Post-disturbance ground vegetation effects on carbon sequestration in a temperate forest landscape

Thomas Dirnböck (1), David Kraus (2), Johannes Kobler (1), Dominik Thom (3), Rupert Seidl (3), Edwin Haas (2), and Ralf Kiese (2)

(1) Environment Agency Austria, Department for Ecosystem Research and Environmental Information, Vienna, Austria (thomas.dirnboeck@umweltbundesamt.at), (2) Institute of Meteorology and Climate Research – Atmospheric Environmental Research, Karlsruhe Institute of Technology, Garmisch-Partenkirchen, Germany, (3) University of Natural Resources and Life Sciences (BOKU) Vienna, Institute of Silviculture, Vienna, Austria

While it is well known, that tree regeneration after disturbance from seeds or saplings is crucial for maintaining carbon sequestration, only little knowledge exists about the contribution of ground vegetation, i.e. herbs and grasses. Their role, however, may be important in many mountainous forests of the European Alps where ungulate browsing and/or dense layers of grass often inhibit tree regeneration.

In order to explore the interaction between ground vegetation, tree regeneration as well as carbon turnover and losses, we reconstructed time series of ecosystem matter fluxes for the National Park Kalkalpen (NPK), a 200 km^2 forest landscape in Austria, which has been affected by a series of wind and bark beetle disturbances. Here, we investigated a 15-year time period from 2000 - 2015 including the storm events Kyrill, Paula and Emma, which hit Europe in the years 2007 and 2008. Ecosystem carbon fluxes were reconstructed with two linked process-based ecosystem models, which were initialized, calibrated and validated with extensive field and remote sensing monitoring data. In a first step, the biogeochemical model LandscapeDNDC was parameterized and validated at the site scale with observation data from the Long-Term Ecosystem Research station Zöbelboden. In a second step, LandscapeDNDC was applied for simulating impacts of several wind and spruce bark beetle disturbance scenarios in the NPK. Respective spatially explicit disturbance scenarios have been derived beforehand from iLand, an individual-based forest landscape and disturbance model previously applied to the study area.

We found that the fast development of grasses and herbs after stand-replacing disturbances significantly contributes to the overall reduction of carbon loss from this forest landscape. While plot-based measurements showed that it reduces carbon loss by approximately 50% after disturbance, model based scenario analysis detailed the effects of failed versus vital tree regeneration in disturbed areas with and without an herb and grass layer at the landscape scale.