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ASSESSMENT OF HALOPHYTIC VEGETATION TO IMPROVE LIVESTOCK–FEEDING RESOURCES ON SALINE DESERT RANGELANDS

OCENA ROŚLINNOŚCI SŁONOLUBNEJ DLA POPRAWY ZASOBÓW PASZOWYCH NA TERENIE SŁONEJ PUSTYNI

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Key words: desert vegetation, halophytes, salinity gradient, GIS, agro-silvi model, Kyzylkum desert, Central Asia
Słowa kluczowe**:** roślinność pustynna, halofity (rośliny słonolubne), gradient zasolenia, GIS, model rolno-leśny, pustynia Kyzył-Kum, Azja Środkowa

Introduction

Extreme continental climate is one of the major factors affecting plant productivity in Kyzylkum desert ecosystems. Annual precipitation (100–120 mm) occurs in the form of snow and rain during the cold season (winter, spring and autumn); summers are dry and hot. The lowest temperature is usually recorded during January and February, while the highest temperature occurs in July-August. The formerly highly productive livestock system has deteriorated and livelihood of the people has dramatically declined. It was estimated that the areas of rangelands seriously affected by salinity in Kyzylkum desert cover about 1.7 mln ha (UNDP Report, 2007). Accumulation and migration of salts throughout soil profiles in these areas induced an irreversible degradation of vegetation and decrease of botanic diversity of the main plant communities. As the result of salinization and in places waterlogging the virgin psammo and xerophytic desert plant communities were replaced by halophytes (salt loving plants). Such a phenomenon leads to eradication of useful, endemic or rare desert plant species and to reduction of rangelands' productivity. Nevertheless, these degraded areas have a huge potential to serve as crop and fodder pasture resources (Mainguet et al., 2002, Gintzburger et al., 2003, Toderich et al., 2009). Today, non-conventional methods have to be devised to study and use the desert rangelands economically, and halophytes might permit such utilization, if the areas are properly characterized and managed. The use of halophytes as indicators of soil physical and chemical properties could be an effective and useful method to facilitate transfer of information about these lands from laboratories to the end users. Soil-vegetation relationship in saline localities has been documented in literature (Aparin et al., 2006; Toderich et al., 2009). Land and water management is critical to reclaim saline-sodic soils and vegetative bioremediation or restoration of saline land through re-vegetation is a new strategy for the reclamation of salt prone soils (Qadir, Oster, 2004). This management could be even more useful because a number of halophytes could be utilized as raw resources for forage, food, as energy-crops, edible oil, fiber materials, traditional medicines etc. Considerable research has been undertaken on soil-vegetation relationship in coastal salt marshes saline soils (Toft, Elliot-Fisk, 2002). However, investigations identifying the major environmental factors associated with vegetation patterns on inland saline desert areas are scarce and limited to descriptive botanic documentation of species. Previous studies showed that many wild halophytes were growing well in association with a variety of salt tolerant traditional crops and often provided severe competition to tree/shrubs species, both in natural and improved pastures and on saline and disturbed mine sites (Toderich et al., 2007; 2008).

The present study aims to describe the spatial distribution of desert plant communities along salinity gradient and explores the relationship between different ecological types of halophytic vegetation and soil properties. Modern techniques to predict trends of neo-halophylization process from soil and plant cover data were tested. The regression analysis was applied to investigate correlation between remote sensing data, Na^+ ion content and EC values calculated from field data in order to predict soil salinity and vegetation changes.

Material and methods

Study Area: The study area covers waste marginal lands and natural rangelands affected by salinity of Kyzylkum Desert, including Karakata saline depression. The Kyzylkum Desert, as shown on Figure 1a, occupies the area between the two largest rivers of Central Asia, the Syrdarya River to the east and the Amudarya River to the south and southwest. The target area (Fig 1b) constitutes a salt depression formed by freely-flowing two saline hot artesian wells (vertical drainage water), which are the only water sources available for crops cultivation under saline sandy desert conditions.

Estimation of dry biomass: The harvested material was packed in paper bags in the field and then oven dried at 65°C for 72 hours in laboratory. The dry weight of all the species was then combined to get the total biomass estimates (Bonham, 1989).

Calibration EM38: Electromagnetic conductivity devices were expressed at standardized reference temperature of 25^0C. The reason for expressing at reference temperature is the fact that electrolytic conductivity increases at a rate of approximately 1.9% (Rhoades et. al., 1999). The formula provided in Sheets and Hendrickx (1995), who fit the curve to conversion table given in USDA (1954), we used as: $EC_{25} = EC_a * [0.4470+1.4034\varepsilon^{(T/26.815)}]$, where EC_{25} is standardized EC_a and T-soil temperature.

