DETERMINATION SOIL MOISTURE IN THE SOME AREA OF MONGOLIA

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ABSTRACT: The article refers to survey work which was carried out during research of the possibility to use the data taken from the space for the arable land survey of Mongolia.

The comparative survey of moisture changes of soil in 0-40 cm depth uses data taken by the PALSAR and ASTER satellites and data estimated by the traditional method. The data were taken in the arable land of the central arable region where the climate is dry during 2010 and 2011. The PALSAR and ASTER satellites are capable to identify and to measure in accuracy spatially and timely, their resolution is less than 1 m.

The modified soil adjusted vegetation indexes (MSAVI) which depends on the normalized different vegetation index (NDVI) and soil in the arable land of the target survey region in Bornuur soum of Tuv province were estimated using the data taken by the LANDSAT satellite and the plant mapping was drawn. The soil moisture found by the ground survey was compared with other factors which influence this moisture and the dynamic specifications of the changes were estimated.

KEY WORDS: Soil moisture, PALSAR, ASTER, NDVI, MSAVI

1. INTRODUCTION

For the last few years there are the dry and hot weather conditions dominantly, there are less precipitation per year in the some regions where climate is harsh, the temperature is being increased dramatically from year to year than the average due to above mentioned negative factors, the soil moisture balance is being lost; the content of soil humus of the arable land; therefore there is difficulty and less possibility to harvest abundant sustainable haymaking because of decrease of nutritive chemical elements and decrease of content of these elements.

If we see the overview of the arable land science, the main issue of the cultivation of harsh weather conditions has been to pay attention for regulating at first the soil moisture into demand and requirement of agricultural vegetation.

The main specification or the index which determines the normal growth, development and process of the flora is the value of soil moisture to be spent during the development maturation stage of the cultivated plants.

The mode of the specifications of the soil fertility such as fertility elements mode, intensiveness of physical, chemical and biologic process is expressed by the supply of moisture in soil. Therefore it is required to research and estimate urgently the soil moisture changes which are caused due to natural and climate and other factors risky and harmful to cultivation production of Mongolia.

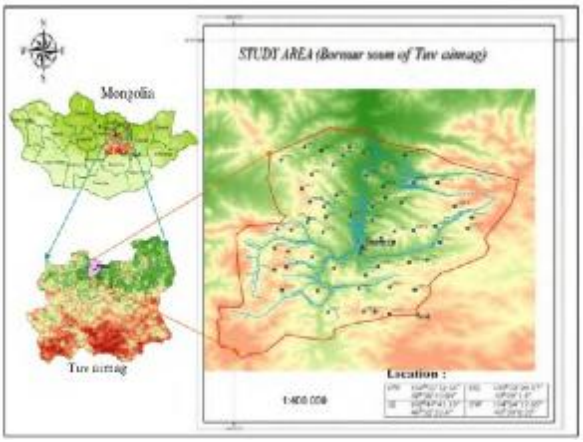
The main management basis for developing the agriculture field, especially the cultivation field, of Mongolia sustainably and properly is to pay attention to permanent control

on soil moisture, amount of the cultivation area and harvest process thus there is full possibility to implement this control using the modern special remote sensing.

The data taken from the space is being used recently widely for the proper utilization of the natural reserves, rehabilitation, surface changes and vegetation status.

We aim to research the dynamic changes of soil moisture of the cultivation of the arable dry regions by using the data taken from the satellite which has high spacial identifying capacity and high time frequency.

2. THE STUDY AREA



The study area is located in the Forest Steppe zone in north-central Mongolia, centered on 48°40'30''N and 106°15'55''E.

The target region of the survey is Bornuur soum of Tuv province, 980 meter above sea level. Bornuur soum is located 105 km from Ulaanbaatar city in the northern boundary of Tuv province, near the western part of Khentii mountain ranges bordering with Baruun Kharaa and Zuunkharaa of Selenge province towards the north, with Jargalant soum towards the west and Batsumber and Bayanchandmani soums toward the eastern and southeastern part.

The study area includes Mongolian State University of Agriculture (MSUA) crop farming and research experimental site (266 hectare).

3. DATA AND METHODS

1. Satellite data: data with resolution less than 1 m taken from the PALSAR and ASTAR satellites in 2011 and the data of LANDSAT TM satellite with 30 meter accuracy taken from May 2011 until September 2011 were used. The LANDSAT TM has 7 spectral channels, its device systems are able to make mapping at near infrared (NIR) regions of spectrum and ultra violate of magnetic wave.
2. Meteorological data of 2011 (weather condition, temperature, precipitation, humidity etc)
3. Soil moisture data / using traditional method/

Natural vegetation chlorophyll or any of a group of green pigments found in organisms, there are four naturally occurring forms, was researched on what spectral zone it is found and NDVI index was estimated on the basis that the vegetation membrane is able to accumulate the sunlight more in red light zone and to reverberate it more in near infrared radiation (NIR).

