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Water Productivity Using Gis For Ghataprabha Basin

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Abstract

Water productivity is generally defined as crop yield per cubic meter of water consumption, and it became a crucial issue in raising the performance of irrigation, as well as on focusing water saving problems. However, varied ideas are also considering, which needs applicable definitions and analysis. As a result of it represents a ratio between harvesting yield and water use. The main concept of this project is identifying the factors influencing the Ghataprabha Command area, such as Evapotranspiration (ET act), Normalized Difference Vegetation Index (NDVI), Soil property, Wind Speed, Surface Temperature. These potentials are improving food security by enhancing water productivity.

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Keywords: *Water Productivity, CWP, ET actual, NDVI, SEBAL, pySEBAL*.

Introduction

The world has finite water resources, underneath that quickly growing world population and per capita demand and each can increase the need for water. Water productivity is one in every of the essential topic that improve the growth of crops in conjunction with a typical things. The crop water productivity is a necessity for the human society conjointly. The foremost of the issues which can arise throughout cropping and getting the yield, for knowing such issues we have to contemplate some earth connected and environmental parameters like Evapotranspiration, Soil property, Surface Temperature, etc. The above-mentioned parameters are handled by pySEBAL.

PySEBAL (python and Surface Energy Balance Algorithmic for Land) is a well-known model, and it is open-source language also. All the data are obtaining through this, using scripts. For running such model requires some additional settings.

Surface Energy Balance Algorithmic for land (SEBAL) this technique is valid on completely different fields victimization numerous methods; it's shown terribly promising results as compared to field measurements. So SEBAL has given hope to calculate evapotranspiration at field scale, M.Menenti, et al., (Dec 1998). Water productivity became a significant issue in up the performance of irrigation, in conjunction with once focusing water saving issues. Adopting associate output/input non-dimensional quantitative relation, the term efficiency is employed for the performance of any irrigation and non-irrigation water system but the term is kind of exclusive of irrigation (Pereira et al., 2002).Summarized major principles of SEBAL for Water-Resources Management for actual field conditions. Spatially analyzed the distribution of ET to ascertain a-like between water allocations below numerous climates and completely different scales further, (Bastiaanssen et al., 2005).

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The idea of water productivity (WP) helps irrigation managers, agricultural extension employees, and policy manufacturers to perceive whether or not water resources in agriculture square measure used expeditiously. This pilot study introduces the WP idea and demonstrates its application in the irrigation system. WP may be an easy and enticing indicator to assess whether or not meant progress goes well. Additional irrigation connected performance indicators square measure has to be compelled to build a primary designation on however irrigation systems perform. During this study, further indicators like crop yield, ET deficit and helpful consumption (Ta) were enclosed.

IRRIGATION EFFICIENCY AND CROP WATER PRODUCTIVITY

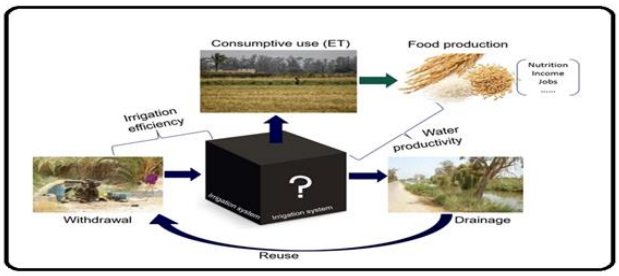

Figure 1: Irrigation Performance (Source: Xueliang Cai et al., 2015)

Water productivity indicators area unit broader than irrigation potency indicators. As shown on top of water productivity doesn't replace irrigation potency. Rather it brings two outcomes of irrigation water management in-to one single expression: crop production, the aim of framing and irrigation, and therefore the water consumed the means to attain the assembly

Water productivity focuses on consumed water. Irrigation system area unit extremely changed, resulting in complicated water cycle processes, that are more exacerbated by management follow as well as irrigation and drainage. Remote sensing-based mostly water productivity assessment specializes in actual evapotranspiration (Eta) – the water consumed. More the Eta is split in-to crop transpiration, and evaporation, from soil/water and cover interception, a non-beneficial consumption from production purpose of read (figure2).