Soil samples: Soil samples were collected from different depth (0–120 cm). Contents of Na ions was analyzed by water extract from air-dry soil and plant samples (100 mg of sample) and detected on atomic adsorption spectrophotometer (Hitachi 2007, Japan). Salinity gradient was characterized by contents of Na+ ions in the soil profiles.

Results and Discussion

The desert soils of Kyzylkum desert, where halophytic plant communities are grown, evolved under semi-arid and arid conditions. They are characterized by low organic matter (< 1.0%), a high level of calcium, often associated with gypsum, and a low agricultural potential. The soils are composed of particles of varying sizes, they are frequently saline, with unfavorable physico-mechanical properties; poor structural characteristics, and often a high level of compaction. Most of these soils have evolved from alluvial, colluvial or aeolian loessic deposits with little weathering of the parent rock. Soil types of surveyed area are light sandy and silt-sandy loam throughout the profile up to the depth of 60 cm. The soil is highly saline in the top layer and in the lower layers, where high content of gypsum is observed. It was also found that the organic matter in these soils ranges from 0.7 to 1.5 mmol g^{-1}, while the cation exchange capacity varies between 5 mmol g^{-1} and 10 mmol g^{-1}. Total nitrogen (N_2) and phosphorus (P) contents in salt affected soils are low, usually ranging between 0.7–5.5 mg kg^{-1} and 10.0–18.26 mg kg^{-1} , respectively. Available potassium (K^+) content is classified as low or moderate. The dominant cation is Na^+ and the dominant anion is SO_4^{2-}. Ground water salinity varies in the range of 2000–8200 mg l^{-1}. Groundwater table fluctuates from 0.5–2.5 m during May-July at the dry solonchaks and experimental agricultural plots and up to 8.0–20.0 m in the virgin desert degraded rangelands area. Soil fertility of the desert saline soils is characterized as rather low, and cultivation of agricultural crops requires high inputs of chemical fertilizers or applying of costly leaching practice. This strategy, however, increases the risk of re-salinization in the root zone of plants and leaching process has to be repeated every cropping season in order to avoid build-up of high salt concentration in the top soil profile. In this respect, appropriate practices for salinity control should be selected based on quantification of water and salt movement in the soil, on crops response and adaptation to water and salinity stress and on the influence of environmental conditions and management practice on these interactions. Therefore, spatial and temporal distribution of natural vegetation according to soil salinity level were studied based on plant vegetation type and soil salinity level. The most important factor for the mapping of zonal halophytic vegetation was soil salinity and the salt tolerance limits of species. In general, the distinction of each ecological vegetation group differs according to relief, floristic composition and the ion concentration (haloaccumulation plant ability) in the above ground dry biomass. It was found that the most important direct source of soil salinization, as is seen in the Table, was shallow groundwater level calculated through the soil moisture content and soil salinity based on the content of ion Na^+ in the upper soil profiles.

A very intensive process of soil salinization occurs in the areas located in the vicinity of settlements, animal drinking points and artesian freely flowing wells along drainage channels and on small saline depressions (wet solonchaks). Analysis of soil samples from each of these 'hot spot' areas separately demonstrated significant differences of cations and anions content (Fig. 2a), strongly interrelated with the halopytic spectrum composition.

Table. Description of halophytic plant communities in the Karakata salt depression, Central Kyzylkum

