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Soil Moisture Change and Regime in Darkhan Region of Mongolia

Dolgorsuren Azzaya[1*] and Eldev-Ochir Erdenebat[2]

[1]*Institute of Meteorology and Hydrology,Juulchny gudamj-5, Ulaanbaatar-46, 210646, Mongolia*

[2]*Ministry of Nature and Environment, Ulaanbaatar, Mongolia*

1. Introduction

One of the most significant sectors of Mongolian economy is agriculture. Mongolia has 1.3 million hectares of arable land that can produce environmentally clean and friendly products. Recently 159.0 thousand hectares are planted with spring wheat, barley and oats, while 9.6 thousand hectares are planted with potatoes, 5.8 thousand hectares are planted with vegetables, 11.7 thousand hectares are planted with oil crops.

Scientists have identified that the major factor, which limits vegetation growth is the soil moisture. Mongolian scientists have studied and estimated the water provision for growing period is about 40% in the central agricultural region of Mongolia.

2. Methodology

Once in every ten days during the crop-growing period soil moisture has been measured using weight difference method. The soil moisture is calculated by formulae.

$$W = W2/W1*100\% \quad (1)$$

Where: ***W2*** – weight after drying, g
W1 – weight before drying, g

Fig. 1. The soil moisture sampling

Fig. 2. Cups for soil moisture samples

The water provision is estimated by formulae.

$$\omega_x = P/E \times 100\ (\%) \quad (2)$$

Where: P – water availability, mm
E – needed water, mm

$$P = R\omega - F + (W_1 - W_2) \quad (3)$$

Where: R- precipitation amount, mm
F- runoff, mm
W_1 – soil moisture in the beginning of growth period, mm
W_2 – soil moisture in the ending of growth period, mm

$$E = k \sum(E-e) \quad (4)$$

Where: k- coefficient, depending on plant biology, k = 0.78
$\sum(E-e)$ – sum of humidity deficit, mm

3. Results and Discussions

Since 1984 the soil moisture measurement has started in the Darkhan-Uul aimag. Currently, for the operational use and research purpose in this area the soil moisture samples are taken every ten days from pasture, spring wheat and potatoes fields.

In this study we have analyzed the ground based long-term soil moisture data of the pasture, spring wheat, potatoes for the growth period from 1985 to 2003 and some meteorological elements at the Darkhan agro-meteorological research station.

The annual precipitation of the Darkhan area is 325 mm, 85-90% of that amount normally have in a warm period of a year. Due to the global warming during the last 10 years amount of the precipitation for the growing period has decreased and amount of the precipitation for the non-growing period has increased.

Fig. 3. shows the soil moisture of the pasture field for different depths (from 5 cm to 100 cm) in Darkhan region. In this figure we have shown average value of the soil moisture of the pasture field for the period from April to October, 1984-2003. Soil moisture pattern (trend) of the pasture varies from 8% in depths 0-50 cm to 5% in depths 60-100 cm for the growth period. In this figure by X axis we have soil depths as 5 cm, 10 cm, 20 cm and 100 cm and number 1 means 5 cm soil depth, number 2 gives 10 cm soil depth and 11 is 100 cm soil depth.

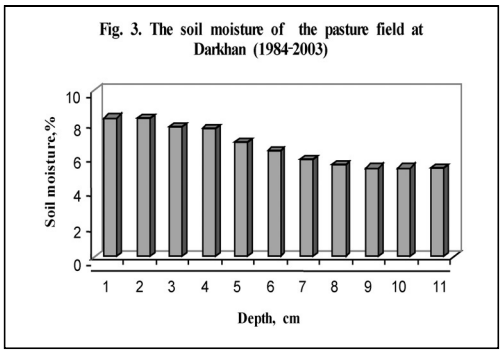


Fig. 3. The soil moisture of the pasture field at Darkhan (1984-2003)

Thus, the change of the soil moisture during the warm period in this area is from 0.0 mm to 0.5 mm in depth 0-20 cm (Table 1), from 0.0 to 2.0 mm in depth 0-50 cm and 0.0-3.0 mm in depth 0-100 cm.

The soil moisture of the pasture field for different decades (from the second decade of April till the second decade of October) of the growth period in Darkhan region is shown in fig 4. The figure says that the soil moisture value of the pasture field is not much variable. After the soil melting in the spring period this value is little be higher than soil moisture values of the warm period. The soil moisture trend from the soil melting period to the end of June is decreasing and after that it's increasing until the soil freezing period due to the summer rain.

