The dark coniferous taiga of the Russian North is drying out against the backdrop of modern climate change

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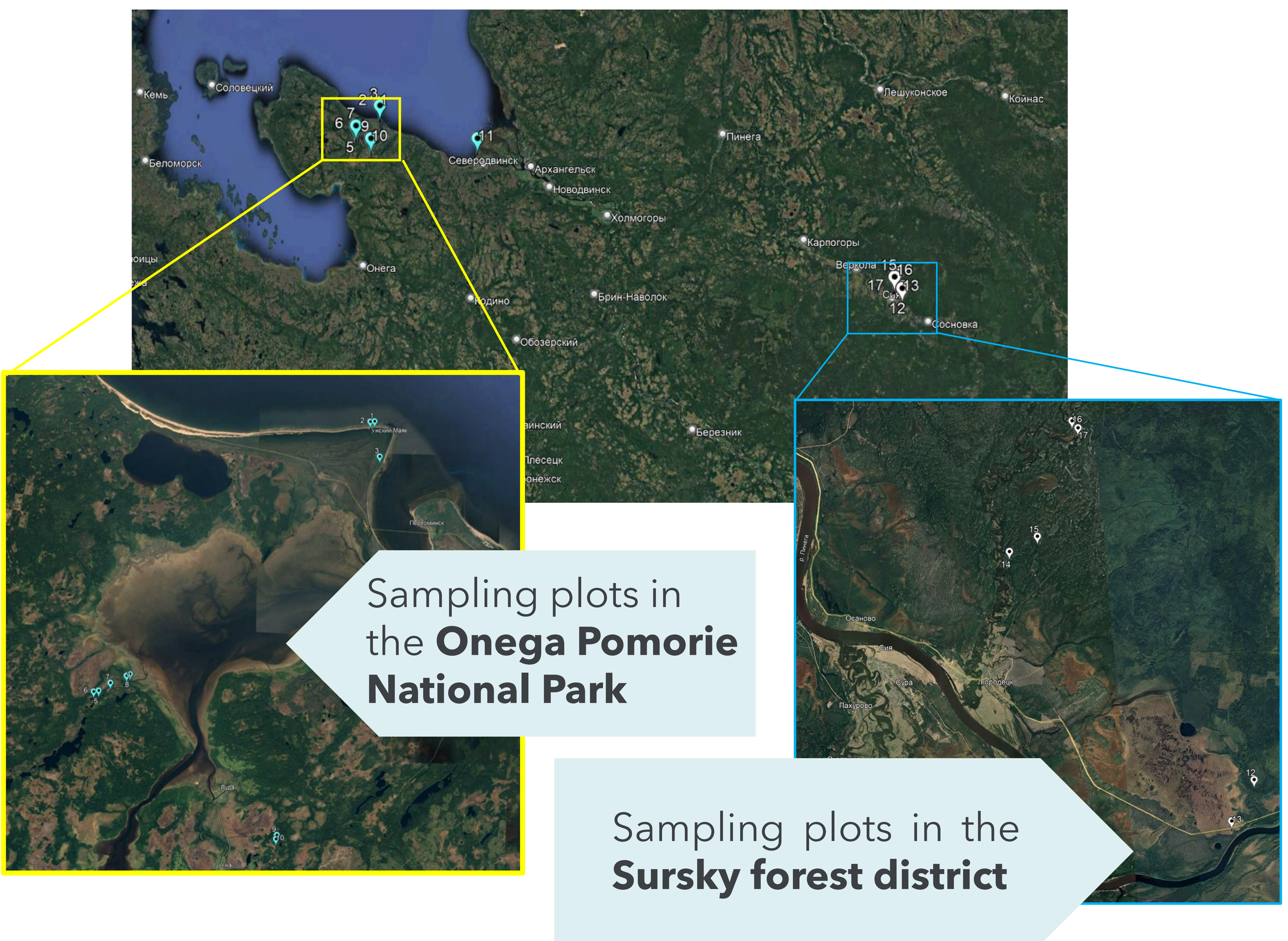
1 Introduction

The study investigates decreasing resistance of dark coniferous forests to adverse environmental factors, which are becoming increasingly pronounced yearly because of modern global climate change. The boreal coniferous forests degradation and dieback are observed in a large area of the Russian forest lands, including dark coniferous forests in the north of the European part of Russia. One of the largest mass drying out of spruce forests is observed in the Arkhangelsk region.

