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WATER REGIME OF ANTHROPOGENIC-DEGRADED SANDY SOILS OF DESERT RANGELANDS AND NECESSITY OF HIS REGULATION

Abstract. The reason of formation of the centers of the mobile sandy barkhans formed as a result of anthropogenic degradation of sandy soils of desert rangelands of SouthernLake Balkhash region is studied. The main soil-hydrological properties the 0-60cm a layer of a sandy barkhan of friable-sandy granulometric composition with absolute prevalence of fine sandy fraction (>90%), having very high speed of absorption (8.1 m/min), filtrations (2,1 mm/min), minimumwater capacity (MWC) - 7.3% and wilting moisture (WM) 1.7% are defined. Features of the seasonal regime of field moisture of a sandy barkhan, characterized maximum moisture (5,6%) during the early-spring period, the beginning of deficiency of moisture (~2%) in June and acute shortage of moisture in July, August and in September with moisture of all thickness of a root zone below WM are established.

Keywords: desert, rangeland, sands, minimum water capacity, wilting moisture.

Introduction. It is known that more than a half of the territory of the Republic of Kazakhstan (54,7%) occupy deserts and semi-deserts most of which part is used as natural rangelands. Among them a special role plays sandy rangelands (25 million hectares), used all the year round where the productivity of natural fodder plants in many respects is defined by ability of the soil, to accumulate reserves of productive moisture by the beginning of summer as development of vegetation entirely decides by reserves of productive moisture in 0-50cm on surface root system therefore studying of its water-physical properties allows to give the quantitative characteristic of various categories of moisture.

Common features of climate of a desert zone of a sub-aerial belt are sharply expressed continentality, dryness, discrepancy between amount of the arriving heat and moisture atmospheric moistening, sharp prevalence of evaporability over rainfall, unevenness of distribution of rainfall on seasons of year, big dryness of air and vigorous activity of wind.

The sandy soils of desert pastures formed in such conditions even at short-term excess anthropogenic loading quickly lose texture of addition of the top horizons and for a short time easily degrading turn into drift sandy barkhans. They often become satellites for many stationary field parking of country farms or settlements, considerably worsening their economic and social situations. Therefore the problem of rehabilitation of the focus anthropogenic-degraded sandy soils against the background of natural process of desertification gains extremely important value for the managing subject aridregions of the republic.

The most rational and ecological reception of fixing of the centers of mobile barkhans of desert rangelands it is possible by cultivation of sand binding brush woods. However the survival of saplings without artificial regulation of the water regime of sandy soils, as a rule, very low, and irrigation in the conditions of sandy deserts because of low water capacity of the soil, demanding frequent watering and high cost of delivery of water is difficult to achieve. From here a conclusion follows – all types of means providing to autonomous improvement of the water regime the degraded sandy soils of desert rangelands have to be used, using all potential of an environment of a landscape. In our opinion it can be use of new materials – synthetic the high swelling polymeric hydrogels (HSPH) and them replacing. Experiences of

use of HSPH in crop production have shown what they considerably increases water capacity and water-retaining ability of sandy soils [1-3]. Therefore use of HSPH when planting saplings or crops of seeds of rangeland plants on sandy desert soils can be considered as means raising their survival.

Considering the above us for reduction in compliance of the water regime of the soil to requirements of saplings of sand binding brush woods the water penetration, minimum water capacity, wilting moisture and seasonal dynamics of field moisturedrift sandy barkhans formed as a result of anthropogenic degradation of desert sandy soils are studied.

Objects and methods. Objects of researches are the centers anthropogenic-degraded sandy soils desert rangeland, transformed to the massif of drift sandy barkhans the village Bakbakty located on the western and northwest suburb of the Balkhash district.

Determination of field moisture of the soil were carried out at the end of the first decade of every month by sampling of the soil to weighing bottle from depths 0-20, 20-40, 40-60, 60-80, 80-100 cm with further drying them in the thermostat to constant weight, and soil temperature – the spirit thermometer in the same terms at depths of 0, 20, 40, 60, 80, 100 cm.

Determination of moisture capacity of HSPH and peat were carried out in lab conditions by their immersion in water to full water capacity with the subsequent weighing after release them from gravitational water. The wilting moisture of the soil was defined by method of sprouts of barley in Astapov-Dolgov's modification [4]. Determination of water penetration and minimum water capacity of the soil it was carried out in field conditions on Astapov-Dolgov's method [4].