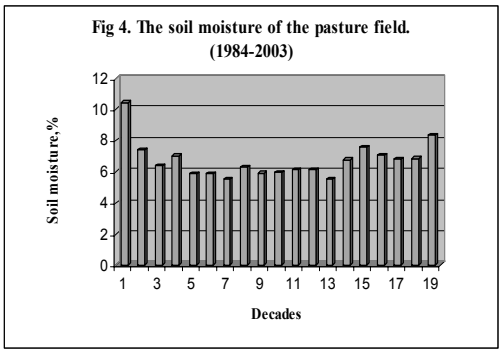
Table 1. The soil moisture of the pasture field, %

Depth, cm	5	10	20	30	40	50	60	70	80	90	100
Soil moisture, %	8.36	8.33	7.81	7.65	6.88	6.39	5.84	5.48	5.36	5.36	5.33

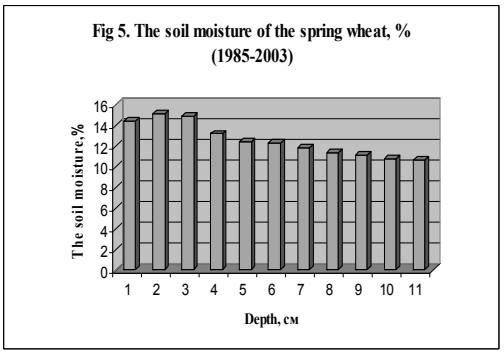
Table 2. The soil moisture of the pasture field, %

Month	April		May			June			July			August			September			October	
Decade	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2
Soil moisture, %	10.4	7.4	6.4	7	5.9	5.9	5.5	6.3	5.9	6	6.1	6.1	5.5	6.8	7.6	7.1	6.8	6.8	8.4

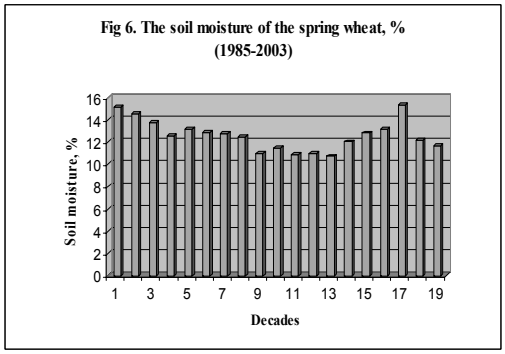
The time series (Table 2) shows that change of the soil moisture for this field is from 1 to 2% for the vegetation period.



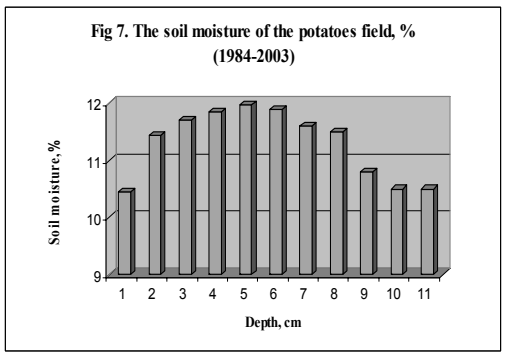
The soil moisture of the spring wheat field in the 0-100 cm of the soil depth is almost 2 times more (Fig. 5) than the soil moisture of the pasture field.



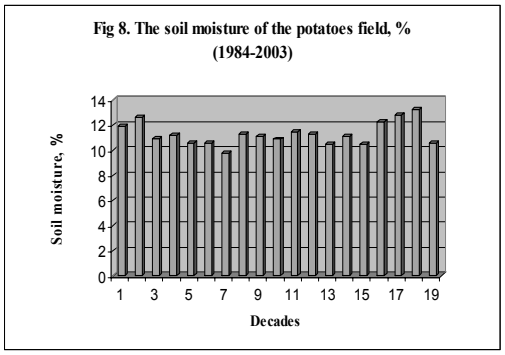
If analyze the soil moisture of the spring wheat field for the different decades of the growing period, then that is decreasing from the soil melting period until the middle of summer (Fig 6) and after that it is increasing.



The soil moisture pattern of the potatoes field is little be different (Fig 7) from previous two field's soil moisture. In this case the soil moisture value is maximum for the depth from 30 cm to 50 cm, in which normally is located the most part of the root system of potatoes. The soil moisture of potatoes has not much big change in the different depths. It changes from 0.1 to 1.6%.



The soil moisture of the potatoes field for the different decades of the growing period is decreasing from the soil melting period until the middle of summer (Fig 8) and after that it is increasing. During the growth period it changes from 1 to 3%.



4. Conclusions

Based on this study we concluded that the soil moisture in Darkhan plays an important role for the pasture and agricultural crops.

Results of the analyses show that rain is the most significant parameter for the soil moisture. Particularly rain of the April-June period is critical for the pasture and agricultural crops.

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