The study aims to analyze the state and dynamics of dark coniferous forests in the European part of Russia under the conditions of modern climate change to develop efficient forest management system.

2 Study Objects



The research objects are the **dark coniferous forest stands** of various condition categories in areas of intensive drying out, and **pine trees** growing in conditions with an expressed impact of a specific limiting factor



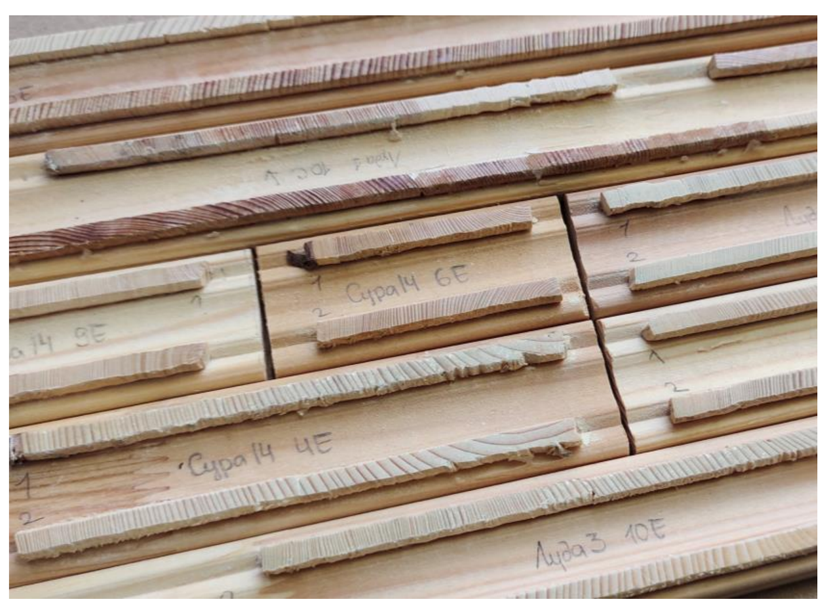

3 Materials & Methods

A study of dead and drying tree areas was carried out on the territory of the Sursky forest district, and a dendroclimatic analysis was implemented for the Sursky forest district and the coast of the Unskaya Bay (Onega Pomorie National Park).

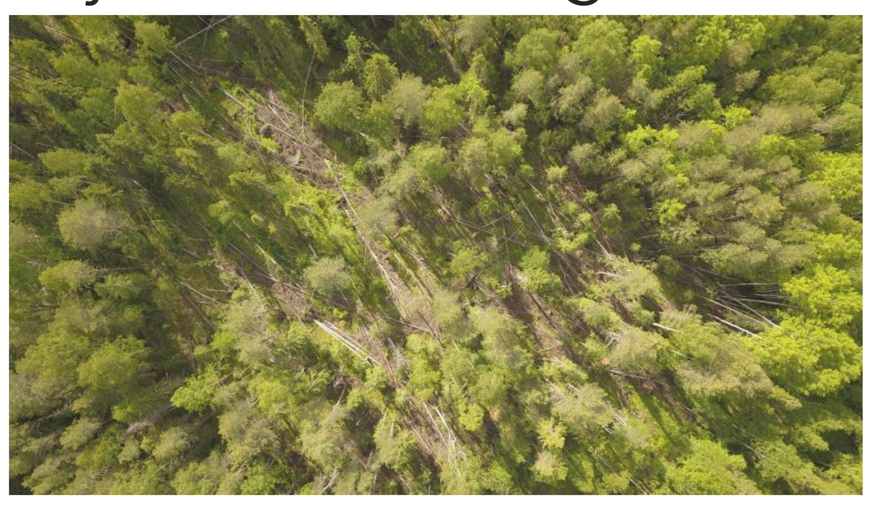
We investigated dark taiga species (spruce, fir). Pine was chosen as an auxiliary species for dendroclimatic analysis since old pine trees grow on the Onega Pomorie territory and exhibit long-term climatic signals.