Results and discussion. Minimum water capacity (MWC) of the soil is fundamental soil-hydrological property for desert sandy soils. She defines the top limit of a possibility of accumulation of a reserve of moisture in the soil. Her size allows estimate soil saturation degree moisture that it gives an idea to moisture-providing of plants at any moment of their development. It is obliged by the origin to capillary or meniscal forces which arise on an interface: soil particles – soil moisture – soil air.

At moisture of the soil the corresponding MWC in her is observed an optimum combination of moisture and air. Her size is a constant for any concrete soil and on her is established the general reserve of moisture in the soil which size (mm) is defined by reduction of values MWC as a percentage on coefficient 1.6. The average value of MWC for desert sandy soils, containing physical clay within 0-5% and 5-10% respectively is 5 and 8% [5]. However, her some part is inaccessible for plants and it is considered as unproductive or not available to plants of moisture which upper bound is equal to the wilting moisture (WM).

Therefore, limits of fluctuation of soil moisture, available for a plant, or, on terminology N. A. Kachinsky [6], the range of active moisture is between valueMWC and WM and the range of this moisture is wider, the it is more than productive moisture, and the soil is considered better in the agronomical relation.

As the sizes of water-physical properties of the sandy soil which have passed into driftbarkhans in many respects is defined by granulometric composition below we give the fractions of mechanical elements given about distribution on a profile of the soil (table 1).

From the table it is visible that distribution of fraction on a profile of the soil it is subject to noticeable changes where her top part (0-60 cm) it is presented by friable composition, and lowers the connected sand.

Table 1 – Granulometric compositionof the sandy soil, passed into driftbarkhans

Depth, cm	Hygroscopic water, %	The content of fraction (mm) in absolutely dry soil (%)						Sum of fraction <0,01 mm
		Sand		Dust			Silt	
		1-0,25 mm	0,25-0,05 mm	0,05-0,01 mm	0,01-0,005 mm	0,005-0,001 mm	<0,001 mm	
0-20	0,4	2,65	92,45	1,93	0,56	0,92	1,49	2,97
20-40	0,4	2,28	90,58	3,49	0,84	0,92	1,89	3,65
40-60	0,4	1,87	89,82	4,90	0,80	0,88	1,73	3,41
60-80	0,4	1,21	75,78	13,41	2,41	4,10	3,09	9,60
80-100	0,4	1,42	78,30	12,5	1,96	3,61	2,21	7,83

In granulometric composition of the top, probably blow, layer absolutely prevails fractions of fine sand (>90%) with insignificant contents the fine dusty(0,90%) and silty (1,80%) particles. In lower part of soil, presented by the buried sandy soilis noted, sharp decrease in fine sandy fraction and increase in share dusty-silty fractions.

It is known that moisture of sandy barkhans of deserts of the Southeast Kazakhstan owing to features climatic condition it is subject considerable fluctuation on seasons of year and, as a rule, the maximum reserves of productive moisture is noted in the first half of spring, and minimum - in the second half of summer and in an early autumn. Is the reason for that seasonal feature of change of temperature and relative moisture of a surface layer of air and quantities of precipitations in South LakeBalkhash region (table 2).

Table 2 – Mean annual (denominator) and average monthly for 2017 (numerator) arainfall (mm), temperature of a surface of air (C^0) and its relative moisture (%), (weather station Bakanas)

Months / Name characteristics	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean annual
Air temperature, C^0	12,0 -7,2	-9,9 -5,5	-0,1 1,8	10.9 11,6	17.7 20,2	23.2 24,7	25.7 27,3	23.2 23,0	16.7 18,0	8,3 9,0	-1,3 2,5	-8,4 -5,1	7,8 10,0
Relative air moisture, %	77 86	77 83	71 75	53 64	45 48	41 46	38 37	38 39	42 45	56 61	74 76	80 83	58 62
Rainfall amount, mm	13 11	10 22	17 2,5	24 27	25 35	19 25	16 0	10 0,7	7 10	19 25	18 16	17 22	19,5 19,6
Temperature of soil, C^0	-12	-9	1	13	21	28	30	28	20	9	0	-7	10

From table 2 it is visible what at mean annual air temperature 7,8^{0}C her values in the coldest month (January) makes - 12,0^{0}C, and in the most hot (July) 27,3^{0}C. Absolute the maximum of air temperature reaches to 44^{0}C, and at least to - 45^{0}C [7].

Relative moisture of air in winter months high also makes 77-80%, and in the summer, on the contrary very low 38%.