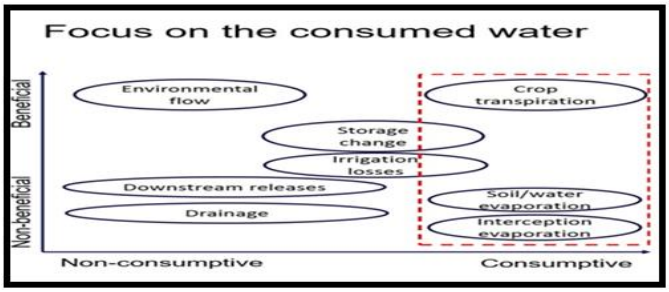

Figure 2: Focus on Water Consumption Evapotranspiration (ET) (Source: Xueliang Cai et al., 2015)

Evapotranspiration and Biomass growth in SEBAL

The major basis of energy balance computation to calculate instant Eta is for each cell of the image as a residual surface energy budget equation is given as below:

ET = Rn - G - H (illustrated in figure 3)

Where ET- Latent heat flux (W/m2)

G - Soil heat flux (W/m2)

Rn - Net radiation flux (W/m2)

H- Sensible heat flux to the air (W/m2

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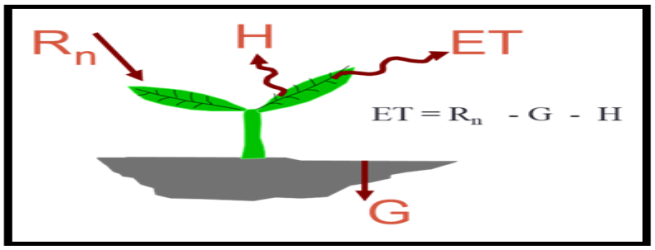

Figure 3: The concept of Surface Energy Balance (Source: Hussein Sabah Jaber et al., 2016)

Net radiation Rn represents the amount of solar radiation incident on earth surface.
The surface radiation balance equation specified as follows:

$Rn = Rs\downarrow - \alpha * Rs\downarrow + RL\downarrow - RL\uparrow - (1 - \varepsilon 0) * RL\uparrow$

Where $Rs\downarrow$ is the incoming short-wave radiation (W/m2)
α is the surface albedo (W/m2)
$RL\downarrow$ is the incoming long wave radiation (W/m2)
$RL\uparrow$ is the outgoing long wave radiation (W/m2)
$\varepsilon 0$ is the surface thermal emissivity (dimensionless)

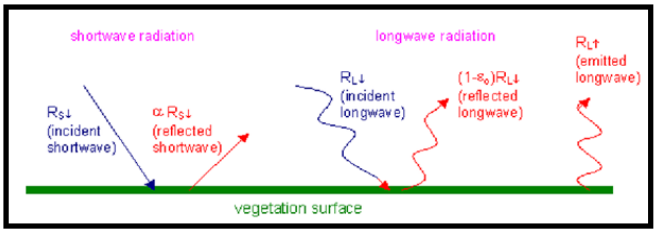

Figure 4: Surface Radiation Balance (Source: Okke Batelaanet al., 2004)
The biomass is obtaining by absorption of solar radiation through the pigments and it is available after the dry matter production, that would be a perform of following:
Biomass Production = APAR(t) e(t) dt (kg/ha)
APAR (Absorption of Photosynthetic Active Radiation) is the absorption of radiation for chemical action that depends on global radiation lightweight and interception therefore that converts energy into dry matters.

Study Area
Ghataprabha Command Area was selected for determining the water productivity which is situated in Krishna basin. The area lies in between 15^0 45' and 16^0 25' and 74^0 34' and75^0 88'. Stretch of the Krishna river is 1400km, and it originates at an altitude of 884m in the region of Western Ghats, Maharashtra, and flows 60km East through districts of the Sindhudurg &Kolhapur in Maharashtra, and enters Karnataka. In monsoon season the maximum rainfall is about 5000mm and Temperature varies from 25.1 to 26.6 0C.

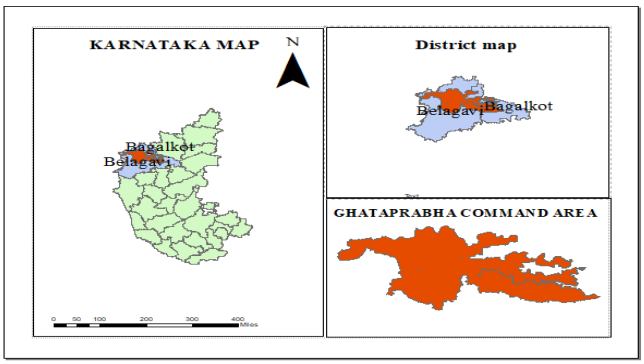

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Figure 5: Location Map of study area