Biotope/Ecological groups	Coordinates	Discription of plant communities	Improve-ment practice	Soil salinity level as per sodium content ($Na+$, mmol g^{-1})	Halophytic pasture yield (t ha^{-1})*	Soil t ha^{-1} moisture (%)
1. Sandy and gray-brown desert soils/aboriginal psammophytic pastures	N 041⁰ 05'654" E 064⁰ 51'925"	*Ferula assa-foetida, Aellenia subaphylla, Ammothamnus Lehmannii, Astragalus villosissimus, Artemisia diffusa, Salsola praecox, Turnefortia sp., Calligonum leocacladum, Stipa sp., Ammodedron Connoliy*	no	low (0.2-0.5)	0.7	2.8
2. Sagebrush with epphemers (Artemisia spp.) sandy desert/ xerohalophyte	N 041⁰ 06'227" E 064⁰ 51'925"	*Artemisia diffusa, Haloxylon aphyllum, Peganum harmala, Salsola sp., Climacoptera lanata*	no	low (0.1-0.7)	2.48	3.3
3. Small sandy hills /Haloxerophyte (1)	N 041⁰ 06'231" E 064⁰ 50'925"	*Peganum harmala, Alhagi pseudalhagi, Ammothamnus Lehmannii, Salsola sclerantha, Salsola praecox, Climacoptera lanata*	no	low (0.9-9.7)	0.40	5.5
4. Haloxylon forest/ Haloxerophyte (2)	N 041⁰ 05'052" E 064⁰ 52'510"	*Peganum harmala, Haloxylon aphyllum, Alhagi pseudalhagi, Salsola sp., Sueda sp., Climacoptera lanata*	no	low moderate (7.0-44.1)	1.5	7.9
5. Desert salt affected soil improved through an agro-silvi – pastoral model (1)	N 041⁰ 04'830" E 064⁰ 52'666"	Aboriginal strips of halophytes with *Climacoptera lanata* mixed with moderately salt tolerant tree-shrubs-traditional crops (*Sorghum, Pennisetum-Amaranthus* etc. crops)	without irrigation & fertilizers (control)	moderately (36.2-65.8)	4.7	8.1
6. Desert salt affected soil improved through an agro-silvi – pastoral model (2)	N 041⁰ 04'830" E 064⁰ 52'666"	Aboriginal strips of halophytes with *Climacoptera lanata* mixed with moderately salt tolerant tree-shrubs-traditional crops (*Sorghum, Pennisetum-Amaranthus* etc. crops)	irrigation with saline water, without fertilizers	moderately (36.2-65.8)	21.8	8.1
7. Desert salt affected soil improved through an agro-silvi – pastoral model	N 041⁰ 04'830" E 064⁰ 52'666"	Aboriginal strips of halophytes with *Climacoptera lanata* mixed with moderately salt tolerant tree-shrubs-traditional crops (*Sorghum, Pennisetum-Amaranthus* etc. crops)	irrigation with saline water & fertilizers	moderately (36.2-65.8)	43.6	8.1
8. Wet solonchak/ hyperhalophytes (pure stands)	N 041⁰ 02'976" E 064⁰ 52'544"	*Tamarix hispida, Salicornia europea, Sueda sp., Climacoptera lanata, Alleropus litoralis, Halostachys caspia, Halimochnemis strobilaceum*	no	high (97.3-751.3)	11.5	8.9

* calculated for *Climacoptera lanata* under different agro-pastoral management practices.

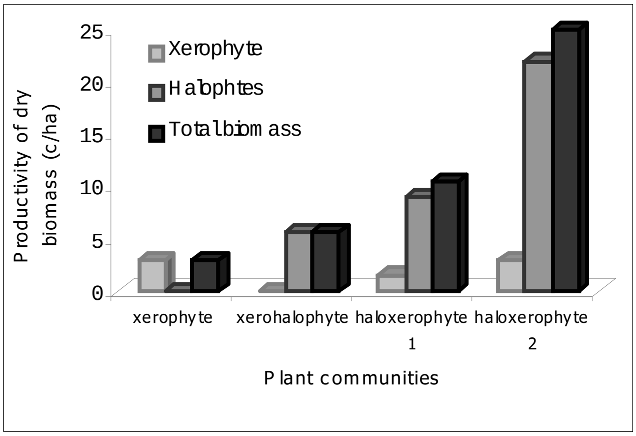
The results generally indicated that the salinity gradient, moisture, available nutrient and sodium ion content in the soil are important factors in controlling temporal and spatial distribution of vegetation. The distribution of halophytic vegetation is related to inter-specific and intra-specific plant species competition, grazing capacity and land management. As indicated in Figure 2a, we used five halophytic vegetation types to build a species-area curve by calculating the cumulative number of species according to soil anions/cations changes, which correspond with habitats heterogeneity and species diversity at fine landscape scale, like Karakata flat salt depression. In this situation, rangelands productivity sharply declined and it was mostly determined by development of monospecific dominant vegetation stands. During extension of the process of neo-halophylization, previously high productive rangelands became converted into saline pastures covered by halophytes, which differed by their salt tolerance limit and vegetation composition, as seen on Figure 2a and Table. Based on accumulation of ion Na^+ in the soil profile over the entire studied area, the key halophytic plant communities were distributed as strong ecological groups starting from non-saline (psammophytes and xerophytes) through moderate saline (xerohalophytes and haloxerophytes) to highly saline habitats or salt marshes (hyperhalophytes) habitats. As shown on Figure 2b, the ability of up-taking and/or accumulation of sodium ion in the upper soils profile and electric conductivity value detected by EM38 were gradually rising according to floristic composition, spatial halophytic vegetation distribution and relief characteristics. Electric conductivity values were graphed and the linear regression was fitted. In general, there is agood fit of the regression line that is demonstrated by high r^2. On Figure 2b, there is also positive correlation between sodium ion content and electric conductivity, both for the 0–150 cm ($r^2 = 0.8642$) and 0–75 cm ($r^2 = 0.8214$) soil profiles.

A map of the spatial distribution of frequently found halophytic types of vegetation across the Karakata salt depression landscape (Fig. 3) was prepared based on global positioning system, seasonal vegetation inventories, geospatial database and simulation modeling by using GIS.

