International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Drought and its Impact on Crop Production And Socio-Economic Condition of Farmers: A Case Study of Washim, Maharashtra.

Kanak K Khan

Student, Amity University

ABSTRACT
India is a largely agricultural country with about 58% of India's population indulging in agriculture as their primary source of income. Being a predominantly rural economy, the condition of the farmers has a great impact on the overall socio economics of the country. Crop Production is the cornerstone of the Agricultural Sector. Crop Production refers to the large- scale cultivation of the same type of plant on a particular portion of land. It is cultivating crops for both domestic as well as commercial use. Rice, Wheat, Maize, Jute, and other crops are among the crops grown on a huge scale in India. Crop production is necessary to support a country's large population. All individuals depend on the crops for their food as well as their income. Agriculture in India provides a living for the bulk of the population and should never be overlooked. Despite the fact that its contribution to GDP has decreased to less than 20%, while the contributions of other sectors have increased at a faster rate, agricultural production has grown.
Despite these facts, the average productivity of many Indian crops is extremely poor. The country's population is predicted to grow to become the world's largest in the coming decade, and feeding them will be a major concern. Farmers are still unable to earn a living wage, making their socioeconomic situation even more precarious. There are numerous factors and reasons for the crop failure and the challenges faced by the farmers and their families. Performing a sample study of Maharashtra, we aim at studying the impact of crop failure with respect to thesocio-economic conditions of farmers. We will be majorly focusing on the various issues caused by the crop failure on the conditions of the Farmers.
As a methodological approach, the findings of the study will incorporate various statistical techniques as well as use of various spatially analytical tools. The result will reflect both qualitative and quantitative aspects.

KEYWORDS: Impact, Socio-economic, Cultivation, Production, Economy

INTRODUCTION

Jai Jawan Jai Kisan - Lal Bahadur Shastri.
Agriculture, with the allied sectors, is the largest source of livelihood in India. Over 70% of rural households in India highly depend on agriculture. Agriculture contributes about 17% of GDP and provides employment to more than half of the population. Despite being the backbone of the Indian Economy, the situation of farmers in India has never been quite satisfactory. The agricultural sector in India faces various challenges. The productivity per unit of land is very low in India. Water resources are

also limited. Most of the Indian agricultural land is dependent on monsoon, specifically southwest monsoon. The plantation of crops depends on the first showers of the season. Therefore, monsoons are critical to farmers in India. In case of high monsoon rain deficit, which is caused by El Nino, there are high chances of Drought. Droughtsare caused by low precipitation over a period of time. Drought causes the depletion of water available in soil, which further causes decrease in crop and livestock productivity. It also causesthe groundwater levels to fall and decreases surface water availability. This increases the coast to access water resources for irrigation. Sometimes, in case of severe drought there are total crop failures.

Suicide is a indicator of human hardship, yet the causes of these deaths remain understudied. Death caused by self-directed injurious behavior with any intent to die as a result of the behavior, is defined as suicide. The farmer's suicide rate in India had ranged between 1.4 and

1.8 per 100,000 total population, over a 10-year period through 2005, however, the figures in 2017 and 2018 showed an average of more than 10 suicides daily or 5760 suicides per year. Around 41.49% of total labour are associated with agriculture in India. Activist, scholars and researchers have offered a number of reasons for farmers suicide, high debt burden, crop failure, price crash, personal issues and family problems. All these factors have a great impact on the physical and psychological health of the farmers.

The fluctuations in climate, specifically temperature, has strong influence over the growing suicides. High temperature increases suicide rates but only druing India's growing season as heat also reduces crop production. (Carleton, 2017).

LITERATURE REVIEW

Fischer, Shah, Tubiello, and Vwlhuizen (2005) analysed Socio-economic and climate change impacts on agriculture: an integrated assessment, 1990-2080. In this research paper, they are discussing Socio-economic and climate change impacts on agriculture:Up to 2080, and at a worldwide level, a complete assessment of the implications of climate change on agro- ecosystems is constructed, however with significant regional detail. To that purpose, an integrated ecological–economic modelling framework is used, which includes climate predictions, agro-ecological zoning data, socioeconomic factors, and global food trade dynamics. Global simulations are carried out using the FAO/IIASA agro-ecological zone model in conjunction with IIASA's global food system model, with climate variables derived from five different general circulation models, and four different socio-economic scenarios from the Intergovernmental Panel on Climate Change.

