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RESEARCH ARTICLE OPEN ACCESS

Soil Moisture Mapping Over Odisha

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ABSTRACT: This paper presents a complete methodology to process SMAP surface soil moisture data to develop monthly average soil moisture maps of the state Odisha. The paper also defines the utility of SMAP soil moisture product (L4_SM product) to identify the soil moisture variations over Odisha by analysing daily soil moisture data for entire duration(June-October,2018) covering the monsoon season of the year. In order to determine the developed methodology the year 2018 was selected wherein a total of 153 SMAP daily data files(ascending pass) surface soil moisture for the desired duration were processed and analysed. It has been observed that the soil moisture variations are in proportion to the seasonal changes as well as the rainfall variations.

I. INTRODUCTION

1.1.Background

Soil moisture is one of the few straight noticeable hydrological variables that plays an significant role in water and energy budgets used in climate studies. The quantity of water present in the soil is essentially important to agriculture and it has an consequence on the rate of actual evaporation, groundwater recharge, and generation of runoff. Soil moisture is of various types such as profile, root zone and surface soil moisture. At the present time there is no practical approach for measuring and monitoring soil moisture at the frequency and scale needed for a large scale analysis. Utilization of passive microwave remote sensing in estimating soil moisture provides an optimum solution for large scale basis. The remotely sensed soil moisture microwave data products have immense potential to be used for different applications in the field of agriculture and in meteorological parameters study, for this each available data product should be understood to develop a methodology to generate maps and extract meaningful information. Passive microwave remote sensing data product of SMAP(SOIL MOISTURE ACTIVE PASSIVE) data has been studied in this paper. A detailed methodology to process it and generate monthly average soil moisture maps for the entire state of Odisha has been studied in this paper.

1.2.Soil Moisture Retrieval through Microwave Remote Sensing

The conventional methods used for measuring soil moisture are point specific and labour intensive. In contrast to the conventional methods, remote sensing techniques can play a vital role in soil moisture estimation on routine basis. Different portions of electromagnetic spectrum such as optical, thermal and microwave can be used for soil moisture retrieval using remote sensing techniques. Among all these bands, microwave remote sensing is the finest option for soil moisture retrieval because of its high penetration ability and high dielectric constant of water i.e. 80 at microwave frequency [Srivastava et al. 2015]. The in-situ methods are very precise in estimating the soil moisture but it has a constraint that the information is confined to that certain location. Remote sensing methods offer rapid data collection of soil moisture over large areal extent with a high temporal resolution with a statistic that the penetration depth is proportional to the wavelength i.e. penetration is directly varied with the wavelength.

1.3. SMAP (Soil Moisture Active Passive)

The SMAP satellite mission was launched on January 31, 2015 by National Aeronautics and Space Administration (NASA). The observatory was established for providing global mapping of high-resolution soil moisture and freeze-thaw state in every two to three days using an L band radar (active) and an L-band radiometer (passive). After an irrecoverable hardware failure of the radar on July 7, 2015, the radiometer-only soil moisture product became the only operational soil moisture product for SMAP. This mission has been providing global observations of L-band (1.4 GHz) passive microwave brightness temperature since 31 March 2015 at about 40-km resolution from a 685-km, near-polar, sun-synchronous orbit [Entekhabi et al. 2010a; Piepmeier et al. 2017]. These observations are highly sensitive to surface soil moisture and temperature, which impact the land surface water and energy balance through, for example, the segregating of rainfall into runoff and infiltration, and the net radiation into latent and sensible heat fluxes. The resulting measurements of SMAP are likely to advance our understanding of the processes that relate the terrestrial water, energy, and carbon cycles, improve our capability in flood prediction and drought monitoring, and enhance our skills in weather and climate forecasts. The most important parameter is soil moisture which can be retrieved from SMAP brightness temperature data. Various algorithms have been developed for the retrieval of soil moisture from SMAP data. The ultimate data product is being circulated worldwide by the National Snow and Ice Data Centre (NSIDC). SMAP provides soil moisture data in volume basis measured in cm3 /cm3 . It uses L band radiometer because it has low frequency (1.4GHz) with higher wavelength (21cm) as compared to C and X band radiometer which have low sensitivity towards soil moisture for even small amounts of vegetation, leading to high soil moisture retrieval errors [Kerr et al. 2001; Njoku et al. 2003; Wang and Choudhury 1981].

