Drought Assessment and Monitoring for the ECO Region Using Satellite Data

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1. INTRODUCTION and BACKGROUND

Drought is by far the most damaging of all natural disasters. Worldwide, since 1967, drought is responsible for millions of deaths and has cost hundreds of billions of dollars in damage. A severe drought in Eastern Africa in August 1984 led to widespread famine killing over 700,000 people during the following year (www.nasa.gov).

Recurrent severe droughts in some parts of the ECO region negatively impact the agricultural production and trade of agro-products. ECO Workshop on Drought Management held in Tehran in 2003 and also Ministerial Meeting on Agriculture held in Islamabad in 2002 identified drought management as one of the priority areas of cooperation for ECO countries and determined the Islamic Republic of Iran as coordinator country for ECO cooperation in this regard.

What is drought and what causes it? How early can scientists forecast the onset of a drought and what can be done to lessen its economic impact?

A drought is defined as "a period of abnormally dry weather sufficiently prolonged for the lack of water to cause serious hydrologic imbalance in the affected area." -Glossary of Meteorology (1959).

In easier to understand terms, a drought is a period of unusually persistant dry weather that persists long enough to cause serious problems such as crop damage and/or water supply shortages. The severity of the drought depends upon the degree of moisture deficiency, the duration, and the size of the affected area.

There are actually four different ways that drought can be defined.

Meteorological-a measure of departure of precipitation from normal. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.

Agricultural-refers to a situation where the amount of moisture in the soil no longer meets the needs of a particular crop.

Hydrological-occurs when surface and subsurface water supplies are below normal.

Socioeconomic-refers to the situation that occurs when physical water shortages begin to affect people.

Climatologists and meteorologists determine the onset and the end of a drought by carefully monitoring meteorological and hydrological variables such as precipitation patterns, soil moisture, and stream flow. To do this, meteorologists make use of various indices that show deficits in precipitation over periods of time. There is no one 'correct' way to measure drought. Drought indices are used to detect and measure droughts, but different indices measure drought in different ways, and no single index works under all circumstances. So the Drought Monitor concept was developed. Drought monitoring has become an integral part of drought planning, preparedness and mitigation efforts at the national, regional and local levels.

The dynamic nature of droughts cause challenges in planning, predicting, monitoring, and providing relief to drought-stricken areas. Because of the variability and significant multiple impacts of droughts, we need to improve the available tools to capture their spatial and temporal dimensions. Traditional methods of drought assessment and monitoring rely on rainfall data, which are limited in the region, often inaccurate and, most importantly, difficult to obtain in near-real time. In contrast, the satellite-sensor data are consistently available and can be used to detect the onset of drought, its duration and magnitude (Thiruvengadachari and Gopalkrishna 1993).

In U.S.A., through the use of satellite remote sensors, researchers at NASA and NOAA have been monitoring the causes and effects of drought over the U.S.A for the past two decades. NOAA web site presents an overview of the art and science of global drought monitoring, with maps showing regions affected by drought, updated monthly.

Xihua and Guoliang (1991) developed a remote sensing approach for wheat drought monitoring and modeling, which based on the principles of soil water balance and energy balance. The initial soil water content was obtained from the relationship between the apparent thermal inertia and soil moisture which was established through the experiments conducted over nearly bare fields on the North China Plain. The evapotranspiration of the wheat field was estimated using the remotely sensed reflected solar radiation and surface temperature extracted from the NOAA-AVHRR digital image as well as the meteorological data such as incoming solar radiation, air temperature, wind speed and vapor pressure from ground meteorological station. They then calculated the solid water content in a certain period of time (10 days) using the equation of soil water balance., At last, a drought index model was developed by concerning the available soil water content and the wheat water requirement. This model has been proved to be practicable in monitoring the wheat drought in parts of the North China Plain.

2. OBJECTIVE

In this study a near real-time drought monitoring system is being developed using drought-related characteristics (indices), which are derived from remote-sensing data. The indices include a deviation from the normalized difference vegetation index (NDVI) from its long-term mean and a vegetation condition index (VCI). In this study data from two famous satellites i.e. NOAA-AVHRR and MODIS are used to drive long-term mean and temporal values of NDVI and VCI.

3. EXPECTED OUTCOMES

- Establish a real time drought monitoring system based on NDVI and other indices
- Producing the maps of the well known remote sensing indices such as NDVI and VI
- Producing normal climatological maps of NDVI and VI
- Fill in the gaps in drought monitoring for the region, resulting from measurement related problems of precipitation and other meteorological parameters
- Establish a www site for drought monitoring maps and related discussions
- Inserting drought monitoring documents and papers in www site with address: http://www.eco.drought.org/.

4. PLANNED ACTIVITIES

The study first investigates the historical pattern of droughts in the region using monthly time-step AVHRR satellite data. Droughts in recent years are studied using 8-day time-interval MODIS satellite images available from year 2000 onwards. Then regression relationships are developed between drought-related indices obtained from MODIS and AVHRR data, which have different pixel-resolution and optical characteristics.

These relationships are established for each month of the year separately, as well as for the pooled data of all months. The results are validated again historical data recorded by meteorological stations in the ECO region. At last, a website is designed for dissemination drought monitoring maps and warnings for the whole ECO region.

5. IMPLEMENTING AGENCIES

The study includes whole 8 ECO member countries namely Afghanistan, Republic of Azerbaijan, Islamic Republic of Iran, Kyrgyz Republic, Republic of Pakistan, Republic of Tajikistan, Republic of Turkey and the Republic of Uzbekistan.

The office and human resource will stay in I.R. Iran Meteorological Organization in Tehran, Iran.

6. MONITORING AND EVALUATION

In this study drought indices produced by satellite data (NOAA and MODIS) will be compared with climatological data measured by responsible organizations for at least 5 years. After the evaluation the satellite indices will be used for drought monitoring until if a new method developed for monitoring drought condition that has better result than the mentioned one.

7. BUDGET

- Software for satellite data processing and GIS analysis (PCI Geomatica and ArcGIS) (About 150,000 $)
- Equipment for satellite data reception (400,000 $)
- Validation data (5,000 $)
- (Hardware) (25,000 $)
- Traveling expenses (30,000 $)
- Application and operating system software (5,000 $)
- Website design expenses (20,000 $)
- Manpower (100,000 $)
- Other expenses (50,000 $)

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SUM 785,000 $

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