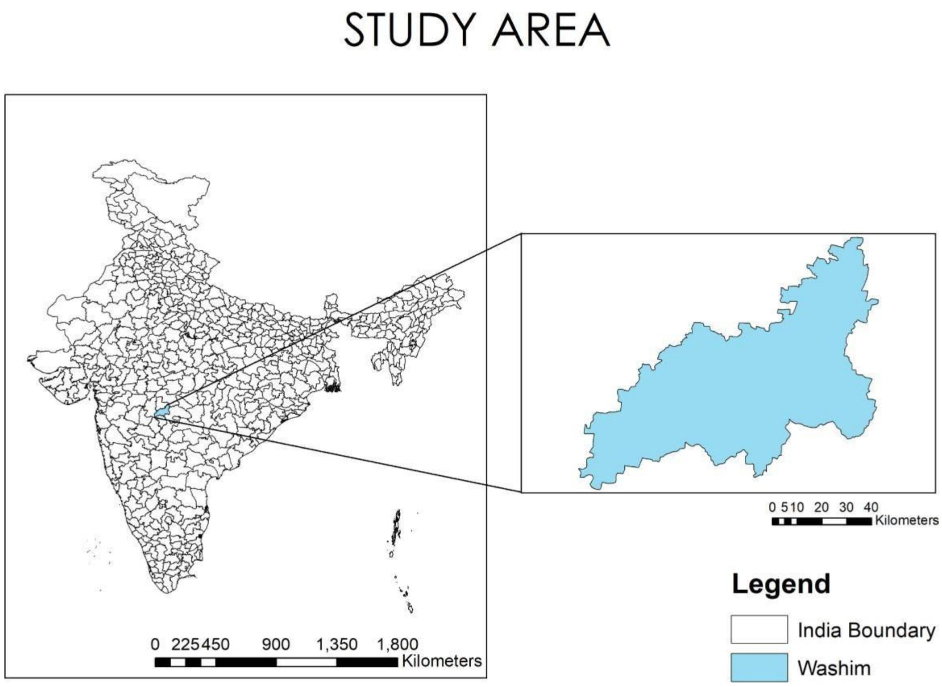
Guha (2012) studied facts, factors and possible fixes of farmers suicide in Maharashtra. The study aims at examining the phenomena of farmers suicide in India, especially in Maharashtra.The research is based on both primary and secondary sources, interviews and journals, articles and books respectively. The study found that there is not a single cause for the suicides but a number of factors come together that lead to such a decision from the farmers end, this paper looks at the several factors that influence farmers to commit suicide. The study also analyses preventive measures like encouraging organic farming techniques, creating effective insurance schemes. It reveals that the major factors which influence suicides among farmers are: integration with the world market, genetically modified crops, government policies, water access and drought, as well as social issues.

Wagh, Panaskar and Mukate (2016) studied the impact of drought on environmental, agricultural and socio-economic status in Maharashtra state, India. The study assesses the effects of droughts on environmental, agricultural and socio-economic status during the year of 2011-2016 in Maharashtra state. The study is based upon secandory data, the rainfall and reservoir water storage data was accquired from Water Resources Department (Jalsampada Vibhag), Govt. of Maharashtra, and the data of agricultural production of crops during Kharif and Rabi season is obtained from Economic Survey of Maharashtra, published by Department of Economics and Statistics, Planning Department, Govt. of Maharashtra, and the data of farmers suicide is obtained from the newspaper, The Indian Express. It concludes that rainfall in the district is gradually decreasing from the year 2011-2015. The area under cultivation in Kharif and Rabi season has decreased to a considerable extent in 2014-15.

STUDY AREA

Washim district is a district in Maharashtra, India. The headquarters is at Washim. The area ofthe district is 5,150 km^2 (1,990 sq mi). Washim is located in Vidharbha's eastern area. It borders Akola to the north, Amravati to the north-east, Hingoli to the south, Buldhana to the west, and Yavatmal to the east. Washim district lies between the longitudes 76.7°N to 77.4°N and latitude 19.61°E to 21.16° E. It has a population of 12,97,160 according to the 2011 Census with a density of 250 square kilometres. The area has an urban population around 18% with a higher than national literacy rate of 83.25% alongside a low Sex Ratio of 943.

The district's topography is highly based on its principal river, the Penganga. It runs through the Risod Tehsil. Later, it flows past the Washim and Hingoli districts' boundaries. The major tributary of the Penganga is the River Kas. About 1 mile from the settlement of Shelgaon Rajgure, the River Kas meets the Penganga. The river Arunavati and its tributaries originate in the Tehsil of Washim and flow into the district of Yavatmal via the tehsils of Mangrul Pir and Manora. River Katepurna rises in the district's steep hills and flows north through the tehsil. The area has an Average Annual Precipitation of around 750-1000mm.



METHODOLOGY

For the purpose of this research, we have used the data collected through Landsat 8. Landsat 8(formerly the Landsat Data Continuity Mission, or LDCM) was launched on an Atlas-V rocket from Vandenberg Air Force Base, California on February 11, 2013. The satellite carries the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS) instruments.

The OLI measures in the visible, near infrared, and shortwave infrared portions (VNIR, NIR, and SWIR) of the spectrum. The TIRS measures land surface temperature in two thermal bandswith a new technology that applies quantum physics to detect heat. Landsat 8 images have 15-meter panchromatic and 30-meter multi-spectral spatial resolutions along a 185 km (115 mi) swath.

A Landsat image with respect to our study area (Washim) was downloaded and processed using two GIS software, namely, ArcGIS and ERDAS. The following Indices were applied on the extracted images of the Area of Interest i.e. FCC (False Color Composite),NDVI(Normalised Difference Vegetative Index), LST(Land Surface Temperature), TCI(Temperature Condition Index),VCI(Vegetative Condition Index),VHI(Vegetative Health Index).