II. MATERIALS AND METHODS

2.1.Study Area

In this study, entire state of Odisha of India has been taken for generating the average soil moisture mapfor surface soil moisture.

Fig:2.1 Odisha map from India

2.2. Dataset

The dataset used for average soil moisture map generation is called SMAP L4 Global 3-hourly 9 km EASE-Grid Surface and Root Zone Soil Moisture Geophysical Data V004 (https://earthdata.nasa.gov/). Briefly, The data product corresponds to a 40 km mean spatial resolution. It contains output from geophysical models utilizing SMAP data. The gridding resolution of L4_SM data product is 9km with a latency of 7 days. This model interpolates and extrapolates SMAP observation in time and space, producing 3-hourly estimates of soil moisture at 9 km resolution and represents the merged information. The L4_SM product thus facilitates the use of SMAP data in applications that require complete spatiotemporal coverage and knowledge of deeper-layer soil moisture. The latter is particularly relevant for drought monitoring, water resource management, and sub seasonal to seasonal climate forecasting [Reichle et al. 2017].The L4_SM outputs include soil moisture estimates for the ‘‘surface’’ (0– 5 cm), ‘‘root zone’’ (0–100 cm) and ‘‘profile’’ (from 0 cm to depth of bedrock) layers. Here in this study surface soil moisture has taken. It provides the average soil moisture data in volumetric basis in cm3 /cm3 (https://nsidc.org/data/smap/spl4sm/data-fields#sm_profile). Here in this study the surface soil moisture for whole Indian subcontinent was downloaded and then the average soil moisture map for Odisha state is extracted from it following the proper procedure in ArcMap.

2.3. Data Processing

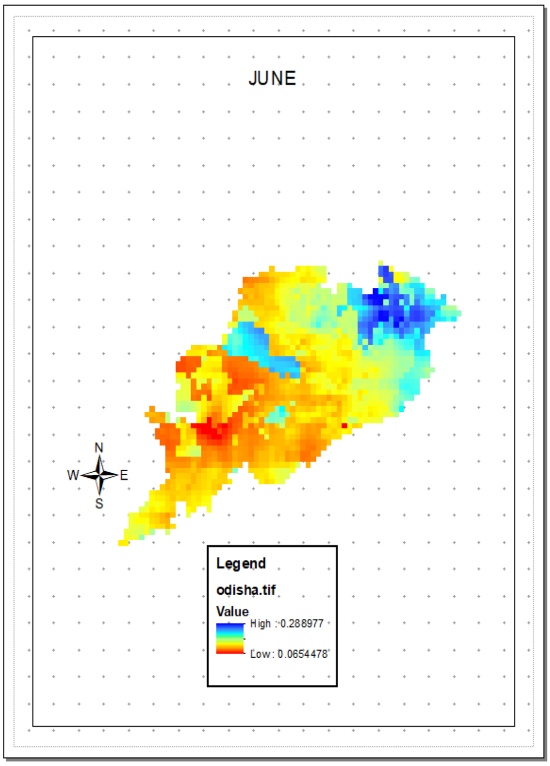
The daily data of surface soil moisture products were downloaded freely in TIFF format from NASA Earth data website. These were downloaded from June to October which included monsoon season.

The daily data were stacked in layer stacking to form the composite monthly data file.

