World Academy of Science, Engineering and Technology
International Journal of Computer and Systems Engineering
Vol:18, No:07, 2024

Reconstruction of Age-Related Generations of Siberian Larch to Quantify the Climatogenic Dynamics of Woody Vegetation Close the Upper Limit of Its Growth

Authors : A. P. Mikhailovich, V. V. Fomin, E. M. Agapitov, V. E. Rogachev, E. A. Kostousova, E. S. Perekhodova

Abstract : Woody vegetation among the upper limit of its habitat is a sensitive indicator of biota reaction to regional climate changes. Quantitative assessment of temporal and spatial changes in the distribution of trees and plant biocenoses calls for the development of new modeling approaches based upon selected data from measurements on the ground level and ultra-resolution aerial photography. Statistical models were developed for the study area located in the Polar Urals. These models allow obtaining probabilistic estimates for placing Siberian Larch trees into one of the three age intervals, namely 1-10, 11-40 and over 40 years, based on the Weilbull distribution of the maximum horizontal crown projection. Authors developed the distribution map for larch trees with crown diameters exceeding twenty centimeters by deciphering aerial photographs made by a UAV from an altitude equal to fifty meters. The total number of larches was equal to 88608, forming the following distribution row across the abovementioned intervals: 16980, 51740, and 19889 trees. The results demonstrate that two processes can be observed in the course of recent decades: first is the intensive forestation of previously barren or lightly wooded fragments of the study area located within the patches of wood, woodlands, and sparse stand, and second, expansion into mountain tundra. The current expansion of the Siberian Larch in the region replaced the depopulation process that occurred in the course of the Little Ice Age from the late 13th to the end of the 20th century. Using data from field measurements of Siberian larch specimen biometric parameters (including height, diameter at root collar and at 1.3 meters, and maximum projection of the crown in two orthogonal directions) and data on tree ages obtained at nine circular test sites, authors developed a model for artificial neural network including two layers with three and two neurons, respectively. The model allows quantitative assessment of a specimen's age based on height and maximum crone projection values. Tree height and crown diameters can be quantitatively assessed using data from aerial photographs and lidar scans. The resulting model can be used to assess the age of all Siberian larch trees. The proposed approach, after validation, can be applied to assessing the age of other tree species growing near the upper tree boundaries in other mountainous regions. This research was collaboratively funded by the Russian Ministry for Science and Education (project No. FEUG-2023-0002) and Russian Science Foundation (project No. 24-24-00235) in the field of data modeling on the basis of artificial neural network.

Keywords : treeline, dynamic, climate, modeling
Conference Title : ICDM 2024 : International Conference on Data Mining
Conference Location : Istanbul, Türkiye
Conference Dates : July 29-30, 2024