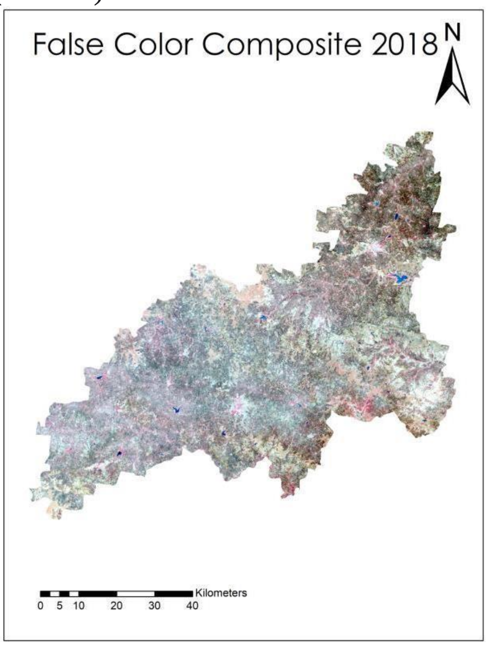
ANALYSIS

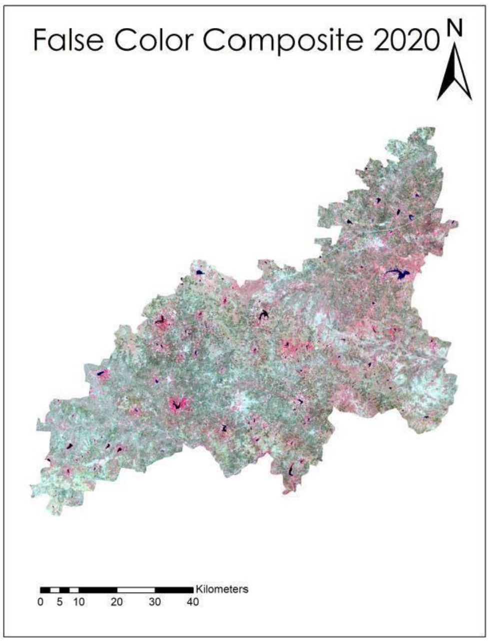
False Color Composite

A False Color Image is used to reveal or enhance features otherwise invisible or poorly visible to a human eye. In other words, a False Color Composite is a multispectral image interpretation using the standard visual RGB band range (red, green, and blue). For the Landsat 8 Data we use the following band combination to create a FCC:

Red: Near Infrared (Band 5)

Green: Red (Band4)
Blue: Green (Band 3)





International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Normalised Difference Vegetation Index

NDVI quantifies vegetation by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs). Healthy vegetation (chlorophyll) reflects more near-infrared (NIR) and green light compared to other wavelengths.But it absorbs more red and blue light. This is why our eyes see vegetation as the colour green. If you could see near-infrared, then it would be strong for vegetation too. Satellite sensors likeLandsat and Sentinel-2 both have the necessary bands with NIR and red. The formula for calculation of NDVI is,

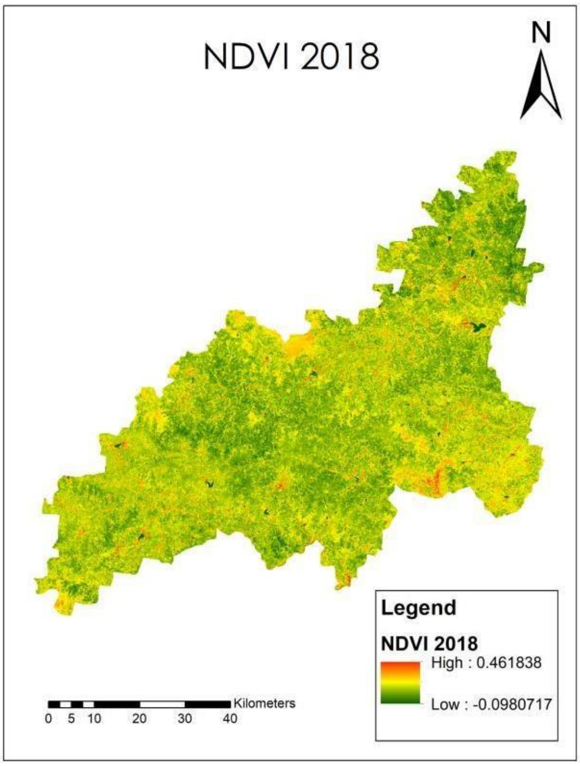
NDVI = (NIR-Red) / (NIR + Red).

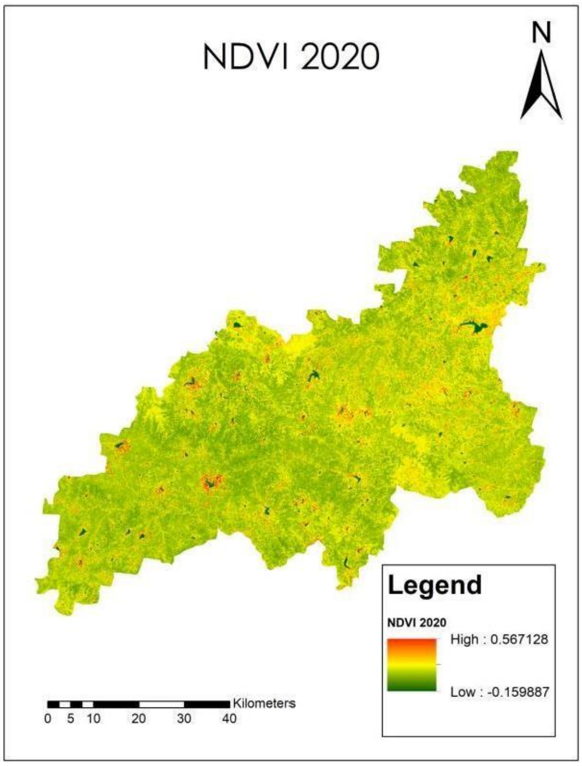
Where,

NIR is Band 5 and Red, Band 4 in Landsat 8 Imagery.

The result of this formula generates a value between -1 and +1. If you have low reflectance (or low values) in the red channel and high reflectance in the NIR channel, this will yield a high NDVI value. And vice versa.

In conclusion, NDVI is a simple way to measure healthy vegetation. When you have high NDVI values, you have healthier vegetation. When you have low NDVI, you have less or no vegetation.





