Tree response to changeable climatic conditions

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IEGULDĪJUMS TAVĀ NĀKOTNĒ
ERAF
EIROPAS REĢIONĀLĀS ATTĪSTĪBAS FONDS
EIROPAS SAVIENĪBA

Introduction

Our research is dedicated to evaluate climate change influence on the forest stand productivity. For this purpose, the mathematical model has been elaborated which predicts response reaction of trees in the given meteorological situation. The model is based on the statistical approach like as linear multivariate regression. The resulting characteristic of model is the average values of annual tree ring width of forest stand, but independent arguments - the active periods of amount of rainfall, maximum and minimum temperature per one decade of days. The active period means the decade during which the climatic factor influence on radial growth is statistically significant. Significance of this influence is determined by the Pearson's correlation coefficient between tree ring width and climatic factor values for decades in the range of 30 years. Information about the weather is obtainable at the nearest meteorological station, but data on tree growth - from wood samples using Presler's increment borer. Active period indicates the extent to which tree growth has met the physiological requirements of the respective decade. Thus become visible decades during which the climatic factor promotes or hinders the formation of wood. The model integrates the influence of forecasted changes of climatic conditions related to dynamics of forest productivity. In most cases, the number of active periods is sufficient for several model iterations. It goes without saying that the results are different. The final result is calculated as the weighted average by taking into account the determination coefficients of individual iterations.

Methods

Two kinds of empirical information have been gathered - data of forest stand radial increment during time period of twenty five or more years and values of climatic factors related to this time span. To reflect dynamics of tree response to changeable climatic conditions, four sample plots (30 x 40 m) were established at Norway spruce (Picea abiea (L.) Karst.) dominated 90 year old stands in western part of Latvia. At each sample plot were accomplished traditional forest stand assessment and were taken twenty wood specimen using increment borer. Wood samples were used for tree ring width measuring performed on the device Lintab 4. Data matrix of tree ring width comprises information of n years and m trees. Values of climatic factors have been obtained from the archive of nearest meteorological station concerning appropriate time span. The computer program detects active periods and represents the chronological scheme (Fig. 1) from which by random order four or five arguments have been selected to realize the current iteration of model (1). The different combinations of active periods allow several iterations for the given forest stand. The final result is obtained as a weighted average according to the values of determination coefficient R-squared. It is possible to demonstrate our proposals during inspection of poster.

Results

The forest stand response model in changeable climatic conditions:

$$i = a + \sum_{j}^{m} b_j x_j \qquad (1)$$

i - average value of annual tree ring width of forest stand, mm;
x - forecasted value of active period for given climatic factor;
m - number of arguments.
Model (1) determines the response of trees as the average width of annual rings, but if necessary, it can be converted into stock keeping units - cubic meters. A suitable transition algorithm ensures that step. The vertical straight line (Fig. 2) separates two intervals - retrospective and future time spans. The right-hand interval information shows the model (1) projections with empirical data. It can be seen that the difference between the model and the actual data is less than 0.2 mm which can be regarded as acceptable. Forest stands reactions accuracy of any particular climatic situation is totally dependent on accuracy of weather data forecast.

Figure #1

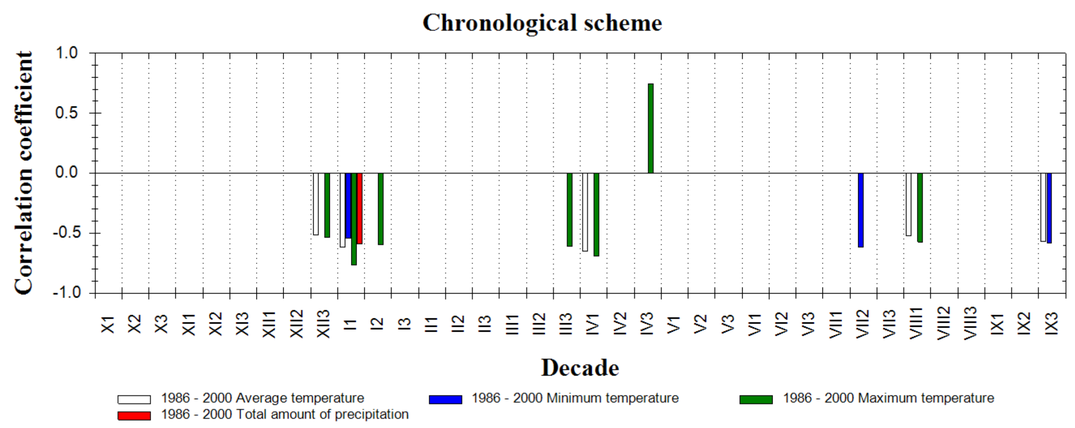
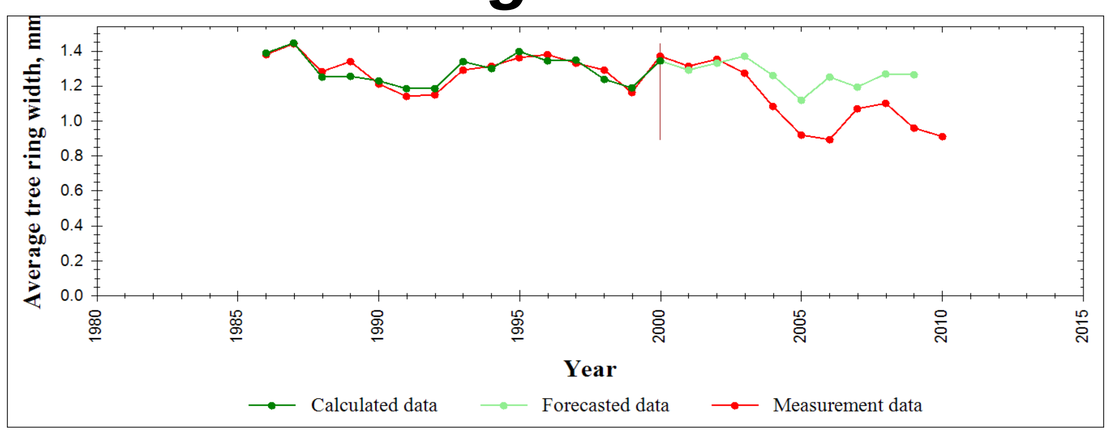


Figure #2



Conclusions

1. The multivariate model (1) for assessment of forest stand reaction to changeable climatic conditions has been carried out. The most important novelty here is the choice of adequate arguments for model. As the arguments serve the values of climatic factors during the active periods which are detected by the retrospective analysis of forest stand radial increment and weather data.
2. Model (1) determines the response of trees as the average width of annual rings, but if necessary, it can be converted into stock keeping units - cubic meters. A suitable transition algorithm ensures that step.
3. Differences between the model values and the actual data are less than 0.2 mm which can be regarded as acceptable. Forest stands reactions accuracy of any particular climatic situation is totally dependent on accuracy of weather forecasting.

Bibliography

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The research is financed through the European Regional Development Fund, project No.2010/0208/2dp/2.1.1.0/10/APIA/VIAA/146 and is carried out by Forest Faculty of Latvia Agriculture University