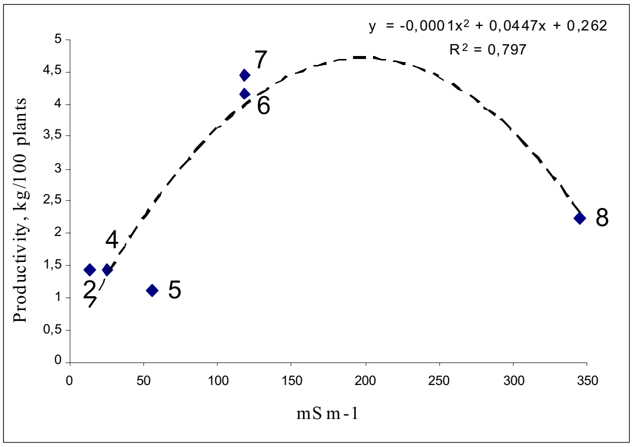
Assessing the grazing potential of rangelands by mapping we found that psammophytes and xerohytes were the dominant types of vegetation covering the largest sand areas of Kyzylkum desert. Halophytic desert vegetation with dominance of xerohalophytes and haloxerophytes *(Haloxylon aphylum, Salsola species, Climacoptera, Suaeda, Alhagi pseudoalhagi, Halothamnus subaphylla, Ceratoides, Haloharis* and different species of grasses) are irregular and patchily distributed, while Hyperhalophytes (representative of salt marshes vegetation) usually grows on solonchaks alkaline wet soils. Each halophytic ecological group described by us consists of different dominant species. The study areas showed a high endemism in plants (about 0.4%). Relative richness of *Chenopodiaceae* is most noticeable with nearly 33%; the investigated small-scale area is also quite rich in *Asteraceae* (20%), *Poaceae* (11%); *Fabaceae* and *Brassicaceae* (about 11%). Species belonging to *Polygonaceae, Plumbaginaceae, Zygophyllaceae, Cyperaceae* account for a smaller share (3–5%), whereas *Eleagnaceae, Plantagainaceae* and *Frankeniaceae* make up an even smaller part (<1.0%) of halophytic pastures. Species from *Asteraceae, Polygonaceae, Poaceae, Brassicaceae* and *Fabaceae* belong mostly to psammophytic and xerophytic types of vegetation, halophytic vegetation is characterized by species from *Chenopodiaceae, Tamaricaceae, Plumbaginaceae* and *Frankeniaceae*. Among cited plant resources there is a number of native and exotic halophytes suitable for reclamation of arid and semi-arid, salt/affected and water logging areas that proved to be very useful in demonstration trials. Where there is a high mineral content both in the soil and water samples, species of genus *Salicornia, Halostachys, Atriplex, Halimocnemis, Climacoptera, Suaeda,* annual *Salsola*, seldomly species of *Tamarix* and various salt tolerant grasses like *Aeloropus, Bromus, Eremopyrum, Cynadon* and others belong to halo-and hyperhalophytes. For this ecological group the vegetation period begins fairly late because marshes are under water for a long part of the year.

The halophytic pasture yields expressed as t ha^{-1} dry weight for representative biotopes increase with radical changes in soil salinity and water table level (Table). *Haloxerophytes* and *halophytes* (salt accumulating plants) usually produce huge green biomass due to juicy stems and leaves. The highest yield dry biomass, as shown in Figure 4a, was observed for halophytic plant communities, which were the first colonizers of salt marshes or wet solonchaks biotopes. The rangelands grazing capacity and yield of green/dry biomass significantly increase, when agro-silvi pastoral management practices are applied (Table).

Based on the map vegetation pattern distribution and on ground data we found that there were only a few core species, which determine productivity of rangelands of the studied biotopes/niches. Assessing the grazing potential of degraded rangelands by mapping zonal halophytic vegetation allowed us to identify salt pioneer plant species for each studied zone in order to initiate the reclamation process of saline prone soils. Among frequently found species there was *Climacoptera lanata (Chenopodiaceae)* – an annual species, growing well both on salty crusts (solonchak-alkaline soils), on clay and gypsum deserts, on takyr and high saline sandy soils. Therefore, we consider this species as a model plant for calculation of rangeland productivity both on virgin area and under cultivation (agro-silvi pastoral model) by using supplement irrigation with artesian mineralized water and application of fertilizers (Fig. 4b).



a



b

Fig. 4: a – Productivity of different ecological groups of halophytic pasture associated with salinity gradient, b – Productivity of Climacoptera lanata on salt affected desert rangelands (points 2, 4, 8); comparison of improvement practice with irrigation and fertilizer (points 6 and 7); and without irrigation and fertilizers in the agricultural areas (5)