In total, 17 sample plots were laid out. On each sample plot, we implemented forest inventory, took wood cores from living trees and disks from dried trees. The dendrochronological method was applied to determine the relationship between meteorological parameters and tree growth.





Studied areas were **surveyed with Mavic3** for recognizing objects, decoding and creating maps.

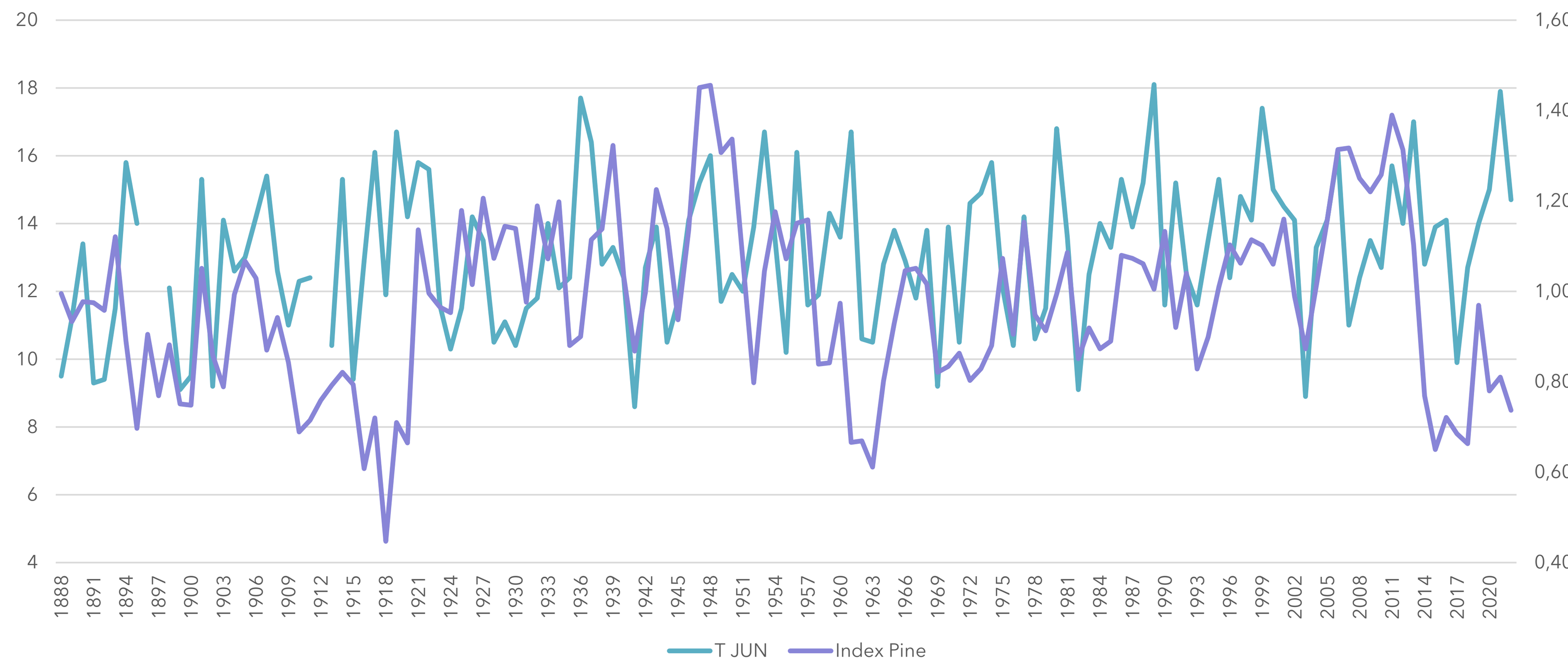


A **forest pathological examination** of living and dead trees was conducted.

