Project title

Response of forest ecosystem to synergetic effect of climate and air pollution changes

Sub-title: Effect of surface ozone on biota under rapid changes in climatic condition;
Sub-title: Effect of acidification / eutrophication processes on health, productivity and biodiversity of forest ecosystem; (sustainable development of ecosystem)
Sub-title: Adaptation of ecosystem to rapidly changed synergies between climate changers and air pollutants (acidifying species, ozone, heavy metals).
Sub-title: Sustainability of terrestrial ecosystems under global changes

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1. Aims

a. to develop time series of biological parameters and use them in conjunction with environmental data;
b. to develop time series of physical and chemical parameters to explain changes in health, productivity and biodiversity of terrestrial ecosystem (first of all forest);
c. To check critical loads of pollutants (S, N, O3) in conjunction with areas location and climate change intensities.

2. Research questions and Hypothesis

Climate change with increasing air temperature by 3-6°C per 100 years may affect health, productivity and biodiversity of all ecosystem (Loustau, et.al., 2005), and its adaptation to unfavourable environmental conditions such as acid deposition and tropospheric ozone. However, todate it is still unclear whether local meteorological conditions affected by climate change will reduce or enhance air pollution effects on terrestrial ecosystem functioning and health. Therefore, their integrated impact on forest ground vegetation, health and increment of the trees in relation to carbon sequestration as well as forest functioning and sustainability is becoming of increasing concern.
The reported results suggested that despite decreases in the emissions of precursor substances (SO2, NO, NO_2) a rise in ozone concentrations is still evident. Tropospheric ozone (O_3) air pollution has been recognized as a major phytotoxic agent since the middle of the last century. However, due to enhanced acidification processes in the soil and due to a change in nutrition imbalances, nitrogen (N) deposition and in particular ammonium (NH_4^+) air concentrations and their deposition still represent one of the key threats to forest ecosystems in the near future, especially in Central and Northern Europe even though, N- and NH_4^+-concentrations and deposition show a tendency towards decreasing.
It is well established that N-deposition may affect species diversity of ground vegetation, and increase tree growth (based on nitrogen concentration data from foliage and soil solution) and reduce the risk of drought stress and pests in certain ecological conditions. In combination, these effects could result in an extreme deterioration of forest condition. On the other hand, a clear direct impact of N-deposition on health and productivity of forest ecosystem could not be well established and requires further investigations. The lack of long-term monitoring data and the use

of short time data series may lead to misinterpretations and, in the context of global change, may contribute to the current uncertainties.
Despite this, there is a general agreement that atmospheric deposition and soil solution have a medium- to long-term influence along with significant cumulative effects on forest condition and vegetation in the context of global change. An extended and integrated assessment of environmental indicators for global change consistently turned out as one of the most important emerging monitoring and research needs. An improved assessment of environmental indicators for global change should provide an increased knowledge of the diagnostic and mechanistic processes occurring in forest ecosystems and allow a more precise prediction of forest health and the state of forest ecosystems for the current global change scenarios. The seasonal variability of environmental contaminants and the main meteorological parameters such as air temperature and the soil water regime, turned out to become key research areas for investigating climate change effects on forest ecosystems.
Uncertainties in this field could be reduced by means of assessing tree condition using remote sensing technologies, which emphasize aerial photography, satellite images, and laser scanning for collecting data on forest condition. Based on the application of hyperspectral cameras, most recent research was conducted in the fields of forest state assessment, forest inventory, and soil and water quality. These advanced techniques offer new possibilities in sustainable forest management under changing climate, which might help to develop reliable scenarios of climate change and air pollution effects on forest adaptation and mitigation abilities.
The work will be done in cooperation with ICP Integrated Monitoring (UNECE) and will contribute to the knowledge of air pollution effects on health, productivity and biodiversity of ecosystem and their sustainability under the global changes

3. Spatial and temporal coverage
Forest habitats across Europe
At least 10-15 years of past data

4. Parameters used/needed

Parameter group (theme)	Selected parameter	Details about the parameter	Should be taken from existing data (yes/no)	Feasibility/constraints regarding existing data	Should be recorded in field (A5 work) (yes/no)	feasibility/ constraints regarding field sampling
1) Climate and physical variability	Monthly &annual mean air temperature	standard meteorological method; monthly & annual mean values of as much as possible years	yes	no problem here because the accuracy is not so important	no	
	Monthly & annual precipitation sum	standard meteorological method; annual values of as many as possible years	yes	no problem here because the accuracy is not so important	no	
2) Biogeochemistry data	Nitrogen deposition	Monthly data on sum of NH3 and NH4) and NO3	yes	Potentially a lot of problems with the exact measurement of total deposition but very high accuracy is not necessary; additionally EMEP modeled data can be used	no	
	Sulphur deposition	Monthly&annual sum of total sulphur in bulk deposition samplers	yes	Potentially a lot of problems with the exact measurement of total deposition but very high accuracy is not necessary; additionally EMEP modeled data can be used	no	
	Surface ozone	Monthly mean value, AOT40 index		Potentially a lot of problems with the exact measurement; additionally EMEP modeled data can be used	no	
	Soil C/N ratio	Soil organic layer C to N ratio as an average value for the habitat for which biological data is available	yes		no	

3) Structure and function of the ecosystems, communities and populations	EUNIS habitat type	EUNIS habitats are used to set Critical Loads for eutrophication/acidification effects (classification will be provided)			no	
	Species cover	Percent cover of each species (vascular plant, bryophyte, epiphytic lichen, etc.) per plot and per year of observation; in case of forests the vegetation layer is important; the entire observation period should at least cover 10 years with at least 2 observations but more observations are very welcome	yes	problem with regard to different plot size and cover estimation and species identification; species reference list will be provided; the plot size has to be reported and can be very small (1 m^2) or large (100 m^2)	yes	as a harmonization effort it should be recorded during the A5 file activities in the year 2012
	Health and productivity of forest ecosystem	Crown condition and annual increment per prevailing main tree species per site; dead wood, biomass, regeneration intensity, the entire observation period should at least cover 10 years with annual data	yes	Problem with annual data with health of tree, no problem with annual radial increment; data on forest monitoring should be used.	yes	as a harmonization effort it should be recorded during the A5 file activities in the year 2012
4) Human population and economy	land use	Sustainability of forest ecosystem under global changes	yes	none	no	

5. METHODS USED

All manual for UN ECE ICP can be used

6. EXPECTED RESULTS

Forest ecosystem sustainability under global changes

7. REFERENCES