A close positive correlation has been found between EM38 and dry biomass yield. Regression curves were fitted to explore response of *Climacoptera lanata* to agricultural management practice including fertilizers and irrigation with high mineralized water. As seen in Figure 4b, productivity of improved halophytic rangelands (in all three biotopes with the dominance of *Climacoptera*) increased more than twice compared with virgin desert pasture. The halophytic rangelands improved by cultivation of *Climacoptera* could be grazed by all kind of animals in the late autumn or winter season. It is not eaten during summer due to woolliness when dry and/or strong smell. It is well consumed by cattle in autumn-winter, usually fruits and as hay, when alkaline salts are leached. Fruits are used to fatten all livestock. It was determined that high water table and salinity provide optimal conditions for accumulation of green biomass for *Climacoptera lanata*. We found out that *Climacoptera lanata* in pure stands or in mixture with other less salt tolerant shrubs and ephemeral desert species represented a highly valuable palatable plant and could be used for improvement and development of production of arid halophyte feeding stuffs.

Conclusion

Information about soil ion content, electrical conductivity, performance of indicator species, biomass clearly indicates which plant species are most likely to contribute to the reclamation process of saline soils. Plant species diversity and distribution are determined by specific features of local soil, i.e. its physical and chemical composition, microrelief and moisture. The climate itself plays a secondary role, as noted by E.V. Shuyskaya et al. (2008). Comparative studies of electric conductivity measurements (EM38) reported in this study are well correlated with sodium ion content in soils and can be recommended as express test techniques for spatial distribution of soil salinity. This assumption is close to those used in the literature (Akramkhanov et al., 2008). Monitoring of these variables may be necessary to assess environmental changes of rangelands vegetation to initiate different revegetation strategies. The lack of long-term monitoring data is one of the largest barriers to the development of successful land remediation strategies.

We also found that halophytes as underutilized plant resources grew well in association with a variety of arid/semiarid rangeland species and often provided severe competition to perennial species, both in natural and improved pastures. Incorporation of fodder halophytes into the livestock feeding system or domestication of wild halophytes species represents low cost strategies for rehabilitation of desert degraded rangelands and wastelands affected both by soil and water salinity. Both local and introduced germplasms for initially lowering water table, followed by management practices to cultivate salt-tolerant forage crops in combination with halophytes can help to improve the livelihood of poor agropastoralists in remote desert areas.

This approach involves evaluation of desert wild plant community and studies of botanic diversity on salinity tolerance limits of each species and its potential biomass, which is of great interest for agropastoralists and sheepherders. Germplasm collection and conservation measures should be conducted since many of the germplasms are on the brink of disappearance due to overgrazing and may become an irreversible loss of biodiversity resources. Usually, the most unpalatable plant communities for animal grazing are widely grown nearly the settlement and water points, where previous vegetation has been destroyed in the result of overgrazing and up-rooting of woody halophytes species for fuel. Most desert halophytes within flora of Uzbekistan represent local and small, sometimes fragmented populations. They frequently have incomplete life cycles with little ability to reproduce, low indices of renewal and replacement.

Future research will focus on rangeland model parameters based on modern sensors (NDVI, Landsat, MODIS and others) and ground data collection to develop environment friendly rangelands rehabilitation techniques.

References

Akramkhanov A.R., Sommer R., Martius Ch., Hendrickx J.M., Vlek P.L., 2008: Comparison and sensitivity of measurement techniques for spatial distribution of soil salinity. *Irrigation and Drainage Systems*: 22: 115-126.

Aparin V.B., Kawabata Y., Ko S., Shiraishi K., Nagai M., Masayoshi,Yamamoto, Katayama Y. 2006: Evaluation of geoecological status and anthropogenic impact on the Central Kyzylkum Desert (Uzbekistan), *Journal Arid Land Studies*, 15 (4), 219-222.

Bonham C.D., 1989: Measurements for Terrestrial Vegetation. John Wiley & Sons, New York.

Gintzburger G., Toderich K.N., Mardonov B.K., Makhmudov M.M., 2003: Rangelands of the arid and semi-arid zones in Uzbekistan. Centre de Cooperation Internationale en Recherche Agronomique pour le Development (CIRAD) , Monpellier, France. 498 p.

Hendrickx J.M.H., Baerends B., Raza Z.I., Sadiq M., Chaudhry M.A.,1992: Soil salinity assessment by electromagnetic induction of irrigated land. *J. Soil Sci. Soc. Am.*, No. 56: 1933-1941.

Mainguet M., Letolle R., Dumay F., Joldasova I., Toderich Ch., Hudzhnazorov M., 2002: Desertification dans les aires seches endoreiques du sud du bassin de l'Aral, Secheresse, No. 1 Vol. 13, 66 p.

Qadir M., Oster J.D., 2004: Crop and irrigation management strategies for saline-sodic soils and waters aimed at environmentally sustainable agriculture. *Science of the Total Environment* 323: 1-19.