Methods

The methodology is a centered on a pySEBAL. It uses the satellite information and weather information for agricultural water consumption, with these activities it gives the thought concerning crop yields and quantity of water needed for growing crops. The well-known development of pySEBSL called SEBAL (Surface Energy Balance algorithmic program for Land). The SEBAL relies on python that is open linguistic communication, and that is useful in crop growing simulation model and CWP. However, it's associate degree valid result for crop yields and it offers a clear indication for understanding the results from image analysis

The followings data are important for the research work:

Biomass production

a) Actual Evapotranspiration (ET act)
b) Normalized Difference Vegetation Index (NDVI)
c) Soil Heat Flux
d) Spectral Reflectance
e) Surface Albedo

The above-mentioned information measure vital for distinguishing the condition of space for growing the crop. For getting such information it includes the numerous parameter, which can be 3hrs, daily and monthly information. These parameters downloading through python exploitation scripts.

The pySEBAL of this version automates the image process method. The 3.3.7 version is pySEBAL which contains for brand spanking new development towards up the accessibility by users. The pySEBAL need crop kind map to estimate the particular crop yields and water productivity. A summary of the method chart is given below.

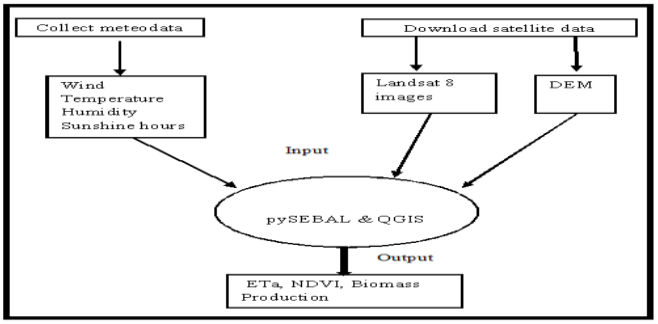

Figure 6: Flow chart of methodology

Digital Elevation Model (DEM):

The Digital Elevation model obtained from the info ASTER shown in figure 7, the special distribution of elevation levels on top of the MSL. The minimum value of the Elevation model is 402mm and the maximum value of the Elevation model is 721mm.

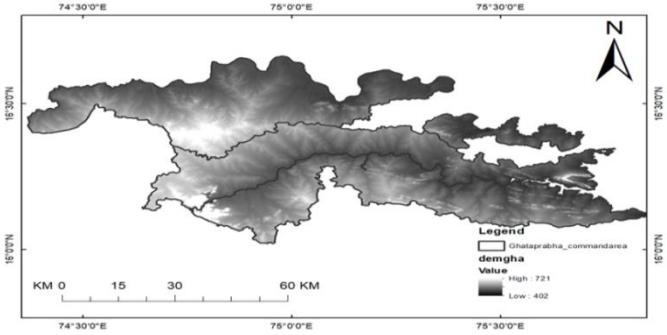

Figure 7: Digital Elevation Model

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Land Use and Land Cover (LULC):

The LULC indicates the population usage of the realm during this region and their socio-economic activities. The Ghataprabha basin having different options concerning land use and canopy that is variable from time to time. The land use land cover could be a project that is referred for this analysis work. The Hidakal Dam is present in this study area. At down streamside of the reservoir that is well irrigated. Because of the Western Ghats, the Western a part of the study area is additionally rich in vegetation. LULC is shown in figure 8.

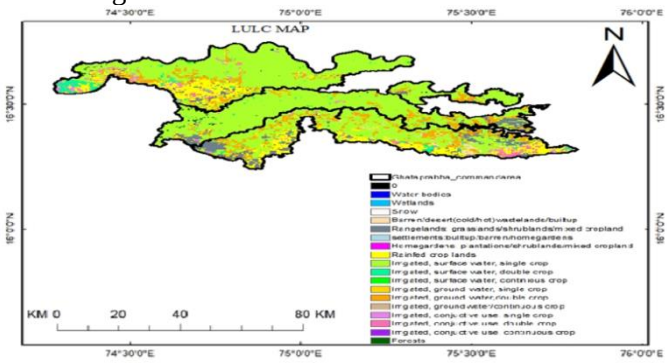

Figure 8: Land Use and Land Cover

Results

Extraction of the Actual Evapotranspiration (ET act) Maps:

The Actual Evapotranspiration map for Ghataprabha command area is obtained for the year of 2017 and 2018. The ET act is shown in figure 9,10,11,12. The map which is generated for month June and Dec 2017and for 2018 Jan and April. The maximum and minimum values in 2017 for June month are 1.29mm/day, 0 and Dec 2017 is 1.42mm/day, 0. Similarly for 2018 Jan vales are 1.54mm/day, 0, and for April 1.89mm/day, 0. The ET act is mainly depending upon the water and energy presence in that area. The higher value is indicated in the northern- range of area due to the high vegetation, and the lower value 0 indicates from Dry rock and dry barren land.

