Analysis drought event in basin of Soyang-ho using drought index from satellite data

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Abstract

Drought is one of the natural disasters relating to lacking water caused by not only deficit of precipitation but also by lasting dry weather for a long period of time. It affects ecological system as well as social and economic situation. In this study, we used Scaled Drought Condition Index (SDCI) as a satellite-based drought index and Soil and Water Assessment Tool(SWAT) as a hydrological model to analyze. The study area is the basin of Soyang-ho and the study period is from 2013 to 2015. This study used Land Surface Temperature(LST) and Normalized Different Vegetation Index(NDVI) from MODIS and daily precipitation data from TRMM to calculate SDCI and considered several input data such like precipitation, air temperature, wind speed, and humidity to compute soil moisture through SWAT. SDCI for the 1, 3, 6, and 12 months were calculated to compare with SWAT model. The 1 month SDCI showed a considerable variability due to the precipitation and then 3, 6, 12 months have similar performance with SWAT however the longer the considered period, the better performance.

Keyword: SDCI, NDVI, SWAT, LST, AMSR2, MODIS

1. Introduction

Drought is one of the natural disasters relating to lacking water caused by not only deficit of precipitation but also by lasting dry weather for a long period of time. The drought has influenced irrigation systems for crops growing or residents. It can occur large amounts of damage to our life if the drought persists for the long-term.

Recent researches are focused on the study using remotely sensed images due to that the ground-based approach has limitation of spatial analysis. (Rhee at al., 2010; Yagci et al., 2011; Choi et al., 2012; AghaKouchak et al., 2015) The satellite-based approach provides the high spatial and temporal resolution for the wide area.

In this study, we used the SDCI by Rhee et al. (2010) as a satellite-based drought index and soil moisture from SWAT as a Hydrologic model to analyze.

2. Study area and data

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2.1. Study area

The basin of Soyang-ho(river) including Soyang dam upstream, located in Gangwon province, Korea, is the target area of our study. The Soyang river is a one of the major water resource for metropolitan area. There was extremely drought on 2015, and consequently it affected the water for living. The study period is from 2013 to 2015.

2.2. Data

LST and NDVI from Moderate-resolution imaging spectroradiometer (MODIS) and daily precipitation data from TRMM to calculate SDCI. The SDCI used in our study detected the drought well at the wet area as well as at dry area. (Rhee et al., 2010) The SWAT is a public domain model established by USDA Agricultural Research Service (USDA-ARS) and Texas A&M AgriLife Research, part of The Texas A&M University System. The precipitation, air temperature, wind, DEM, land use, soil map, and humidity are considered as variables to compute soil moisture through SWAT. It is more effective way to identify the spatial distribution of the drought events because the SWAT is separated out Hydrologic Response Units (HRUs) by same parts of soil types. Advanced Microwave Scanning Radiometer 2 (AMSR2) is onboard the GCOM-W satellite. It is measure the surficial and the atmospheric weak microwave emission. The AMSR2 was used to compare the soil moisture with the SWAT.

All data excepting the AMSR2 are rescaled as same as the spatial and temporal resolution of MODIS, and the resultant through SWAT is divided into 115 HRUs

3. Methodology

Temperature Condition Index (TCI) by Kogan (1995) is calculated with weekly LST and maximum and minimum LST. The TCI formula is following (equation 1):

$$\mathrm{TCI} = \frac{\mathrm{LSTmax} - \mathrm{LST}}{\mathrm{LSTmax} + \mathrm{LSTmin}} \qquad (1)$$

Precipitation Condition Index (PCI) is calculated using weekly TRMM, maximum TRMM, and minimum TRMM as following (equation 2):

$$\mathrm{PCI} = \frac{\mathrm{TRMM} - \mathrm{TRMMmin}}{\mathrm{TRMMmax} + \mathrm{TRMMmin}} \qquad (2)$$

Vegetation Condition Index (VCI) by Kogan (1995) is computed using weekly NDVI, maximum and minimum NDVI. The following is VCI formula (equation 3).

$$\mathrm{VCI} = \frac{\mathrm{NDVI} - \mathrm{NDVImin}}{\mathrm{NDVImax} + \mathrm{NDVImin}} \qquad (3)$$

These three indices are used as a component of SDCI.

We compared the SDCI and SWAT for the drought level and the SWAT and AMSR2 for soil moisture depending on the period of 1, 3, 6, and 12 months

4. Results and discussion

The reports and articles report that there was extremely drought on the early summer of 2015. (KMA, 2015) Our calculated SDCI is detected the intensely drought on the same time. The results show the same pattern when the drought is reduced. The average SDCI over the whole river tends to better performance if the considered period is longer.

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