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主　論　文　の　要　旨

論文題目　Assessment of drought in Inner Mongolia based on remote sensing drought severity index and its improvement
（リモートセンシング干ばつ指標を用いた内モンゴルの干ばつ評価と指標の改良）

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論　文　内　容　の　要　旨

Drought has a deep impact in Inner Mongolia, which relies on livestock and farming. It is very important to choose a suitable drought index to characterize the drought conditions in Inner Mongolia. Considering the characteristics of multiple vegetation in Inner Mongolia, the temporal and spatial variability of drought conditions in Inner Mongolia was analysed with a drought severity index (DSI), which is derived from the ratio of evapotranspiration to potential evapotranspiration and the Normalized Difference Vegetation Index (NDVI) based on satellite remote sensing measurements. The DSI was used to evaluate the drought in the growing season (May–September) of Inner Mongolia from 2001 to 2010, and to improve the DSI deficiency. The two layers of soil moisture (0-10 cm) and (10-40 cm) were used to replace the evapotranspiration items, and the improved drought index IDSI and IDSI-D were made, and the drought status of Inner Mongolia was evaluated again.

In Chapter 2, DSI was applied to evaluate the monthly drought situation in the growing season in Inner Mongolia during the 10 years. Because the soil moisture as an important drought measure has not been used in the calculation of DSI, the relationship between DSI and soil moisture was investigated with correlation coefficient and regression analysis. Different seasonal and spatial patterns of drought occurrence were found in the notable drought years of 2001, 2007, and 2009. The largest correlations between DSI and soil moisture were attributed to the links between evapotranspiration and soil moisture. The spatial distribution of the correlation coefficients between DSI and soil moisture varied seasonally, tracking closely with the movement of rainfall belt. DSI could not reflect the

variation of soil moisture in woodland. In grassland, DSI correlated with surface soil moisture in the east at the beginning of the growing season. As the rainfall belt expands to the west in the second half of the growing season, DSI reflected apparently deeper soil moisture conditions because of the spatial difference of soil properties, that is, the water-holding capacity becomes larger from west to east. However, evapotranspiration and NDVI are not independent of each other, and the drought situation will be repeatedly superimposed and become difficult to assess.

In Chapter 3, the ET/PET item in DSI was replaced with soil moisture (0-10 cm) to establish a new improved DSI drought index (IDSI). IDSI was proposed to evaluate the drought situation in Inner Mongolia. In IDSI, the two items are independently derived, and the effects of evapotranspiration are still contained in the soil moisture, even the changes of precipitation could be reflected. Using monthly IDSI data during the same period as DSI to re-assess the drought conditions in Inner Mongolia. The confidence interval estimation analysis to determine the interval of the IDSI and also got 11 classification intervals. IDSI also pointed out that 2001, 2007, and 2009 were drought-significant years. The areas for extreme droughts were less than those assessed by DSI because the ET/PET item, which contains the effects of NDVI, were removed. The Z_{NDVI} (the normalised values of NDVI) and Z_{SM} (the normalised values of soil moisture) in IDSI have the same contribution to IDSI at all times. IDSI not only contained the degree of change of precipitation in the current month through soil moisture but also reflected the influence of water and heat in the previous month through NDVI. IDSI had better applicability except for the west grassland areas and areas without vegetation and was generally consistent with agricultural drought disaster records.

In Chapter 4, the improved drought severity index with different depth of soil layer (0–40 cm, IDSI-D) was applied to evaluate the drought situation in Inner Mongolia. Compared the results with IDSI, the dry and wet condition classification of IDSI-D by the confidence interval estimation analysis was almost not different from IDSI. The Z_{NDVI} and Z_{SM} in IDSI-D also had the same level contribution to IDSI-D at all times. The drought conditions of the regions from central to west characterized by IDSI-D were quite different from IDSI in May and June of the early growing season because of smaller fluctuation of soil moisture and seasonal lag in precipitation.

Through the study of DSI, IDSI, and IDSI-D, it was found that soil moisture is very important for evaluating drought conditions in Inner Mongolia. Soil moisture does not only include the effects of precipitation and evapotranspiration but also fully reflects the regional characteristics of Inner Mongolia. Therefore, the drought

index based on soil moisture, especially the IDSI with shallow soil moisture (0-10 cm), is the most suitable for evaluating the drought conditions in Inner Mongolia, especially the grasslands from the central to the east. Understandings of the drought conditions in the 2001–2010 growth season evaluated by IDSI on this study can improve monitoring and early warnings of drought disasters in Inner Mongolia.