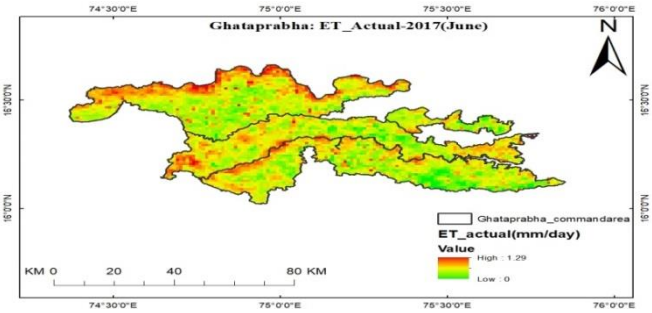

Figure 9: ET actual 2017 (June)

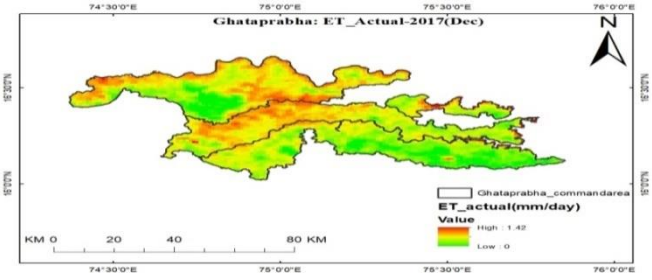

Figure 10: ET actual 2017 (Dec)

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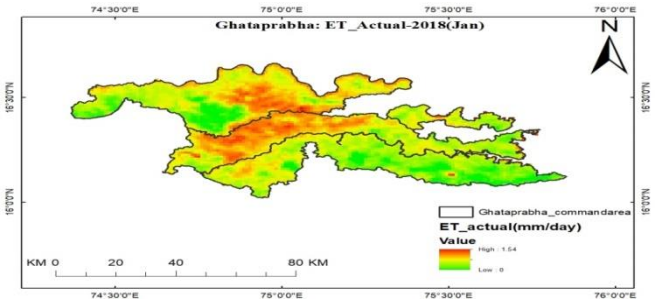

Figure 11: ET actual 2018 (Jan)

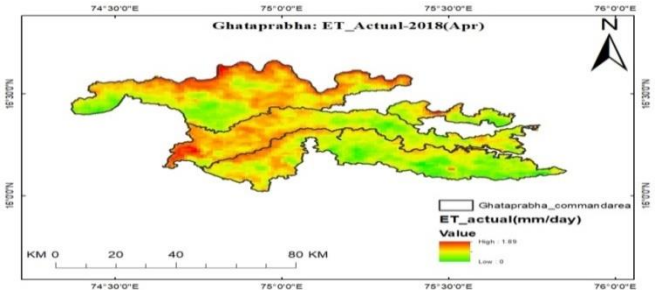

Figure 12: ET actual 2018 (Apr)

Extraction of Normalized Difference Vegetation Index (NDVI):
The presence of Greenery land is indicated by NDVI. The spatial difference of NDVI is obtained for 2017 and 2018 which is shown in figure 13,14,15,16. The greater and lower values for 16-01-2017 is 0.99, -0.07 and in 25-07-2017 is 0.99, -0.18. And for 01-01-2018 values are 0.78,-0.19 and 07-09-2018 values such as 0.81 and -0.12. If the surface is completely covered with rich in greenery it shows higher value. Usually the lesser values are indicated on the water surface, and dry rock surface.