On fluctuation of relative moisture of air the seasons of year, along with air temperature exerts impact and distribution of rainfall.

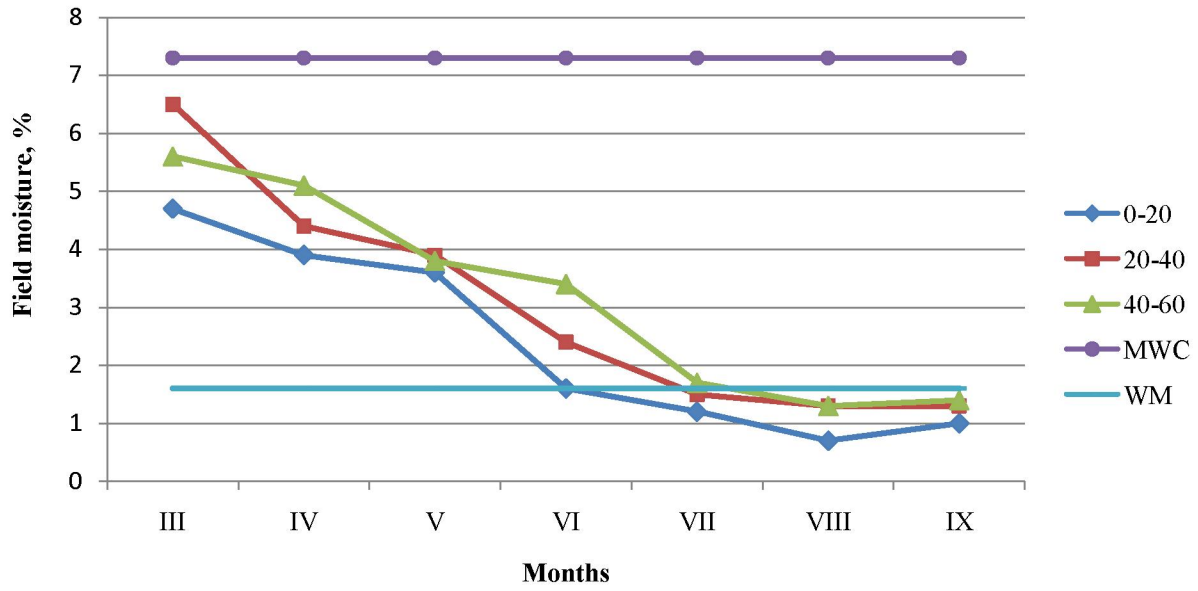
Also follows from data of the table that at a small average annual amount of rainfall (195 mm) a considerable part them drops out in the winter (28%) and in the spring (44%), and at the last in the second half drop out 70%. Similar seasonal distribution of rainfall in combination with temperature condition of a surface of the atmosphere defines the water regime of sandy soils of desert rangelands. Considering the above-noted circumstances promoting a high dynamism and contrast of the water regime of sandy soils transformed in driftbarkhanswewere studied ranges of fluctuations of active or productive moisture the spring-autumnal period. For this purpose are made field and laboratory experiments by determination of their water penetration, the minimum water capacity and wilting moisture.

Determination of speed of absorption and filtration of sand [8], have been shown high speeds of absorption (8,1 mm/min) and filtrations (2,1 mm/min).

Determination of the minimum water capacity of the soil was shown about her increased for friable sandy granulometric composition that, probably it is connected by absolute prevalence (>90%) to fine sandy fraction. The value MWC for layers of 0-20, 20-40 and 40-60 cm was respectively made by 7.0,6.9 and 8%.

The wilting moisture of the soil corresponds to the lower limit of moisture at which plants lose turgor therefore by its value determine a reserve of unproductive moisture in the soil. The wilting moisture of a root zone of a sandy barkhan is 1.7% (±0.1).

Thus, the range of possible fluctuation of available soil moisture is in a root zone of a drift sandy barkhan ranging from 7,0 up to 1,7% that specifies about a small amount of active soil moisture 5,3%, i.e. more than 2 times below soils of loamy granulometric composition.



Seasonal dynamics of field moisture of a sandy barkhan

From data of the diagramabout seasonal dynamics of moisture of a sandy barkhan follows that thawed snow of winter rainfall (55 mm) exceeding a mean annual indicator on 15 mm to the beginning of spring (09.03.2017) doesn't provide achievement of field moisture by the 0-60cm of a layer of soil to the level of her MWC (7,3%), having made only 5,6% or 77% of MWC. At the same time distribution of moisture in layers the 0-20, 20-40 and 40-60cm were different and have respectively made 4.7, 6.5 and 5.6% or 67, 94 and 70% of MWC.