Rachkovskaya E.I., Akzhygitova N.I., Kurochkina L.Ya, Litvinova N.P., Khramtsov V.N., 1995: Vegetation of Kazakhstan and Middle Asia (Desert Region). Sankt-Petersburg: 127 p.

Rhoades J.D., Chanduvi F., Lesch S., 1999: Soil salinity assessment: Methods and interpretation of electrical conductivity measurements. FAO Irrigation and Drainage Paper 57.

Shamsutdinov Z.Sh., Savchenko I.V., Shamsutdinov N.Z., 2000: Holophytes of Russia and their ecological characteristics and use. Academy of Agricultural Sciences. Russian Fodder Institute. Moscow: 399 p.

Sheets K.R., Hendrickx J.M.H.,1995: Noninvasive soil water content measurement using electromagnetic induction. Water Resources Research 31: 2401-2409.

Shuyskaya E.V., Matsuo N., Toderich K.N., Sunada K., Gismatullina L., Radjabov T., Ivanova L.A., Ronjina D.A., Ivanov L.A., Voronin P.Yu., Black C.C., 2008: Carbon ^{13}C Isotope Discrimination with C_3 and C_4 Photosynthesis Under Soil Salinity Stress. Abstracts of the international Conference on „Physical-chemical basis of structure-functional of plant organization". Yekaterinburg. Russia, 6-10 October, 28-29.

Toderich K., Shoaib I., 2007: Plant Production on salt affected soils in Central Asian Region. Annual Report of ICBA-CAC, Tashkent-Dubai: 78 p.

Toderich K., Shoaib I., 2008: Plant Production on salt affected soils. Biannual Report of ICBA-CAC, Tashkent-Dubai: 160 p.

Toderich K.N., Ismail S., Juylova E.A., Rabbimov A.R., Bekchanov B.B., Shyuskaya E.V., Gismatullina L.G., Kozan O., Radjabov T., 2008: New approaches for Biosaline Agriculture development, management and conservation of sandy desert ecosystems. [In:] Biosaline Agriculture and Salinity Tolerance in Plant: Chedly Abdelly, Munir Ozturk, Muhamad Ashraf, Claude Grignon (eds.), Birkhauser, Verlag/Switzerland: 247-264.

Toderich K.N., Shuyskaya E.V., Ismail Sh., Gismatullina L., Radjabov T., Bekhchanov B.B., Aralova D., 2009: Phytogenic resources of halophytes of Central Asia and their role for rehabilitation of sandy desert degraded rangelands. *Journal of Land Degradation and Development*, 20 (4): 386-396.

Toft C., Elliott-Fisk D., 2002: Patterns of vegetation along spatiotemporal strands of a desert basin lake. *Plant Ecology* 158: 21-39.
UNDP & Agency for transfer of Technology Collaborative Project, 2007: Assisting Development of Biogas Technology in Uzbekistan.
USDA, 1954: Diagnosis and improvement of saline and alkali soils. Handbook 60. US Salinity Laboratory Staff. US Government Printing Office, Washington D.C.

Streszczenie

W badaniach zależności pomiędzy przestrzennym rozmieszczeniem roślinności na pustyni Kuzył-Kum a zmianami biofizycznej i chemicznej charakterystyki gleby wykorzystano geobotaniczny opis zespołów roślinnych oraz mapy roślinności uwzględniające gradient zasolenia.
Wyniki tych badań wskazują, że zasolenie gleby, wilgotność i zawartość jonów sodu są głównymi czynnikami odpowiedzialnymi za zmiany roślinności. Bogactwo roślinności, różnorodność gatunków botanicznych, biomasa roślin są dobrze zintegrowane z zasoleniem gleby liczonej dla nagromadzenia jonów sodu. W sezonie zimowo-wiosennym stwierdzono spadek zasolenia gleby oraz koncentrację innych jonów, co przypisuje się efektowi rozcieńczenia przez wodę ze śniegu i deszczu. Zawartość jonów mineralnych, mierzona za pomocą EM38 oraz elektrokonduktometru (EC), w połączeniu z opisem geobotanicznym dominujących zespołów roślinnych, posłużyły jako wskaźniki biomasy (ilość żywej tkanki roślinnej) i są używane razem z liczbą dni wegetacji z temperaturą wyższą od zera (GDD>0) lub dni od zasadzenia do dokładnie przewidywanego terminu zbiorów. Wykonany w badaniach pomiar przewodności elektrycznej (EM38) wskazuje na dodatnią korelację z zawartością jonu Na^+ w profilach gleby i może być wykorzystywany dla szybkiego testowania rozkładu przestrzennego zasolenia gleby, a w efekcie zmian pokrywy roślinnej w środowisku słonej pustyni.
Większość gatunków słonolubnych wykazywała regularne rozmieszczenie. Ich obfitość wahała się znacznie w zależności od gradientu zasolenia, a w mniejszym stopniu od wskaźnika suchości klimatu. W wyniku rosnącego zasolenia gleby zaobserwowano zastępowanie zespołów drzew i krzaków głównie trawiastymi roślinami słonolubnymi. Struktura gatunków zmieniła się również w wyniku wypasu bydła – pojawiły się w pokrywie roślinnej egzotyczne, mniej smaczne, rośliny słonolubne.
Rekultywacji i zwiększeniu produktywności terenów o glebach podatnych na zasolenie sprzyjałoby zagospodarowanie i włączenie roślin słonolubnych, wartościowych jako pasza, do systemu rolnictwa biosolnego. Problem żywienia bydła można by rozwiązać wprowadzając uprawę na pasze trawiastych roślin słonolubnych pomiędzy plantacjami drzew i krzewów tolerujących sól. Tym samym wzrosłyby dochody rolników.