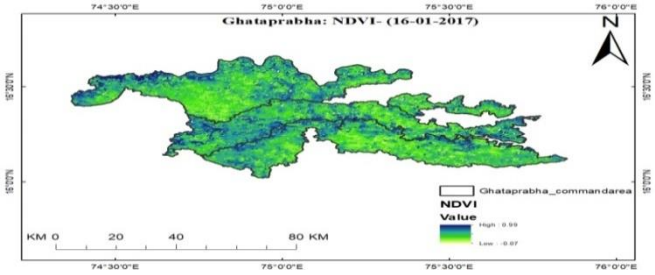

Figure 13: NDVI 16-01-2017

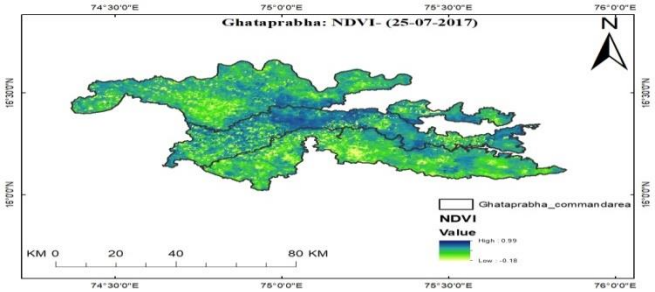

Figure 14: NDVI 25-07-2017

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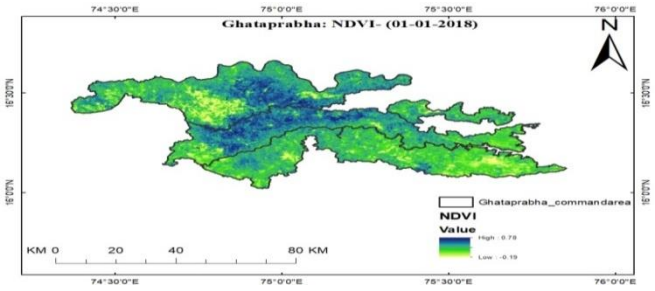

Figure 15: NDVI 01-01-2018

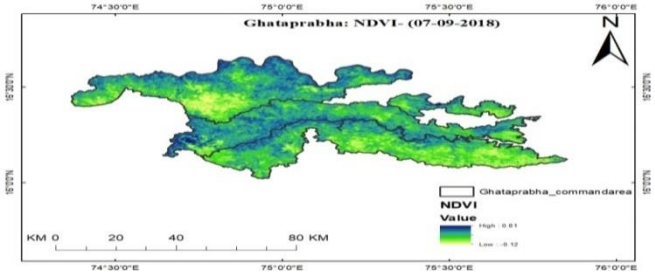

Figure 16: NDVI 07-09-2018

Some of the important parameter (Soil and Environmental parameter)

a) Instantaneous soil heat flux:

The variation of heat flux is directly depending on the heat absorption capacity of the soil. It is mainly depending upon the presence of moisture in the soil. Most of the land which is irrigated in the Ghataprabha region due to this condition it increases the higher values. Northern and Southern part due to the presence of rocky surface value indicated as lower value. The soil heat flux of the Ghataprabha region is 202.34 W/m2,-67.03W/m2, and which is shown in figure 17.

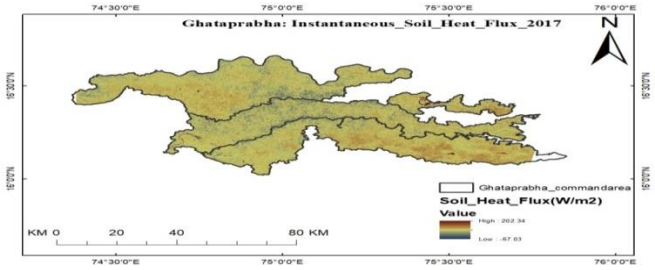

Figure 17: Instantaneous soil heat flux

b) Spectral Reflectance:

Spectral properties are used within the context of their utility in learning vegetation from remote sensing platforms. A synthesis of information on spectral properties, vegetation varieties, growth and energy conditions provides valuable info about biomass and productivity. The spectral reflectance maximum value is 1 and minimum value is 0 and it is shown in figure 18.

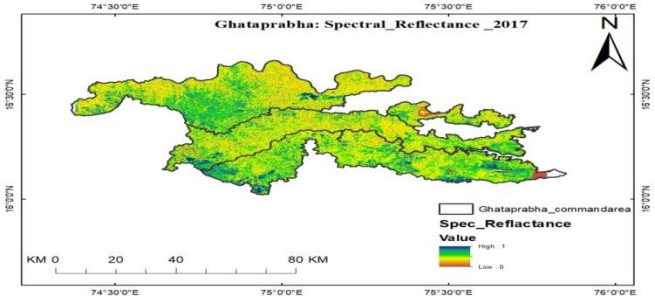

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Figure 18: Spectral Reflectance

c) Surface Albedo:

It provides valuable information about the reflecting capacity of the area and also energy consumed by the land. Most importantly lighter color indicates more reflectance and darker color absorb more which is shown in figure 19. In the Ghataprabha region, it is observed that 0.6 is a higher and lower is 0.