Observed higher moisture in 20-40 cm a layer is explained by his later thawing, reaching maximum value in February and saturation by his thawed snow of rainfall of winter months.

In March at average air temperature 1.8^{0}C (a minimum - 8.6^{0}C and a maximum 22^{0}C), soils 1.0^{0}C, amount at the rainfall 17 mm and descent of snow and thawing of a frozen layer to the middle of the second decade, in the conditions of activity of winds (76% of windy days) South-East, South-East and North North-East of the directions to average speed of 2.6 m/s (a maximum of 9 m/s, break up to 25 m/s) occurs gradual decrease in moisture of the soil, especially in the top 0-20 cm a layer.

In April, despite relevancy of rainfall (27 mm or 14% of annual), an cooling of air temperature (11.6^{0}C with a minimum - 3.7^{0}C and a maximum 28.4^{0}C) and soils (13^{0}C) this month because of very high activity of winds (88%) North, West, North-West and South-East of the directions, blowing with an average speed of 3 m/s (a maximum of 10 m/s, break up to 19 m/s) is observed small decrease in moisture of the soil: for 0,8% in 0-20cm, 1.1% in 20-40 cm and 0.5% in 40-60 cm layers or have respectively made 56, 63 and 64% of their MWC.

May in difference of other months of spring differs in more high temperature (20^{0}C) of air with moderate relative moisture (48%), the average monthly maximum amount of rainfall in a year (35 mm or 18% of annual) and very high activity of winds (86%) South, South-East, South South-East and West directions blowing the greatest in the scale of year the speed of 3,3 m/s (a maximum of 9 m/s, break up to 19-25 m/s). The similar combination of climatic conditions leads to rapid growth of temperature of the soil to 21^{0}C and small (for 0,7%) to decrease in its moisture (up to 3,8%) that is optimum for the root system of plants.

At the beginning of summer, in June growth of average monthly air temperature to 24^{0}C (minimum 8,2^{0}C, maximum 38,6^{0}C) and decrease in quantities of precipitations to 25mm is led to an decrease of relative moisture of air to 46% which at moderate activity of winds (77%) the South-West, West and South South-West of the directions blowing with an average speed of 2,9 m/s (a maximum 9m/sec., break to 19m/sec) promote the accelerated dry up of a top layer of a sandy barkhan, especially his windward sides that in general results in decrease of field moisture 0-60 cm of a layer of soil on average to 2,5%,

and 0-20 cm of a layer are lower than valuesWM (1,6%), i.e. the obvious deficiency of moisture for plants is created already at this time.

In July when average monthly air temperature reaches an annual maximum 25,7^{0}C, (minimum 13,7^{0}C, maximum 41,4^{0}C) in conditions lack of rainfall relative moisture of air reaches an annual minimum (37%) sometimes released up to 11% that at moderate activity of winds (68%) East North-East, East South-East and East directions with an average speed of 2,0m/s (maximum 7m/s, without breaks) is considerable conceding spring and June winds blowing in the directions opposite by him leads to deep warming up (to 29^{0}C at a depth of 40 cm) and to intensive dry up by with quick falling of moisture by the 0-60cmlayer of the sand is lower than the level of valuesWM, i.e. are created conditions incompatible for lives of root system of plants.

In August in the conditions of proceeding heats with the average air temperature of 23^{0}C (difference from 9 to 37^{0}C) and at practical lack of rainfall (0,7mm) over sandy barkhansremains air with low relative moisture (39%), sometimes falling up to 9%. At such indicators of a surface layer of air in the conditions of moderate activity of winds (75%) of South-East, EastSouth-East, East and South South-East directions blowing with an average speed of 2,5 m/s with maximum 7m/sec. without break (at mean annual 25 m/s) there is a further dry up of all thickness of 0-60 cm of a layer of sand that brings to further decrease moisture to 1,1%, i.e. is much lower WM.

In an early autumn, in September, in connection with decrease in average monthly air temperature to 17^{0}C and loss of a small amount of rainfall (10 mm) appreciably increases (by 7%) relative moisture of air which at moderately high activity of winds (78%) of South-East, East South-East, East and South South-East directions blowing with an average speed of 2,7 m/s with a maximum to 10 m/s (at mean annual 20 m/s) with break to 24 m/spracticallydon't exert impact on a condition of moisture of the soil, created in August.

