveying and characterizing salt minerals in soil surface efflorescences, and on 39 localities (at 29 villages) were found salt efflorescences between 1995-2005.
The soil profiles were described and sampled by the Hungarian soil survey manual and were analysed by international standard methods. The salt minerals were mainly determined by X-ray diffractometry.
There were differences in the geographical distributions of salt mineral associations in surface efflorescences: sulphate mineral associations were only found in salt affected areas West of the Danube and North of Tisza river. Other salt mineral associations: carbonate, carbonate-chloride, carbonate-sulphate and carbonate-sulphate-chloride minerals were found in Danube-Tisza interfluve and in Trans-Tisza river region. Except for gypsum, salt minerals were dominantly sodium salts, sodium-magnesium salt minerals were found only at one site.
Concerning long-term changes in salt efflorescences more occurrences were recorded in the past (1817-1995) than at present (1995-2005): 107 sites compared to 39 spots. The extent of salt efflorescences became much less than they were in the past.
The geographical distribution also changed, in the past more occurrences were observed in the Danube-Tisza interfluve and Nyírség region, and less in Hajdúság region than today, and sodium-carbonate minerals were more frequent.
Attempts were made to observe short-term changes by repeated sampling (six sampling in 2001) at Nyírőlapos (Hortobágy). Only thenardite was determined in springtime. In addition to this, mineral gypsum, sodium carbonate minerals (mainly trona) were identified in summer, termonatrite, thenardite and halite in autumns were found. This is likely due to increasing salt concentrations in the solutions.
The relationship between the chemical composition of groundwater and occurrence and nature of salt efflorescences has already been well-known. In our study we tried to find relationship of groundwater levels and the distribution of salt minerals in soil surface efflorescences.

Reference **Bailey, R. C. (1996)**: Ecosystem geography. New York. Springer.

An investigation on soil salinity variability using different methods of geostatistics

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The spatial and temporal distribution of ecosystem characteristics is required for sustainable management and optimum exploitation of the resources. Soil quality preservation is one of the most important factors in sustainable ecosystem management. Therefore, knowing the spatial distribution of soil characteristics is very important. In the present study, kriging, cokriging and IDW methods were used for prediction of spatial distribution of salinity in soils of Khezrabad region in Yazd province. After data normalization, the variogram was developed. For selecting the best model for computing an experimental variogram, the lower RSS value was used. The best model for interpretation was selected by means of cross validation and error evaluation methods, such as RMSE method. The results showed that kriging and cokriging methods are better than IDW method for prediction of soil salinity spatial distribution. Also the results showed that soil salinity was better determined by cokriging method. The sum of Ca+Mg concentration which was highly correlated with soil salinity is used as auxiliary parameter in this study. At last the soil salinity map was prepared, using the best interpolation method in GIS environment.
Key word: soil salinity, spatial distribution, geostatistics, cross validation

Application of remote sensing to soil salinity mapping in the arid region (Iran)

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Soil salinity is a severe environmental hazard that affects the growth of many crops. It pronouncedly occurs in arid and semiarid regions and reduces crop production with different levels. Therefore with correct information and up to date maps about it, evaluating and monitoring of soil salinity can be conducted. Mapping soil salinity is difficult due to its large spatial and temporal variability. Remote sensing is widely used to survey salinity. In the present research 48 surface soil samples representing Yazd-Ardakan plain were collected and surface soil salinity was measured. Landsat ETM^+ data were acquired in 2002. Results showed high correlation between ETM^+ band 3 and salt concentration expressed by the exponential equation: $y = 0.001e^{0.058x}$ and correlation coefficient R=0.58. Thus, applying this equation to Landsat band 3, a soil salinity map was prepared. Ten soil samples for investigation of map accuracy were applied. The obtained soil samples and other ten soil samples which basically had high similarity in spectral reflectance and geomorphologic characteristics were used to examine the produced soil salinity map and to assess its accuracy. According to results the produced soil salinity map had an overall accuracy equal to 87% and Kappa index equal to 47% indicating an acceptable accuracy for this classification.
Key words: ETM^+ images, soil salinity, Yazd-Ardakan plain

Two transects along the inner and outer sides of a sixty years old Tisza River dike