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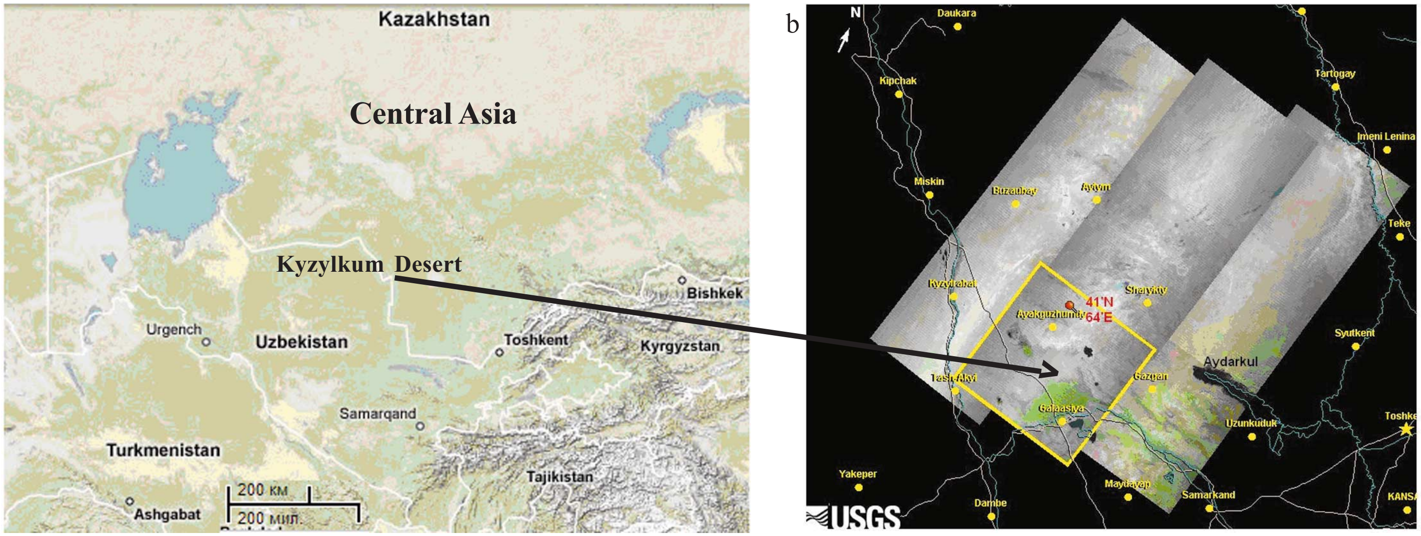
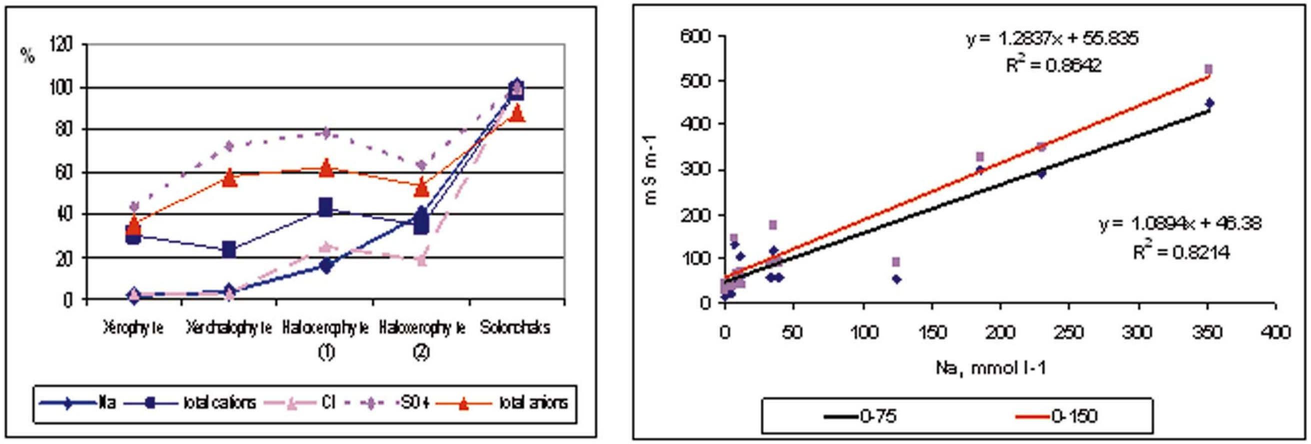