Land Surface Temperature

LST is the earth surface temperature which is directly in contact with the measuring instrument(usually measured in Kelvin). LST is the surface temperature of the earth's crust where the heatand radiation from the sun are absorbed, reflected and refracted. LST changes with a change inclimatic condition and other human activities where the exact prediction becomes challenging.LANDSAT 8 carries two sensors, i.e., the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). OLI collects data at a 30m spatial resolution with eight bands located in the visible and near-infrared and the shortwave infrared regions of the electromagnetic spectrum, and an additional panchromatic band of 15m spatial resolution.

TIRS senses the TIRradiance at a spatial resolution of 100m using two bands located in the atmospheric window between 10 and 12 µm.

Estimation of Land Surface Temperature

Step 1 - Calculation of Radiance of Band 10 and Band 11using equation 1.

$L\lambda = (ML) * (DN) + AL$ (Equation 1)

Where,

$L\lambda$ = TOA spectral radiance (Watts/ (m^2 * sr * µm))ML = Radiance Multiplicative Band (Band 10, 11)

AL= Radiance Additive Band (Band 10, 11)

$Qcal$ = Quantized and calibrated standard product pixel values (DN)

Step 2 -Calculation of Satellite Brightness Temperature of Band 10 and Band11 by means ofequation 2.

Where,

$T = K2 / \ln (K1+1) L\lambda - 273.15$ (Equation 1)

T = Atmosphere Satellite brightness temperature

$L\lambda$ = TOA spectral radiance (Watts/ (m^2 * sr * µm))

K1 = Band-specific thermal conversion constant from metadataK2 = Band-specific thermal conversion constant from metadata

Step 3 - Calculation of Proportional Vegetation (P v) using NDVI values in equation 3.

$PV = [(NDVI - NDVIS)/(NDVIV - NDVIS)]^2$ (Equation 3)

Where,

NDVI s = Minimum value of NDVINDVI v = Maximum value of NDVI

Step 4 - Calculation of Land Surface Emissivity (LSE) by applying equation 4.

Where,

$\varepsilon = 0.004Pv + 0.986$ (Equation 4)P v = Proportional Vegetation

Step 5 - Calculation of Land Surface Temperature (LST) by executing equation 5

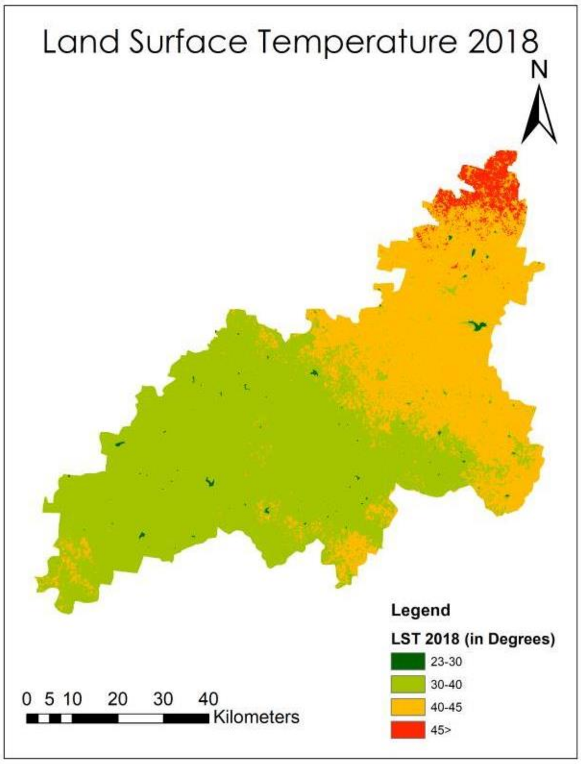
LST = $BT/(1+(Ts/hc))*\ln()$ (Equation 5)

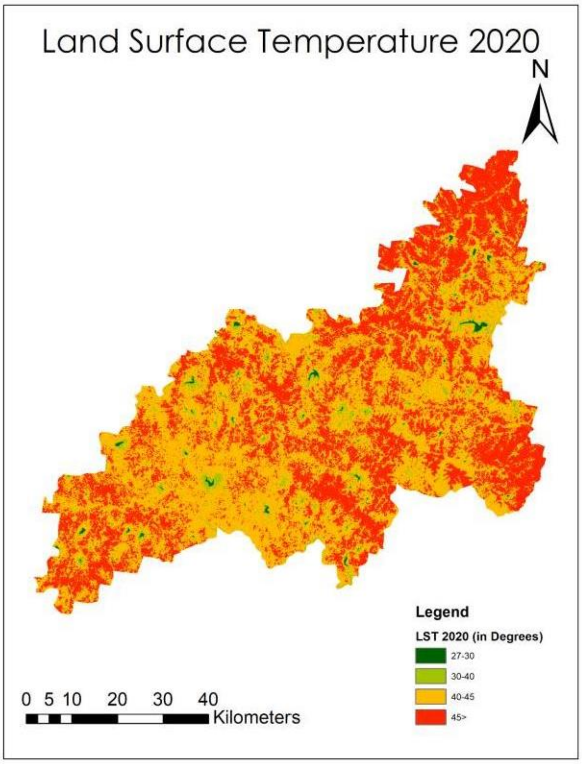
Where, BT = Satellite Brightness Temperature

h is Planck's constant (6.626 x 10^{-34}Js)

€ = Land Surface Emissivity

and *c* is light velocity in the vacuum (2.998 x $10^{-8}$$ms^{-1}$).



