Estimation of Net Primary Productivity of Turkey's Forest Ecosystems

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ESTIMATION OF NET PRIMARY PRODUCTIVITY OF TURKEY'S FOREST ECOSYSTEMS
The aims of this study are, (i) evaluation of MODIS (MODerate resolution Imaging Spectroradiometer) Net Primary Productivity (NPP) product (MOD17A3) for Turkey's forest ecosystems, using field data from Ministry of Forest and Water Affair (MFWA) and (ii) improving a remote sensing based model (Carnegie-Ames-Stanford Approach (CASA)) using local meteorological data.
In the first part of the study, we created a new approach to overcome the uncertainties within a MODIS pixel due to mixed land cover-land use (LCLU) types, based on NDVI ratio. First, 1 km MODIS NDVI images for each LCLU type were summed up to calculate annual NDVI values for a given area. The reason to use total annual NDVI values is because other than the evergreen vegetation, most areas have 0 (zero) or close to 0 NDVI during non-vegetative period. However, for the agricultural areas for example, the NDVI values for the vegetative period may become more than any other areas including forests. Second, a ratio for each LCLU type was calculated with respect to forest areas. Finally, using these ratios, total contribution of forest areas in a MODIS pixel is calculated to evaluate using MFWA field data. Our analysis showed that, although there is a clear relation between MODIS and field data (R2 = 0.34), MODIS is not capable of reflecting local conditions especially areas with abrupt changes. We discussed all possible reasons to create this results including usage of global assimilated data.
The second part of the study covers the improvement of NPP estimation of Turkey's forest ecosystems. We selected CASA model due to its ease of application. To improve CASA model we used local meteorological data obtained from State Meteorological Affairs (SMA). The main variables of the model are Absorbed Photosynthetically Active Radiation (APAR), Light Use Efficiency (LUE), water stress, and two temperature stress parameters. We calculated APAR values using two different approach. The first approach is based on simple ratio created using NDVI (Potter et al., 1993), and second is calculated using probability distribution function (PDF) of NDVI (Yu et al., 2009). The temperature stress factors were calculated as it was proposed in the original CASA paper (Potter et al., 1993). However, due to the complexity and required data for the calculation of water stress in the original paper, Thornthwaite's Potential Evapotranspiration (PET) formula based approach proposed by Yu et al. (2009) was used. Our analysis showed that, although, MODIS NPP product can explains only 34% of Turkey's forest productivity, usage of local data can improve the overall (for all Turkey) results up to 39%, and up to 48% for the regional based relation over the central Anatolia. The correlation between MODIS and our locally improved model is higher with respect to local data (R2 = 0.62).
This study is the first effort not only to evaluate MODIS NPP product for Turkey but also, it is the first attempt to estimate NPP of Turkeys forest ecosystem using remote sensing based models.