***Overview***

To determine the effects of deforestation and afforestation on carbon sequestration, We used Net Primary Productivity (NPP) as a measure of carbon sequestration. NPP can be defined as the amount of carbon dioxide plants takes in during photosynthesis and accounts for carbon dioxide released by plants during respiration. We prepared NPP data products to compare results across two time periods and sites. A brief analysis revealed that mean NPP for Radhanagri WLS decreased from 162.04 g C m−2 per month in 2017 to 150.12 g C m−2 per month in 2022. A small decline in NPP values in Kali WLS was observed from 178. 24 g C m−2 per month in 2017 to 176.13 g C m−2 per month in 2022.

# Study Site

The two study sites for which I produced NPP maps were Radhanagri Wildlife Sanctuary (WLS) (351 km2), Maharashtra, India, and Kali WLS (1345.58 km2), Karnataka, India. We prepared maps for years 2017 and 2022 to study temporal and spatial changes across these sites

# Methodology

Data

We acquired imagery from Landsat 8 OLI/TIRS from USGS Earth explorer(https://earthexplorer.usgs.gov/). Table 1 provides more details about the imagery. Given the geography of the study sites, We carried out analysis for the post-monsoon season when trees re-grow foliage after shedding during a harsh summer.

*Table 1. Details of imagery used in analysis*

|  |  |  |
| --- | --- | --- |
| **Site** | **Date of acquisition** | **Path, Row** |
| **Kali WLS, 2017** | 16 November 2017 | 146,50 |
| **Kali WLS, 2022** | 30 November 2022 | 146,50 |
| **Radhanagri WLS, 2017** | 23 November 2017 | 147,49 |
| **Radhanagri WLS, 2022** | 28 October 2022 | 147, 49 |

Analysis

We used the CASA model to calculate NPP, which incorporates “incorporates meteorology, environment, and soil factors to simulate the physiological process of vegetation absorbing photosynthetically available radiation and transforming it into organic carbon” (Chengyong Wu et al. 2022). The model can be described using the following formula

NPP = 0.5 \* SOL \* FPAR \* Tε1 \* Tε2 \* WSC \* εmax

Table 2 provides a detailed description of the methods used to calculate the parameters. Bands 4,5,6, and 7 were used to calculate input parameters required to determine NPP.

*Table 2. Calculation for input data for CASA model*

|  |  |
| --- | --- |
| **Parameter** | **Method of Estimation** |
| **0.5** | Constant – proportion of radiation that can be absorbed  by plants |
| **SOL** | Total Solar Radiation – Average value for India used for analysis  SOL = 578.1 (MJ m-2 per month) |
| **FPAR** | Fraction of absorbed photosynthetically active radiation  (𝑁𝐷𝑉𝐼−𝑁𝐷𝑉𝐼𝑚𝑖𝑛)×(𝐹𝑃𝐴𝑅𝑚𝑎𝑥 − 𝐹𝑃𝐴𝑅𝑚𝑖𝑛)  FPAR = + 𝐹𝑃𝐴𝑅𝑚𝑖𝑛  𝑁𝐷𝑉𝐼𝑚𝑎𝑥−𝑁𝐷𝑉𝐼𝑚𝑖𝑛  NDVI was calculated using red or band 4 (R) and near  infrared or band 5 (NIR) bands of the imagery  𝑁𝐼𝑅−𝑅  NDVI =  𝑁𝐼𝑅+𝑅  FPARmax is a constant with a value of 0.95  FPARmin is a constant with a value of 0.001 |
| **Tε1** | Temperature stress factor calculated using the formula Tε1 = 0.8 + 0.02 ∗ 𝑇𝑜𝑝𝑡 − 0.0005𝑇𝑜𝑝𝑡2  Topt was set to 26.34 (Annual average temperature (in  °Celsius) for region close to both study sites) |
| **Tε2** | Temperature stress factor calculated using the formula  1.1814 1  Tε2 = ×  1+ 𝑒0.2∗(𝑇𝑜𝑝𝑡−10−𝑇) 1+ 𝑒0.3∗(−𝑇𝑜𝑝𝑡−10+𝑇)  Topt was set to 26.34 (Annual average temperature (in  °Celsius) for region close to both study sites)  T was set to 27 (monthly average temperature (in  °Celsius) for November for region close to both study sites) |
| **WSC** | Water Stress Coefficient  WSC = 0.5 + 0.5 ∗ (1 − 𝑁𝑠𝑖𝑚𝑖)  NSIMI – normalized shortwave infrared soil moisture index  𝑆𝐼𝑀𝐼−𝑆𝐼𝑀𝐼𝑚𝑖𝑛  NSIMI =  𝑆𝐼𝑀𝐼𝑚𝑎𝑥−𝑆𝐼𝑀𝐼𝑚𝑖𝑛  SIMI – Shortwave infrared soil moisture index  SIMI was calculated using shortwave infrared (SWIR)1 or band 6 and SWIR 2 or band 7  SIMI = 0.7071√𝑆𝑊𝐼𝑅2 + 𝑆𝑊𝐼𝑅2  1 2 |
| **εmax** | Maximum radiation conversion efficiency (gCMJ-1)  εmax = 1.044 (Running et al. 2000) |

# References

Wu, C., Chen, K., You, X., He, D., Hu, L., Liu, B., Wang, R., Shi, Y., Li, C. and Liu, F., 2022. Improved CASA model based on satellite remote sensing data: Simulating net primary productivity of Qinghai Lake Basin alpine grassland. *Geoscientific Model Development*, *15*(17), pp.6919-6933.

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