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Effect of Drought Stress on Forest Evapotranspiration- A case study on Indian forests

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Forest evapotranspiration (ET) is one of the most important processes regulating the terrestrial hydrological cycle, and it is increasingly affected by drought episodes. This emphasizes the need of comprehending the relationship between forest ET and forest drought stress, we chose two forested regions for our investigation, a Deciduous Broadleaf Forest (DBF) and an Evergreen Needle leaf forest (ENF) from India. ET was reduced in most forests around the world during severe and extreme droughts that lasted for lengthy periods, yet their susceptibility to forest drought stress is the crucial component in ensuring their long-term viability. Rainfall data from CHIRPS was used to estimate the monthly Standardized Precipitation Index (SPI) and identify wet and dry spells during the period 1981 to 2020. Vegetation drought indexes viz. Vegetation Condition Index (VCI), Temperature Condition Index (TCI) and Vegetation Health Index (VHI) were estimated using MODIS EVI and LST data from 2002 to 2020.

According to our findings, the ENF experienced a lengthier dry spell from 1998 to 2007. In 2002, the lowest (-2.28) SPI was recorded. There is a substantial increase in the frequency of dry spells for DBF. In 2002, the most negative SPI of -2.03 was recorded in DBF. As a result, 2002 is considered a drought year for the type of forests. 2015 was selected as a wet year due based on SPI values 3.94 and 3.46 for ENF and DBF, respectively. The ET of these two regions was estimated using an auto-calibrated METRIC model. During the drought period (2002) the ET of the DBF region decreased to 0.17-2.19 mm/day from 0.66-4.89 mm/day during the normal/wet period (2015). Similarly, ET of the ENF region was also decreased to 2.81-4.51 mm/day during the dry period in comparison to 2.92-6.65 mm/day in the year 2015. The ET rate is not changed as much by ENF as it is by DBF.

There are three possible explanations for why these distinct plant species react to drought stress. The first is the pattern of precipitation. Because ENF's overall precipitation is always higher than DBF's, the ET rate is naturally higher, and there is very little change in ENF's ET between drought and non-drought years. The next factor to consider is temperature variation; during droughts, the temperature in DBF is higher than in ENF, hence the ET is higher. The final cause is due to physiological and anatomical differences between DBF and ENF. The governing variables of evapotranspiration are leaf water content, stomatal conductance, the relative water content in leaves, absolute and relative transpiration rates, variation in species-wise water usage efficiency,

and deep plant root systems. Drought conditions impair plant development and productivity by reducing stomatal conductance, reducing leaf area, stem extension, and root growth, and disrupting plant osmotic relations and water-use efficiency, among other things. As a result, DBF has a higher intensity of drought stress than ENF. In this sense, ENF outperforms DBF in terms of plant resistance and strategic adaptation to drought stress.

Key Words: Forest drought stress, forest evapotranspiration, SPI, VHI, METRIC