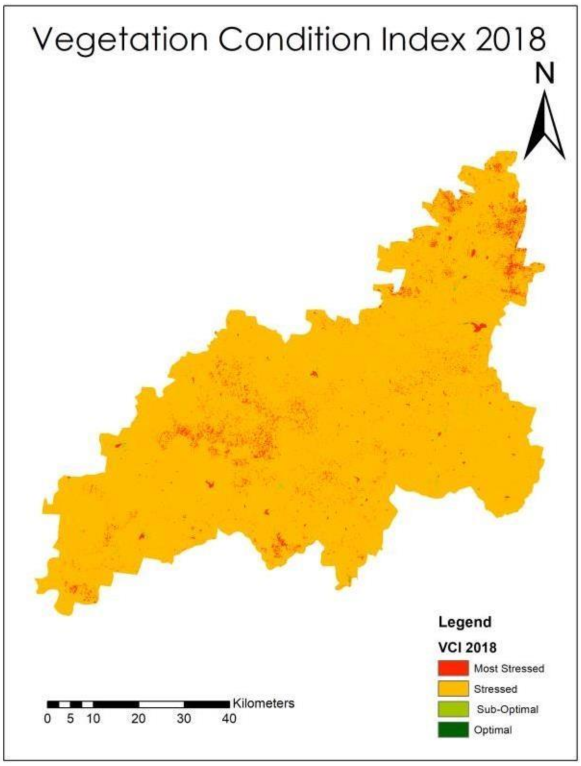


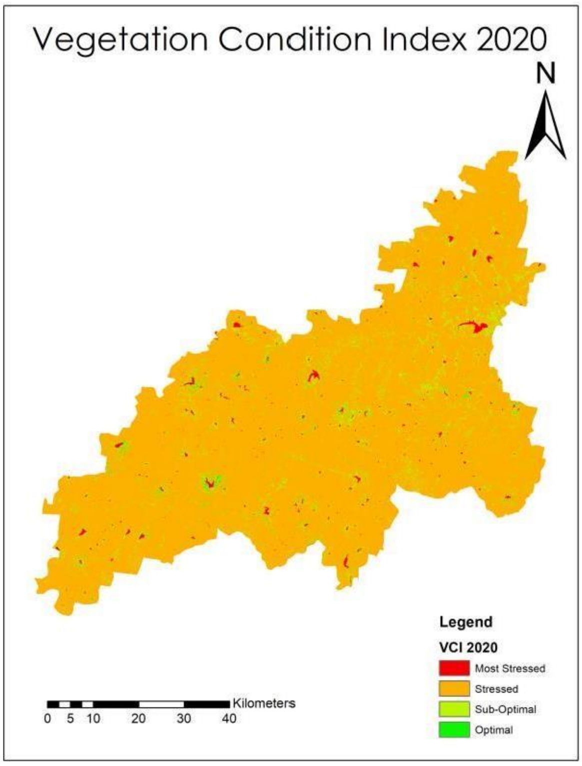
Vegetation Condition Index

VCI is an index which quantifies the amount and strength of the area which covers Vegetation.This index was first recommended by Kogan in 1997. Vegetation Condition Index is mainly related to the healthy vegetation which reflects on the Near - infrared portion through the spectrum. The green leafy areas are having a 20% or less reflectance on the Green to Red bandranging 0.5 - 0.7µm as well as 60% reflectance on the Near - infrared band ranging 0.7 – 1.3µm.The estimation was done using the following formula:

VCI = (NDVI- NDVI min) / (NDVI max- NDVI min) * 100

Where, the NDVI min and NDVI max is the minimum and maximum value of Normalised Difference Vegetation Index of an image. The status of vegetation cover is shown by this indexwhich is measured in a percentage form. In this index, the values between 50 – 100% indicate above normal situations whereas zero percent indicates severe dry conditions. This index is very useful for quantifying the vegetation related to weather conditions from high to low. From these studies, it results that VCI has given an opportunity to analyse the characteristics of drought and the severity as well as duration which is very much favourable with the rainfall patterns.





Temperature Condition Index

TCI was also propounded by Kogan in 1997. It is an index which is based only through the Thermal band of AVHRR (Advanced Very High-Resolution Radiometer) for converting with the Brightness Temperature (BT). It was suggested because of the reflection towards vegetation in response to Temperature i.e., when there is a high temperature, it can have a severe droughtsituation. TCI is usually used to detect the temperature which concerns the Vegetation relatingStress and this stress was caused due to intense wetness in an area.

The Temperature Condition index theorem is very much similar to the Vegetation condition index theorem. This index is formulated as:

Step 1 - Calculation of Radiance of Band 10 and Band 11(for Landsat 8) / Band 6 (for Landsat5) using equation 3.

$$L\lambda = (ML) * (DN) + AL \quad \text{(Equation 3)}$$

Where,

$L\lambda$ = TOA spectral radiance (Watts/ (m^2 * sr * µm))

ML = Radiance Multiplicative Band (Band 10, 11 / 6)

AL = Radiance Additive Band (Band 10, 11 / 6)

Qcal = Quantized and calibrated standard product pixel values (DN)

Step 2 - Calculation of Satellite Brightness Temperature of Band 10 and Band11 / BAND 6 by means of equation 4.

