Long-term monitoring of CO2 fluxes and development of a forest plantation in a post-mining reclamation site with the use of eddy covariance measurements and satellite imagery

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Reclamation of lignite mines with the establishment of tree plantations is very important for the post-mining land restoration, especially during the ongoing transition to the post-lignite era. Black locust (*Robinia pseudoacacia* L.) is a species that have been extensively used worldwide in relevant projects, however its ecophysiological responses and its contribution to carbon cycle has not been extensively studied yet.

In this study, we provide a 9-year estimation (2013-2021) of carbon dynamics, in terms of GPP fluctuation, for a 20-year old black locust plantation, located in the restored areas of the Lignite Center of Western Macedonia, Greece. GPP estimation was performed with the use of a satellite LUE model. The model was evaluated with a combination of LandSat 8 and Sentinel 2 products and validated with eddy covariance measurements performed in a two-year period. The novelty of the model was the combined use of two water-stress indices, one for the ecosystem water deficit effects, expressed through the Land Surface Water Index and one for the atmospheric drought-liked effects, expressed through VPD.

Our results highlight the seasonal pattern of GPP fluctuation of the site on both annual and interannual time-scale. According to our findings, the fast-growing plantation has reached its peak development very early, as for the period 2013-2021, no significant trend in both GPP and vegetation indices during the summer period was observed. On the other hand, a significant increase of the growing period was observed, that was mainly referred to a constant increase in October GPP during the 9-year period. GPP during leafless period was found to have a significant contribution to annual GPP, mainly due the activity of the well-developed grass understory vegetation. From the studied environmental parameters, VPD and summer precipitation was found to be more strongly correlated to summer GPP and air temperature to springtime GPP of the leafless period.

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