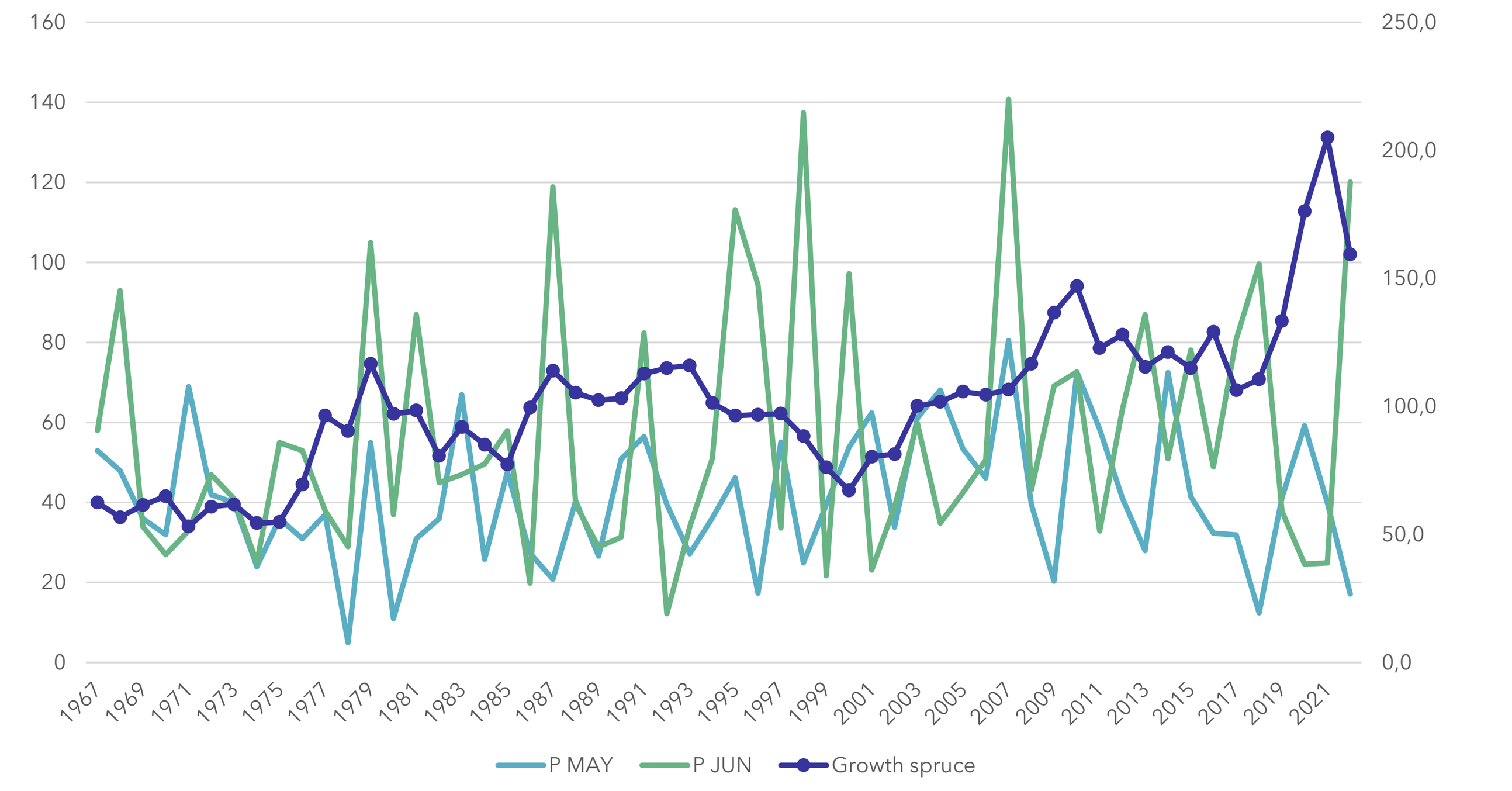


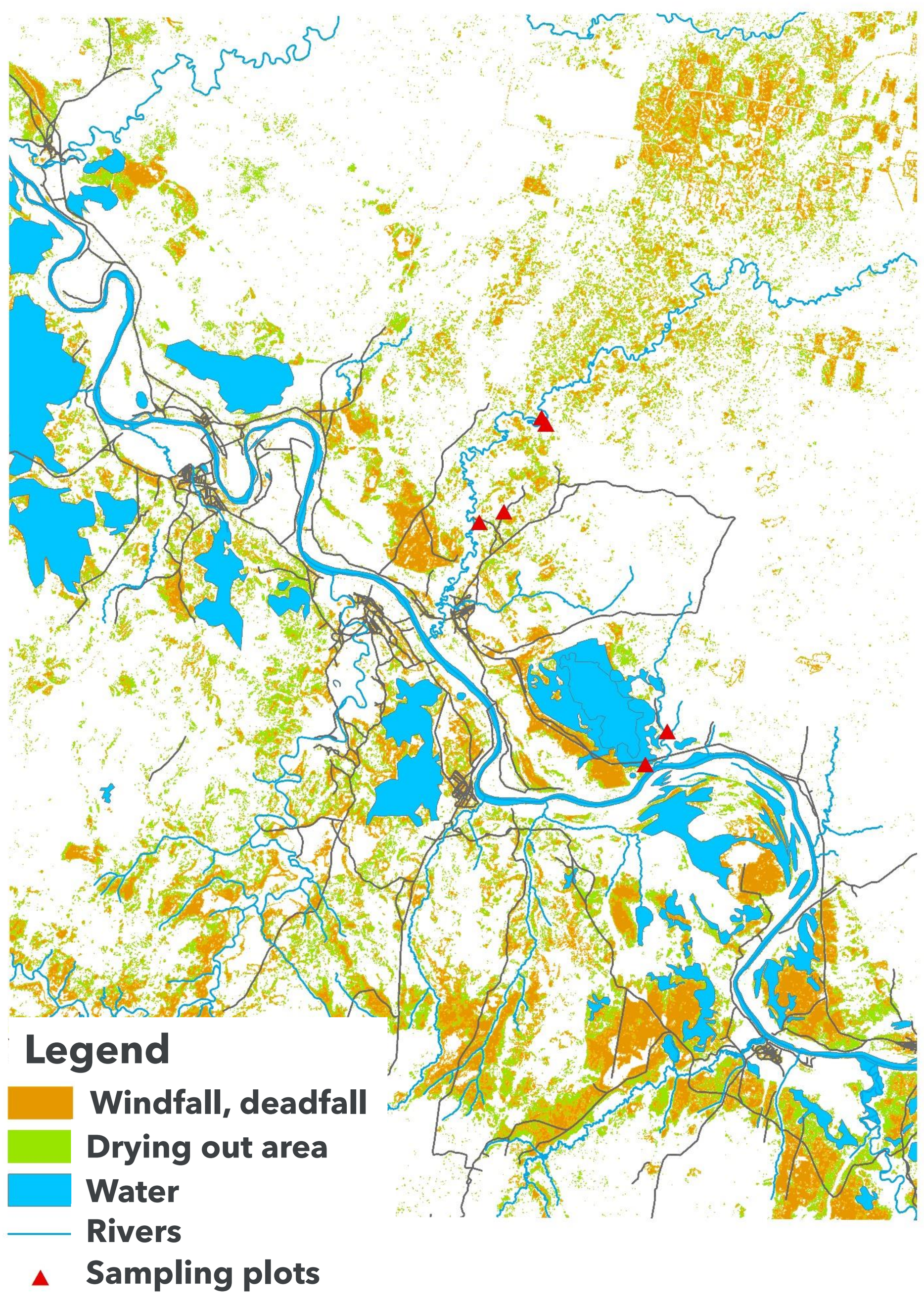
4 Results

Dendroclimatic analysis exhibited a correlation of pine radial growth with **temperature of June**; and spruce radial growth with **precipitation of May and June**.



The drying and dead trees damaged by stem pests, that were identified as **European spruce bark beetle** (*Ips typographus*) and **Monochamus sartor**; and fungi **Heterobasidion annosum** and **Phellinus pini var. abietis Karst.**





The determined fundamental causes of forest dieback were the trees weakening under the influence of adverse climatic conditions, droughts in particular, and subsequent tree damage by stem pests.

The conducted studies allows to **evaluate the scale of forest degradation** due to the various natural factors impact caused by climate change (windfalls, droughts, changes in groundwater levels).