T = K2 ln(K1/Lλ+1) −273.15 (Equation 4)

Where,

T = Atmosphere Satellite brightness temperature

Lλ = TOA spectral radiance (Watts/ (m^2 * sr * µm))

K1 = Band - specific thermal conversion constant from metadata

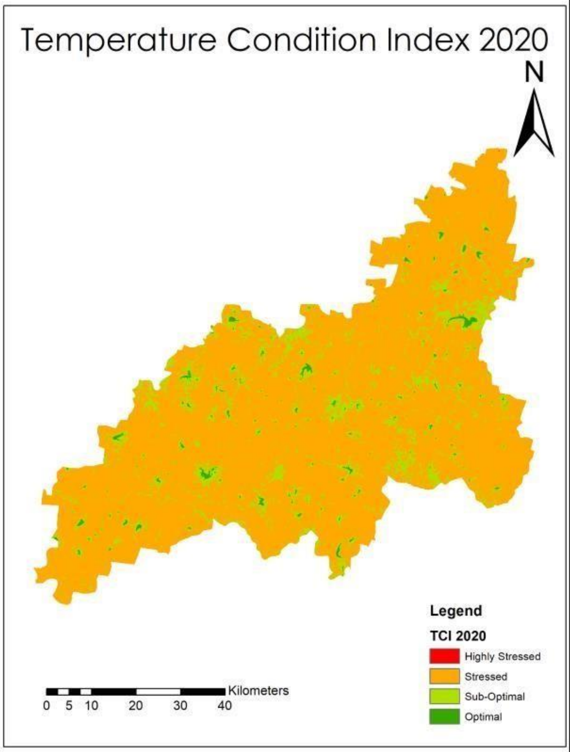
K2= Band - specific thermal conversion constant from metadata

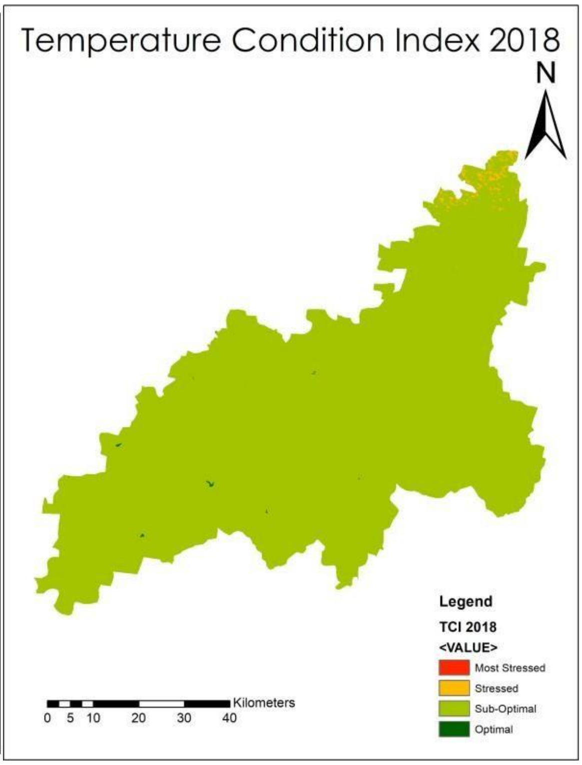
Step 3 - Calculation of Temperature Condition Index using Brightness Temperature.

$$TCI = (BT\ max - BT) / (BT\ max - BT\ min) * 100$$

BT max and BT min being the Maximum & Minimum values of Brightness Temperature which are computed by satellite image in a particular period.

The main limitation for using thermal data is its sensitiveness towards atmospheric water content. The relationship between the Ground Surface Temperature with moisture content affects the area which can cause drought are often analysed before degrading the biomass occurs. Therefore, the Temperature Condition Index plays a dominant role in monitoring drought conditions.