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Two transects were studied with field pedological investigations and soil bulk electrical conductivity meter in order to understand the effect of a 60 year old dike on soil formation and vegetation composition. The depth to groundwater followed the usual tendency: with decreasing elevation it became shallower. There was a difference in the groundwater depth: outside the dike it was deeper, its salinity smaller than inside the dike. The same tendency was observed for the standing water: it was diluter outside the dike than the river water. There were no great differences in the soil properties. Soil is more saline and wetter inside the dike and vegetation reflected this situation. The alluvial sediments seem to be non-calcareous, yet calcareous subsurface horizons have been observed in all the profiles. This calcareous material might be related with calcareous dust input. Along both transects a dark coloured, organic rich subsurface horizon has been observed. Soil characteristics (both morphological and field measured chemical) indicative of alkaline conditions have been observed in the transects. Perched rain water has been observed in all the profiles. Since the profiles were located in the highs the effect of recent sediment deposits was not dominating. Therefore the soils could be characterized as Meadow soils, except for the highest lying Solonetz soils in both transect. Previously the river was cutting deep into surface and there might have been opportunity to carry some of the salt load of the groundwater flowing into its bed. At present there is less and less chance for such transport, since the river bed is being filled up and less and less groundwater is getting into the bed. This phenomenon can give clue to the larger soil, groundwater and water salinity observed inside the dike than outside. Kuti, 1989 presented a hypothesis on the formation of the salt-affected areas of Danube valley due to the groundwater traps. These traps are formed under the effect of groundwater flowing from two directions: the river bed and the ridges. Similar mechanism can be responsible for the increased salinity inside the dike. We hypothesize that the increasing build up of the riverbed might contribute to the contrast in soil and groundwater salinity between the area inside and the area outside the dike, similarly as conceptualized by Kuti, 1989, but at a much finer spatial scale.
Key words: salinization, groundwater, conceptual model

An ecohydrological approach to salinity and sodicity problems in natural and agro-ecosystems

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Soil salinity and sodicity have been studied much from an experimental and an irrigation science and agronomic point of view. In recent years, profound links have been made to integrate our knowledge and data bases using GIS. These advances are perfect ingredients to be combined with the ecohydrological framework of root zone water balances as developed by e.g. Rodriguez-Iturbe and Porporato (2004) in their book entitled Ecohydrology. This framework is based on the working hypothesis that a systems analysis approach to the rootzone water balance (even in case of nonlinear functionalities) can be a compelling way to deductive research of Soil Water – Vegetation – Atmosphere interactions and feed backs. In recent work, we extended the original framework to take into account groundwater-rootzone interactions as well as salinity/sodicity issues. With the extended framework, we can assess how soil, climate, vegetation, and local geohydrological conditions affect whether or not salinity/sodicity problems will arise. Obviously, such an assessment requires the confrontation with ground truth, for which knowledge and data bases are available (e.g. using Toth et al., 2008, at the European scale), as many parameters are not easily accessible. We will reveal how our approach can lead to useful, robust, and well-focused suggestions for improved soil water and crop irrigation management guidelines as well as improved vulnerability maps for salinity and sodicity.

Salinity/sodicity as environmental stresses in the Carpathian Basin

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Salinity/sodicity are significant **environmental stresses** in the Carpathian Basin caused either by natural factors or by human activities. These stresses result in an increasing ecological hazard to the biosphere; limit the agro-ecological potential and represent a considerable socio-economic risk for sustainable development.

Water as solvent, reactant and transporting agent plays a decisive role in the formation of salt affected soils. In the hydrogeologically closed Carpathian Basin **subsurface waters** have particular importance in salinization/sodification processes. In the poorly-drained lowlying areas the capillary flow transports high amounts of water soluble salts from the shallow, „stagnant" groundwater with high salt concentration and unfavourable $NaCO_3$-(HCO_3) type ion composition to the overlying soil horizons. Due to the strongly alkaline soil solution, the Ca and Mg salts (mostly carbonates and bicarbonates) are not soluble and Na^+ becomes absolutely predominant in the migrating soil solution, which leads to high ESP even at relatively low salt concentration.

High Na^+ saturation of heavy-textured soils with high amount of expanding clay minerals results in unfavourable physical–hydrophysical properties and **extreme moisture regime** of these soils, which are their main ecological constraints and the limiting factors of their fertility, productivity and agricultural utility. The simultaneous hazard of waterlogging or overmoistening, and drought sensitivity in extensive lowland areas, sometimes in the same places within a short period, necessitates a precise, „double function" soil moisture control against their harmful ecological/economical/ social consequences.