"Normalized Differenet Vegetation Index" is formulated by using the data of LANDSAT TM satellite measured at similar colors evoked by light consisting predominantly of the longest spectral wavelengths

$$NDVI = (NIR - \mathrm{Re}\ d) / (NIR + \mathrm{Re}\ d)$$

Developed the advanced version which is possible to be used for the image data by having determined the correlation of the factor in vegetation density and soil, "Modified Soil Adjusted Vegetation Index" or MSAVI was formulated as shown below:

$$MSAVI = \left[2\ NIR + 1 - \sqrt{(2\ NIR + 1)^2 - 8(NIR - \mathrm{Re}\ d)} / 2 \right]$$

Within the scope of field survey, spectroradiometer measurement was done at every stage of crop plants growth, elevation point an height, and coordinates were determined and the sample was taken from the soil surface for determining the moisture .
Soil moisture sample was taken from the 0-60 sm depth soil surface layer, three splits then conserved into preliminarily numbered box against evaporation, delivered to laboratory and determined the soil moisture by the standard methodology.

$$W = \frac{a \cdot 100}{b}$$

W - soil moisture of the crop land /%/

a - weight of evapoured water /gr/
B - absolute dry soil weight /gr/

4. RESULTS AND DISCUSSION

Using the data taken by LANDSAT TM satellite with 30 meter accuracy from May to September 2011 measured at red infrared and near infrared radiation, vegetation coverage of sites where the wheat is non rotation wheat and wheat site cultivated at the front and behind of the mountain, barley and oat, second wheat after fallow and third wheat of three field rotation was estimated, mapping was done by using modified soil adjusted vegetation indexes (MSAVI) and normalized different vegetation index (NDVI).

Let's consider the normalized different vegetation index (NDVI) at site cultivated for the 3rd years: it is 0.126 in May, 0.598 in June, and 0.357 in July, 0.622 in August, and 0.471 in September. The NDVI is applied between -1.0 and +1.0. August which has more correlation to value of NDVI is the most effective period for vegetation growth and is the month in which the maturity is fully developed.

Estimated with the traditional method in 30 cm depth during the mentioned period the moisture was 6.3-8.0 % in May, 8.0-8.2 % in June, 7.5-8.4 % in July, 8.8-9.0 % in August and 7.5-10.8 % in September. So it was proved that the soil moisture has direct influence to vegetation growth.

The modified soil adjusted vegetation index (MSAVI) at site cultivated for the 3rd year was estimated: the MSAVI was approximately 0.2233 in May, 0.7473 in June, 0.81373 in July, 0.7654 in August, and 0.6395 in September. So it is increasing in similar level to NDVI.

The NDVI value of the site where the oat is cultivated is 0.1662 in May, 0.3215 in June, 0.42691 in July, 0.7983 in August and 0.5691 in September. When we measured the soil moisture in 0-30 cm depth, the value was 5.7-8.5 % in May, 11.9-14.1 % in June, 9.1-12.3 % in July, 9.9-13.3 % in August and 10.6-16.5 % in September. So it is the same to index of wheat site cultivated for the 3rd year. The index in May is lower or 0.1 so the vegetation plant is in sprouting stage after having cultivated only. It proves that there is not vegetation cover. But the index transfers to 0.798 in August, green vegetation mass cover the whole site. In September it decreased to 0.5691, this indicates that the vegetation maturity is fully grown, vegetation mass begins turning to yellow so the index value is down. The soil moisture reaches its maximum amount in September; the plants accumulated the reserve moisture during their growth.

5. CONCLUSIONS

1. August, which has high correlation to the normalized different vegetation index (NDVI), is the most effective period for vegetation growth and can give more reflection.
2. Vegetation and moisture results in August indicate that the vegetation development stage is more dependable on moisture since plant growing period.
3. It is possible to carry out survey of the crops of Mongolia and to do mapping using the vegetation index.
4. It is required to research the possibility to determine the factors which might influence to crops of the arable land using the data of the satellites which have high identifying capability.

References

1. Amarsaikhan. D, Ganzorig. M, Saandari. M and Adiyasuren. Ts “Remote sensing studies and geographic data system procedures”, 2006
2. Ariunzul. Ya “Estimating the forest zone of afforested area by remote sensing method”, doctor thesis, 2008
3. Gonchigsumlaa. Ch, “Formation of soil studies, prevalence and its classification”, Ulaanbaatar , 2008
4. Sainbayar . D “ Dynamic of soil water”, scientific research, Ulaanbaatar, 2008