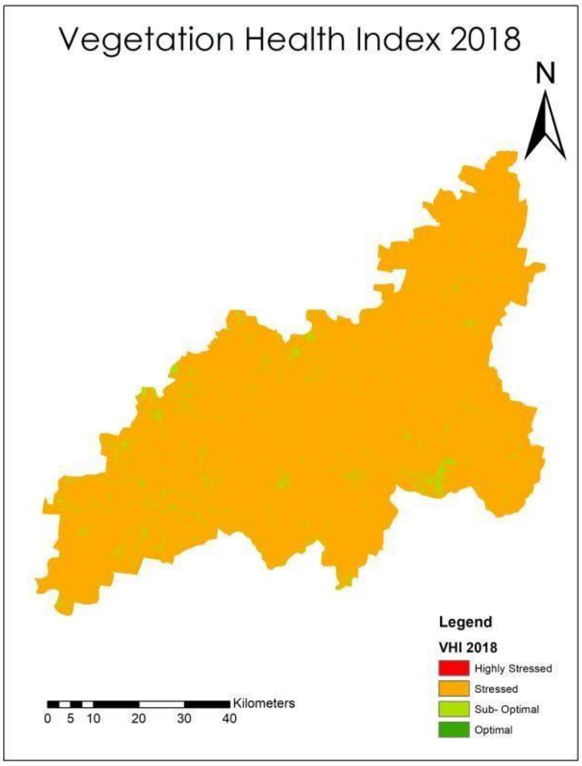
Vegetation Health Index

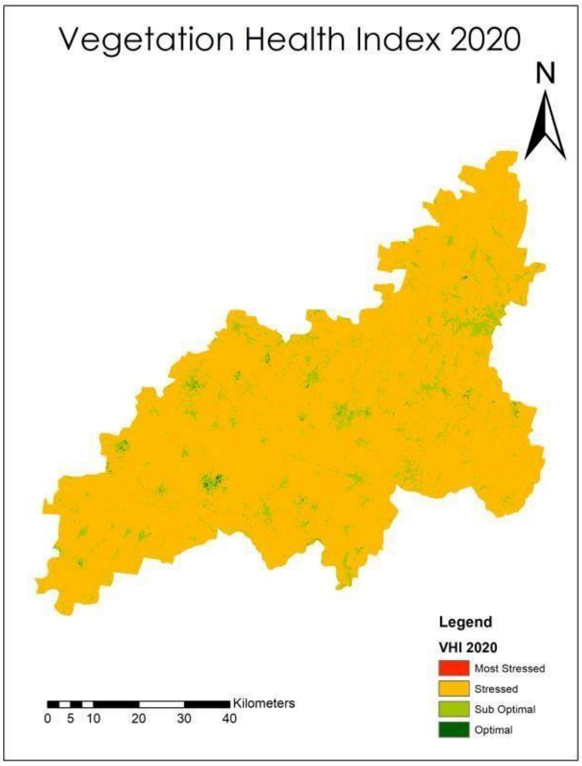
VHI is an index which combines both the information about VCI (Vegetation Condition Index) and TCI (Temperature Condition Index) proposed by Kogan for more useful in drought detection i.e., it was used in various studies for monitoring and examining the drought conditionin different areas. Overall, it is said to be represented as a combined evaluation of Moisture and Thermal circumstances for determining vegetation health. Vegetative health index is calculatedas using the following formula:

VHI = a * VCI + (1 – a) * TCI

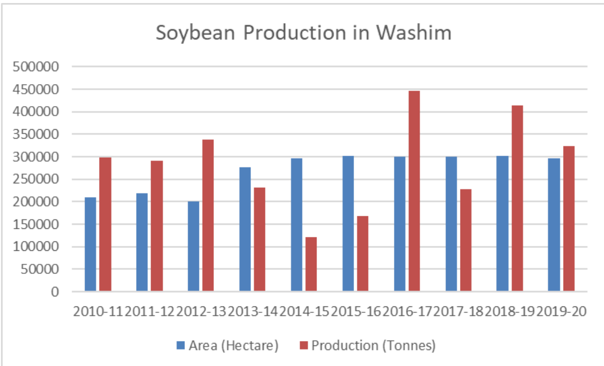
Where ‘a’ is the measurement resulting between Temperature & Precipitation having differentconditions in a particular area. It is also known for moisture conditions where ‘a’ is taken as 0.5. Therefore, Vegetation Condition Index and Temperature Condition Index are equallymeasured for calculating VHI (Vegetative Health Index).

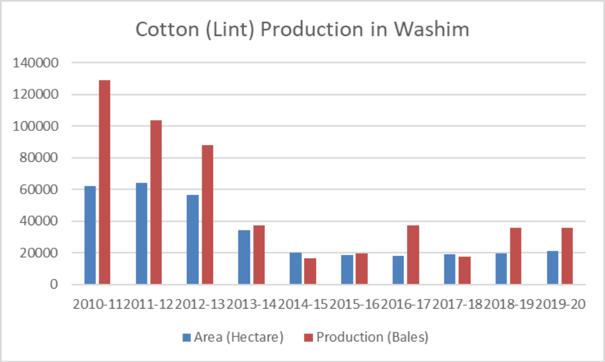
It is proven that when the value of VHI is lower, the intensity of drought will be greater.





AGRICULTURE IN WASHIM

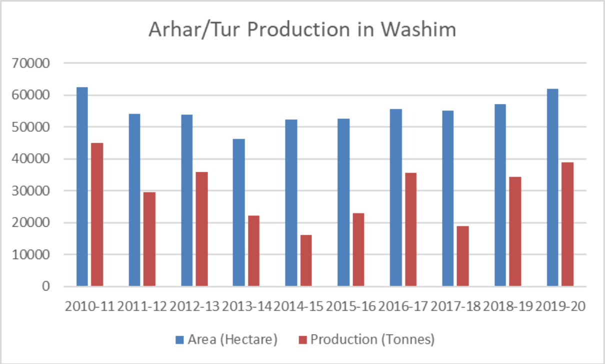




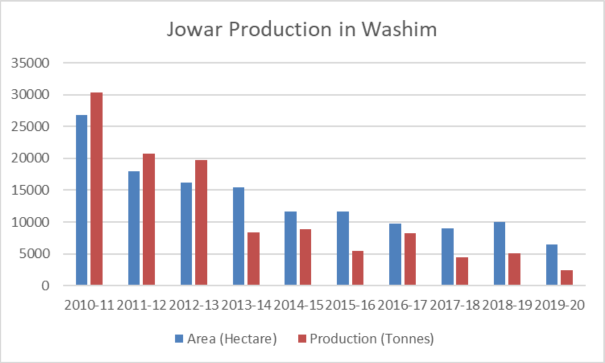
Washim is an agriculturally oriented District, categorised under agro climatic zone seven andeight. The district receives an average annual rainfall of around 750-1000mm. Farming in the District is highly dependent on Rainfall as most of the area under cultivation is Rainfed. The district is scattered with prominently plainsurface land. The year can be broadly divided into three seasons as Kharif which starts from June and ends September. While Rabi ranges from October to January and Summer season falls within the period of February to May.

Agriculture sector continues to be the pivotal sector in the economy of Washim. The Whole District divided in four agro-ecologicalsituations

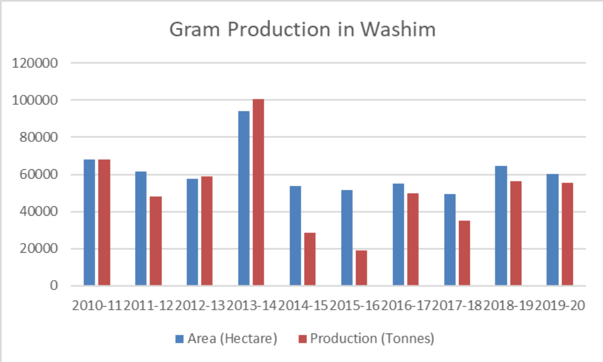
1. Shallow to medium type soil with high irrigation potential. Major crops include Soybean, Cotton, Tur, followedby citrus orchards and vegetables.