Most of the environmental constraints (including salinity/sodicity) can be efficiently controlled: prevented, eliminated, or – at least – moderated. But this needs permanent care and proper soil and water conservation practices, which necessitate the continuous registration of facts and changes (monitoring); exact and quantitative knowledge on the existing soil processes, their influencing factors and mechanisms.

A comprehensive soil salinity/sodicity **assessment system** was elaborated in Hungary during the last two decades on the basis of all available soil information and experimental results, including the application of (geo)statistical analyses, simulation- and predictive transport and transformation *models*, as well as, the integration of remote sensing and GIS techniques. The assessment was the basis of an „early-warning system" giving possibilities for the efficient control of salinization/sodification processes with special attention to their **prevention.**

Key words: salinity/sodicity; extreme moisture regime; assessment system; control of soil processes; prevention

Soil salinization in the Volga delta landscapes

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The soil cover of the delta of the river Volga is characterized by a wide variety and mosaic-like appearance. It is represented as high-contrast combinations and complexes of inefficient saline, alkaline, conjoint and water-logged soils that are characteristic for about 80 % of the territory, and also there we can find mellow lands of zonal alluvial soils of the bottom-land of delta of the river Volga. The territory of the region is differed a complex landscape-geomorphological structure. Ecological regimes, defining the condition of the land cover, within these landscapes are different. That is conditioned with the presence or absence of the surface overflowing and it's dynamics. The main feature of the study region is soil cover's natural inclination to the salt impoundment. The processes of salt impoundment are an integral part of genesis and evolution of the bottom-land and deltoid landscapes. The factors of salt impoundment in delta of the river Volga are the land configuration, the salinity of soil-forming rock, the marine wind, Ber's hills, man's activity. The positive element of the land form is hills and low ridge that are the accumulators of salts, and lower areas are desalted. The intensification of the salinization of the soil body can be seen in a closer deposit of salted soil-forminf rock – most commonly it is khvalynskiy clay.
Keywords: soil covering, salinity, salt impoundment, saline soil

Gypsum pedofeatures in arid soils and their transformation under the impact of anthropogenic loads

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The morphology of gypsum pedofeatures and their role in the microfabric of arid soils were studied at the Dzhizak Experimental Station, Uzbekistan. Regularities in the spatial distribution of different morphotypes of gypsiferous horizons were studied, and the ways of their cartographic representation were developed.

The territory of the Dzhizak Experimental Station can be considered a model of the Golodnaya Steppe piedmont plain to the north of the Turkestan Ridge; it is composed of the sediments of merging alluvial fans. The territory occupies a local plateau with nonsaline and nongypsiferous (in the upper meter) sierozems and the valley of a temporary stream with hydromorphic strongly saline and gypsiferous meadow and solonchakous soils. Our studies were performed before the construction of a drainage channel and 20 years after it to trace changes in the character of gypsiferous soils

The following conclusions can be made.

(1) Three morphotypes of gypsum pedofeatures have been specified: (a) the incrustational gypsum with the subtypes of fine-, medium-, and coarse crystalline gypsum; (b) the nodular gypsum and (c) the powdery gypsum with the subtypes of crumb-like and marly gypsum.

(2) These morphotypes of gypsum pedofeatures are developed in dependence of the character of soil hydromorphism and the position of soil in the landscape. The micromorphological description of gypsiferous horizons attests to the partial substitution of calcite for gypsum crystals.

(3) Specially developed scales of the morphological parameters of gypsiferous horizons were applied to develop the maps showing the distribution of different morphotypes, the depth of the horizon with the maximum accumulation of gypsum and the gypsum content in this horizon with indication of the relative contribution of each morphotype.

(4) The morphotypes of gypsiferous horizons can be mapped on a detailed scale. According to the logic of the new substantive-genetic classification of Russian soils, the content of gypsum in the soils can be reflected at different taxonomic levels (orders, types, subtypes and varieties) in dependence on the intensity of gypsum accumulation and its morphological manifestation.

(5) Studies performed after 20 years, when the groundwater level dropped by about 1 m, showed that the gypsum content in the soils decreased insignificantly. The major morphotypes were also preserved. However, micromorphological investigations demonstrated certain changes in the microfabric of gypsum pedofeatures. Thus, fine dispersed crystals of gypsum disappeared from the soil profiles, and the number of pseudomorphic substitutions of calcite for gypsum crystals increased significantly attesting to the progressive calcification of the soil profiles.

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Key words: gypsiferous soils, morphotypes of gypsum, soil mapping, microfabrics of gypsiferous horizons