Climate change poses a serious challenge to the forest environment, causing a number of disturbances resulting in loss of vitality and forest decline. The problem of unfavourable changes in forest ecosystems occurs all over the world, and the scale of this phenomenon is increasing. Numerous studies indicate an increase in the area of forests affected by dieback, which is mainly caused by climatic factors. Also in Poland, dieback of stands is observed, especially of Norway spruce in mountainous areas.

The dieback of spruce trees is associated with extreme droughts, which have been observed more and more frequently for several years. Not only drought has a significant impact on the condition of forests, but also the physicochemical components of the soil environment. Climate warming accelerates the cycle of carbon and nitrogen, making these elements more accessible to plants. Nitrogen accumulated in organic soil horizons is released due to the climate-enhanced decomposition rate, causing a series of soil changes and leading to faster forest growth. Climate changes will force completely new environmental conditions for trees, often not meeting the requirements of species growing in a given place; global warming is expected to change the altitude ranges of species such as spruce, beech and fir. Spruce, which is currently one of the main species of mountain stands in Central Europe, may be replaced by beech, which may be more tolerant to new climatic conditions. Potential directions of changes in the species composition of mountain forests are poorly understood and focus mainly on prognostic models. Therefore, there is a need to understand the growth reactions of these species in the face of elevated air and soil temperature, as well as to determine the dynamics of biogeochemical changes in forest soils, with particular emphasis on nitrogen.

The aim of the project is to investigate the effect of simulated warming on the dynamics of nitrogen and carbon changes in soils under the spruce stand, as well as to determine the effects of soil warming on the growth and development of individual parts (leaves, branches, roots) of spruce and beech trees. Therefore, we formulated hypotheses that (1) global warming may lead to changes in the decomposition of soil organic matter, especially in the transformation of nitrogen compounds in developed, mature spruce stands; (2) global warming adversely affects the growth of young spruce; (3) young European beech trees show better growth in warming conditions. Open Top Chambers will be used to simulate the warming. Their effectiveness in climate change simulations is guaranteed by high visible light transmittance and low infrared light transmittance. The project involves two simulation experiments: in a mature spruce stand (to determine the scenario of changes in the soil environment) and in a forest nursery (to determine the reaction of young spruce and beech trees to warming). The stable ^{15}N nitrogen isotope will be used in the research as a marker that will allow to accurately trace the migration routes of this element in the system: soil organic matter - soil - young trees. We expect significant differences in soil physicochemical parameters between the simulation and the control sample. Moreover, we assume that young beech specimens will show better tolerance to environmental warming than young spruce trees.

The expected result of this project is to create a theoretical basis for the scenario of changes in the soil environment due to climate change, with particular emphasis on the nitrogen cycle.