Figure 1: a – Topographical landscape map of Central Asia, b – Landsat image of experimental areas



a b

Figure 2:
a – Relative content of different cations and anions in the studied zones,
b – Linear regression between estimated soluble salts from electrical conductivity (EM38) and Na^+ content across salinity gradient at fine landscape level

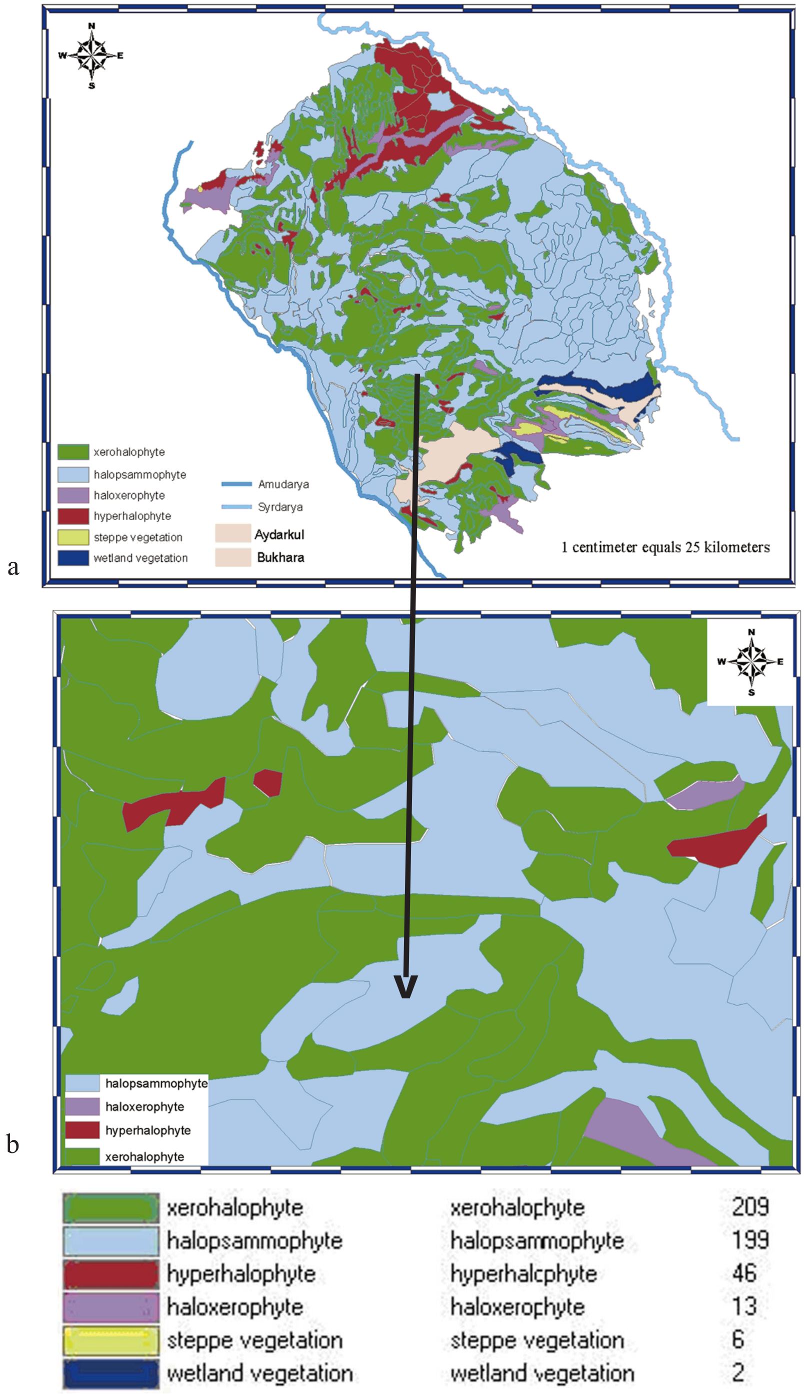


Figure 3: a – The map of Vegetation of Kyzylkum Desert, b – Karakata salt depression showns spatial halophytic plant communities distribution along the soil salinity gradient.
It was elaborated on the map of Kazakhstan and Middle Asia (Rachkovskaya et al., 1995).
The map is based on the scale 1: 2 500 000