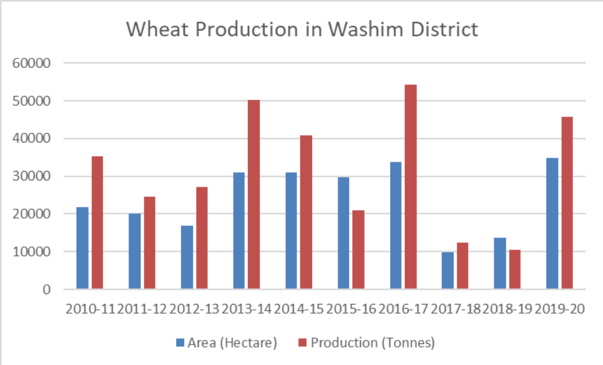
2. Natural saline track with deepblack Cotton soil predominantly rain fed situation, Major crops are Soybean, Cotton, Tur, Jawar, Sunflower and Gram.



3. Heavy rainfall zones, medium to heavymedium clayey soil, major crops are Soybean, Cotton, Jawar, Floriculture crops irrigation mainly by bore wells followed by canal.



4. Non saline track with heavy to mediumblack soil with Soybean and Cotton as main crops. Dairy is a major subsidiaryoccupation as a source of income.



Horticulture

Washim District has diversified fruit and vegetable production which includes Kagzi, Lime Banana, Papaya, and Mandarin. Farmers are also diversifying towards pomegranates. The horticulture industry generates income through its quality of fruit and vegetable production and productivity. It also creates employment opportunities and enhances nutritional security of the farmers in the district. They are very innovative and are involved in organic cultivation. Fisheries The district has 44 tanks and 5 Reservoirs with a water spread area of 3119 ha. shows a bright scope for extension of the activity across the district. The district has 40 registered co- operatives societies and increasing demand for fish in the cities as well as in rural areas can be exploited to improve the marketing offish.

OBSERVATIONS

1. This area has moderate vegetation cover with improvements in the span of two years as we can see in the vegetation index of both the years i.e. 2018 and 2020. It can also be observed that the North eastern part of the district had less vegetation in 2018 but it gradually improvedafter two years. Even though the degree of the change is not very high the changes are quite easily visible visually in the images as well as the highest values of the NDVI also show an overall increase in the vegetation cover in the area Some parts of the study area has healthy vegetation too which is sparsely distributed in patches all over the image.
2. The Land Surface Temperature of this area varies drastically in different parts of the districtin the year 2018 as we can observe a pattern of different temperatures. Whereas, in 2020 most of the areas experienced more than 40° which can be the result of change in climatic conditions and other anthropogenic activities. In the LST map of washim district 2020, there are still fewareas which are experiencing low temperatures as compared to the other parts of the district.
3. The Temperature Condition Index of the area shows a better condition in 2018 as comparedto the year

2020. We can observe that in the year 2018 a large section of the area comes under the sub optimal category, with only few parts in the North Eastern section falling under the Stressed Temperature Condition. Whereas in 2020, we can observe that most of the area is experiencing stressed temperature conditions. There are a few sparsely distributed areas which have optimal temperature conditions. This difference is also visible in the Land Surface Temperature comparison of the two years.

4. The Vegetation Health Index has also improved in the span of two years. We can see the trend of stressed VHI in most parts of the district in both the years. Some areas in the 2018 image are observed to be Sub-Optimal which have improved to be Optimal in the 2020 Imagery. A large portion of the area in the imagery is under the Stressed Category in 2018 which has reduced in size in 2020, but still a large portion of the area stayed Stressed.

CONCLUSION

Agriculture in India is mostly rainfed and practiced for personal consumption and commercial consumption. But it is highly personal consumption based. Agriculture in India is highly dependent on monsoon for water supply.

As we observed in the Land surface temperature map, there are drastic changes in LST in boththe years. These changes are due to climate change, the increasing effect of global warming. The degree of change in both the year's land surface temperature is not much but a small change over a long period of time results in very drastic effects. A very small change in the climate drastically affects the monsoon in India. If the rainfall gets delayed or is less than required, it results in crop failure. The conditions of farmers in India are not very satisfactory. They are burdened in debt, most of the farmers take loans from various sources for a growing season tobe able to cultivate. But when there is crop failure, many times they cannot handle the unpredictable and take life threatening decisions.

The number of farmers suicide in Washim district has been increasing from 2001 till now. In 2001, 7 farmers committed suicide, it increased to 26 in 2005, 122 in 2010, 108 in 2015, 98 in 2018, and 96 in 2020. The number of suicides is high in 2010 and 2015 because 2010-15 the growing season was affected by very high temperatures. March 2010 was ranked as 35th driest March. In 2013 Maharashtra witnessed drought. Also, nearly 50% of the suicide cases happens in the growing season (June to October).

The government needs to focus upon the issue, the agriculture sector has been suffering from hidden unemployment, cash crash and indebtedness. The government have been waving off the loan payment of farmers time to time and giving concession to the dead person's family, but if a female farmer commits suicide many times no concession is provided to the family. Also, we need to start working towards minimising the rate of climate change. The governmentneeds to make effective laws and schemes to curb the emission of greenhouse gases, which drives climate change.