Conclusion. Summarizing the results the above-stated of climatic and soil processes proceeding on sites of distribution of the centers anthropogenic-degraded sandy soils of desert rangelands of South LakeBalkhash region it is possible to draw the following conclusions:

- desert sandy the soil at short-term anthropogenic loading quickly lose texture of addition of the top horizons and for a short time (5-6 years) being easily degraded transformed into driftbarkhans, becoming satellites of parking of country farms;
- the centers of drift sandy barkhans have two-layer constitution; the top blow layer with friable sandy granulometric composition, and lower layer is presented by the buried sandy soil with heavier granulometric composition;
- drift sandy barkhans havevery high speeds of absorption (8.1 mm/min) and filtrations (2.1. mm/min);
- range of fluctuation of available soil moisture in the top (0-60 cm) layer of a drift sandy barkhan is 5.3%, being ranging from 7.3 up to 1.7%;
- in the seasonal water regime of the soil the maximum contentof moisture (5,6% or 70% of MWC) is noted in the first decade of March and despite relevancy of rainfall, it contents at the end of spring decreases to 3.8% or 52% of MWC;
- in June moisture of the soil quickly decreasing, especially in 0-20 and 20-40 cm layers respectively up to 1.6% and 2.4% reaches valuesWM, and in the lagged behind summer months and in September the moisture of all thickness of a root layer is much below than WM, the is created conditions incompatible for lifeof the root system of saplings.

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ШӨЛДІ ЖАЙЫЛЫМНЫҢ АНТРОПОГЕНДІ-ДЕГРАДАЦИЯЛАНҒАН ҚҰМДЫ ТОПЫРАҚТАРЫНЫҢ СУ ҚҰБЫЛЫМЫ ЖӘНЕ ОЛАРДЫ РЕТТЕУДІҢ ҚАЖЕТТІЛІГІ

Аннотация. Оңтүстік Балқаш маңы құмды жайылымының құмды топырақтарының антропогенді деградацияға ұшырауы нәтижесінде пайда болған жылжымалы құмды шағыл ошақтарының түзілу себептері зерттелген. Құмды шағылдың 0-60см қалыңдығының негізгі топырақ-гидрологиялық қасиеттері анықталған. Олар гранулометриялық құрамы босқұмды майда құмды фракцияның (>90%) абсолютті басымдылығымен, өте жоғары жылдамдықта (8.1 м/мин) сіңіргіштігімен, фильтрациясымен (2,1 мм/мин), 7.3% ең төменгі су сыйымдылығымен (ЕТСС) және 1.7% солу ылғалдылығымен ерекшеленеді. Құмды шағылдың далалық ылғалдылығының маусымдық құбылым ерекшеліктері анықталды. Ол ерте көктем кезеңінде максималды ылғалдылықпен (5,6%), маусымда ылғалдылық жетіспеушілігінің (~2%) басталуымен және шілде, тамыз және қыркүйек айларында ылғалдылықтың қатты жетіспеушілігіменжәне тамыр жайғасқан қабаттың барлық қалыңдығының ылғалдылығы ЕТСС-тан төмен болуымен сипатталады.

Түін сөздер: шөл, жайылым, құмдар, ең төменгі су сыйымдылық, солу ылғалдылығы.

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ВОДНЫЙ РЕЖИМ АНТРОПОГЕННО-ДЕГРАДИРОВАННЫХ ПЕСЧАННЫХ ПОЧВ ПУСТЫННЫХ ПАСТБИЩ И НЕОБХОДИМОСТЬ ЕГО РЕГУЛИРОВАНИЯ

Аннотация. Изучена причина формирования очагов подвижных песчаных барханов, образовавшихся в результате антропогенной деградации песчаных почв пустынных пастбищ Южного Прибалхашья. Определены основные почвенно-гидрологические свойства 0-60 см слоя песчаного бархана рыхлопесчаного гранулометрического состава с абсолютным преобладанием мелкопесчаной фракции (>90%), обладающие очень высокой скоростью впитывания (8.1 м/мин), фильтрации (2,1 мм/мин), НВ-7.3% и ВЗ 1.7%. Установлены особенности сезонного режима полевой влажности песчаного бархана, характеризующиеся максимальной влажности (5,6%) в ранневесенний период, начало дефицита влажности (~2%) в июне и острого дефицита влаги в июле, августе и в сентябре с влажностью всей толщи корнеобитаемого слоя ниже ВЗ.

Ключевые слова: пустыня, пастбище, пески, наименьшая влагоемкость, влажность завядания.

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