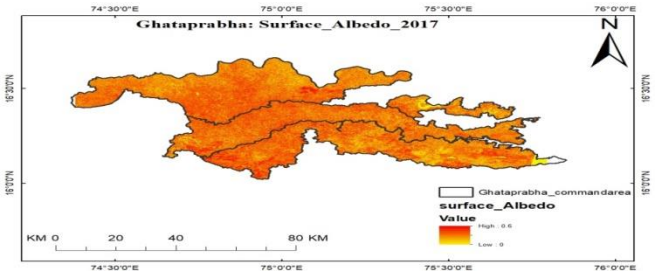

Figure 19: Surface Albedo

The Bio-Mass Extraction:

Bio-Mass is extracted for 2017 and 2018, which is shown in Figures 20 and 21. The Bio-Mass indicates the generation of waste from agriculture after the harvesting. The map is generated by the combination of both the ET act and NDVI. The crop yield is mapped through biomass initial so reborn to yield map victimization harvest index established with field knowledge. The dry biomass is dry matter production accumulated through the chemical process, which might be a calculable victimization satellite image. In 2017 the higher Biomass value is 112.44kg/ha and in 2018 the higher Biomass value is 100.2kg/ha.

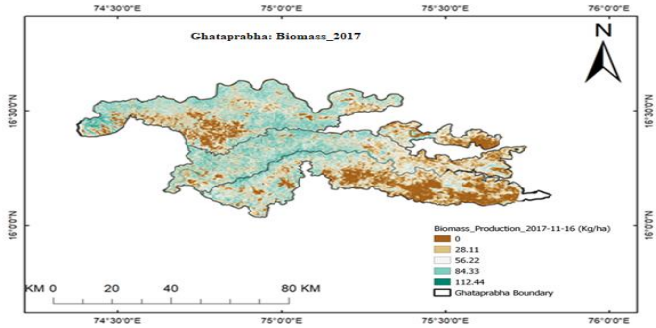

Figure 20: Bio-Mass 2017

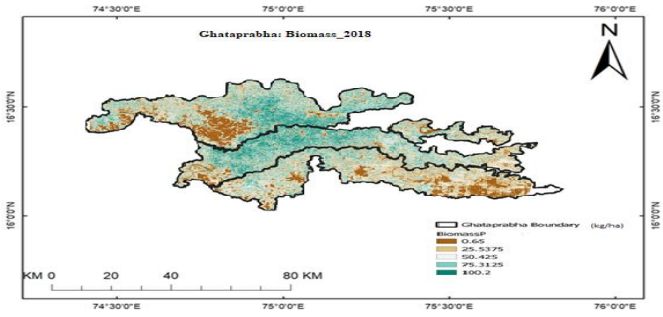

Figure 21: Bio-Mass 2018

Discussion

The remote sensing-based approach provides a detailed but also a quick snapshot of what is happening on the ground. To understand the spatial distribution of the results, the information from

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the field is compared to the pySEBAL outputs. This study collected secondary information to know how WP, yield, ETa changes with each other. The results of CWP assessment are compared with the following factors: administrative boundaries for potential effects on extension services, distance to water bodies, distance to canals and rivers, slope, soil quality, season variations, soil, fertilizer, and seeds.

Conclusion

The results represent the demonstration part of a capacity- building project on integrating Crop Water Productivity (CWP) in-to irrigation development and management. The project introduces and demonstrates the concept of Water Productivity (WP) and the use of state of- art- remote sensing technology for develop and rehabilitate irrigation projects. While rehabilitation and modernization are essential to keep pace with the rapid changes in challenges facing farmers, the effectiveness of investments depends on the main constraints to improve yield and WP.

A genuine storage of lack of water to the dearth of precipitation and low storage in the reservoir will be the first reason for low productivity. The impact of individual fields is different. The irrigation system exhibits nice native variability in each yield and Actual Evapotranspiration (ET act), reflective the assorted factors however particularly that associated with water accessibility at field level. Factors like Earth temperature, management, cropping pattern, and irregular timing of watering have direct effects on water consumption, yield and CWP.

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