Then the cell statistics were calculated using raster calculator for getting the average monthly surface soil moisture value. After it the shape file of India was overlayed on the monthly composite map to select the state of Odisha on it. Then the average surface monthly soil moisture map was extracted by masking the shape file of India.

III. RESULTS AND DISCUSSION

After Colour coding the monthly average surface soil moisture maps of Odisha were developed which are shown below.


JUNE
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Legend
odisha.tif
Value
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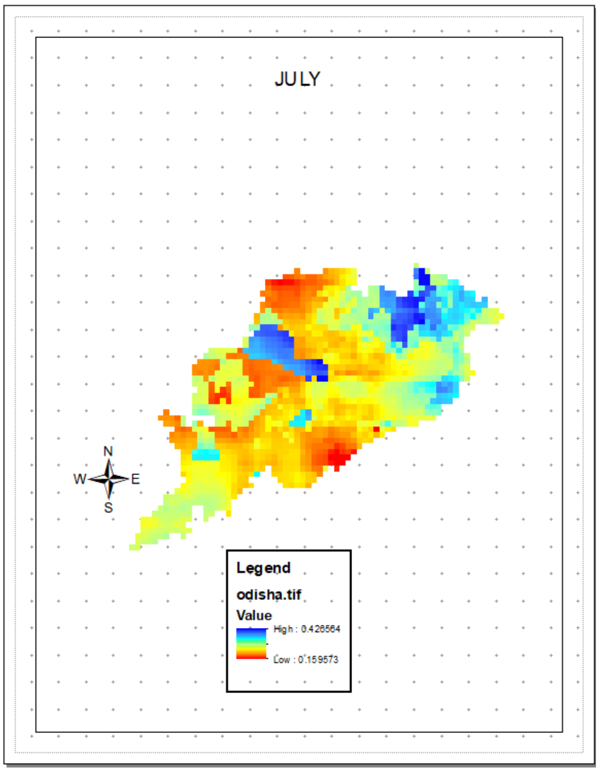
Low : 0.0654478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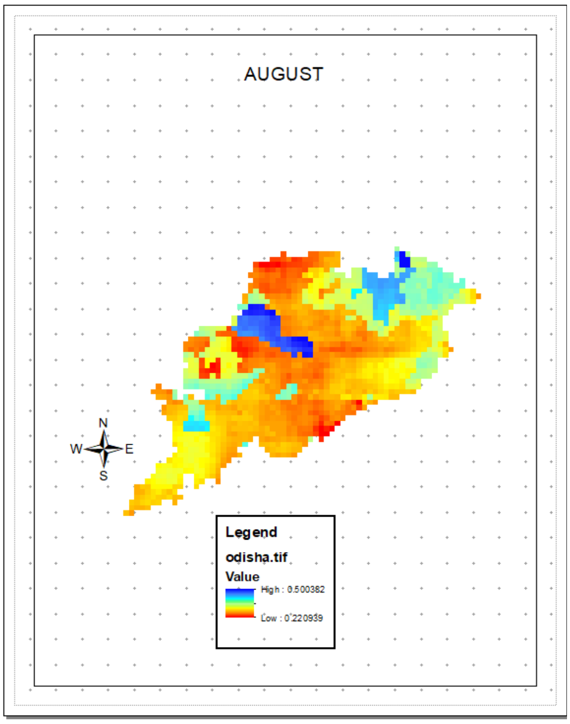
AUGUST
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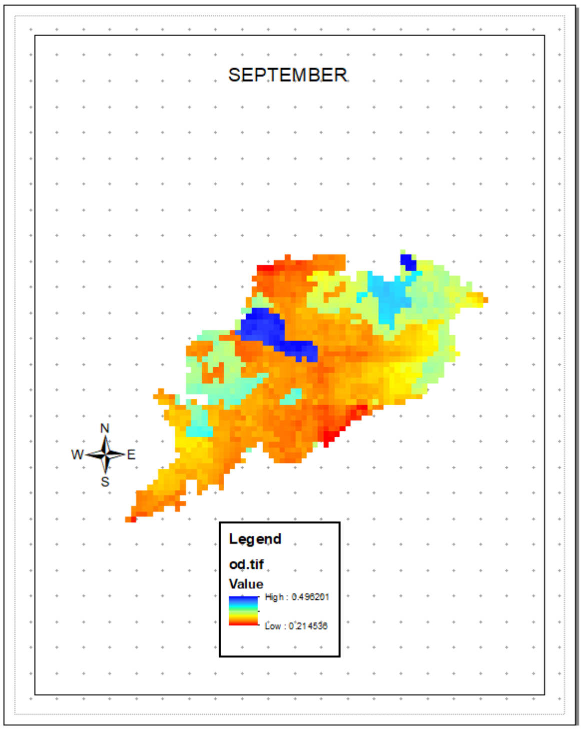
SEPTEMBER
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Legend
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Value
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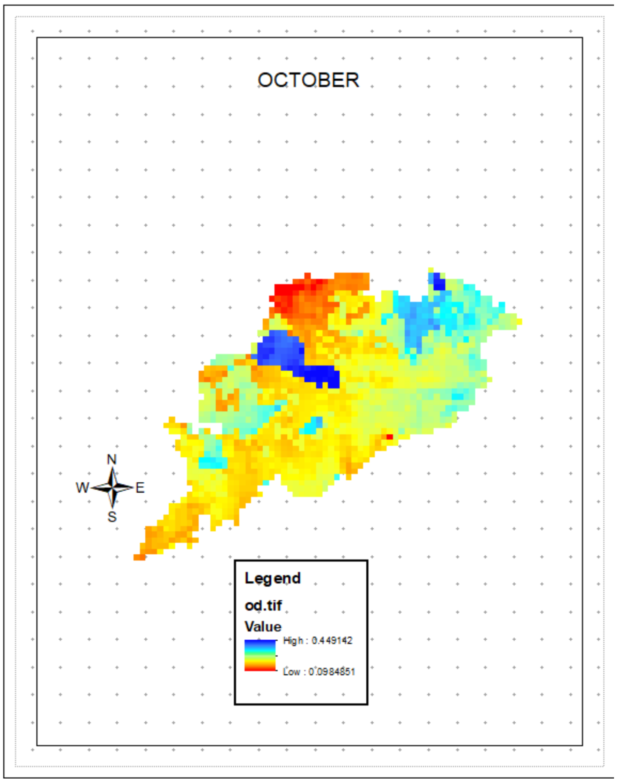
Low : 0.214536



From the map of June it was observed that the surface soil moisture ranges from 6-28% . But in July due to the onset of monsoon in Odisha, the moisture content increases to 15-42%. In August , due to high rainfall , the moisture content is also high which is 22-50% as shown in the map. In September and October the moisture content range were 21-49% and 9-44% respectively, which are little lower as compared to August due to withdrawal of monsoon. But due to the residual moisture and irrigation practices followed in some districts of Odisha the moisture content is not much lower in the month of October. From the map it can be observed that the Bargarh district is showing highest soil moisture. As rice is the main crop grown during this season , the available moisture in this region is very high.

IV. CONCLUSION

The soil moisture map can be well studied on the basis of rainfall, as the surface soil moisture mainly depends upon the amount of rainfall in that region. The present study has been undertaken to develop a detailed methodology for generation of average surface soil moisture maps of desired interval (e.g. monthly) for Indian state, Odisha. The proposed methodology is based upon the analysis of 153 SMAP data and has been well tested over Odisha covering monsoon season of the year 2018.The main advantage for analysing this technique is that anyone can go for mapping soil moisture for any duration(it may be /weekly/monthly/yearly) for any areal extent which needs less time and labour. It can be further used in hydrological modelling and flood forecasting model in which soil moisture plays a vital role.

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