Forecasting development of forest complex in the formation of
digital economy

T L Bezrukova1,*, I V Kuksova1, S S Kirillova1, A T Gyiazov2

1Voronezh State University of Forestry and Technologies named after G.F. Morozov,
8 Timiryazeva Street, Voronezh, 394087, Russian Federation
2Kyzylkiysky Versatile Institute, Batkentsky State University, 1 Nigmatulina Street,
Kyzyl Kia, Batken Region, 720300, Republic of Kyrgyzstan

*E-mail: bezrukova_t_l@mail.ru

Abstract. Scientific issue considered in the given article is in modernization of forest complex
development assessment in regard with up to date mechanisms of digital economy. The
assessment is spreading by means of modern achievements of informational technologies that
create a platform for new condition formation of their functioning, for forecasting methodology
working out and forest development complex strategy for taking correct management decision.
To reach the stable development of digital space of forest complex we need to apply the newest
mechanisms of digital economy basing on cartographical optimization of informational and
analytical tools. The basic item of the research is construction of forecasting methodology of
forest complex development in the period of digital economy formation in Russia that will
improve its further development alongside with the effective usage of scientific and
 technological potential. The research of the existing system of forest complex and its basic data
indicators with new data introduction devoted to the standardization of implementation of
mechanisms of digital economy in the conditions of multiple-valued initial data are given in
the article. Modernization of the traditional producing branches is needed by means of forestry-
ecological and economical platform management as well as allied financial and logistic
operations. The structure of consumption and strategy of forest complex development should
be changed in the period of digital economy formation through penetration of informational
technologies into industrial spheres of Russia.

1. Introduction

Effective national policy implementation in prior spheres of social and economic development,
application of mechanisms and tools of state management are the necessary preconditions for
formation of economy of stable development. It’s is impossible without informational provision of
observations for process of development.

Consideration of the digitalization of the forest complex is quite new in the studies of foreign
researchers, because of complexity and versatility of merging the two significant points of digital
economy and the forest complex studying as independent objects of research. In the literature review
of works of foreign authors in the field of digital economy studying, the latter one is considered in the
past period, present and future [1], the study of digital technologies from the point of view of tools for
managing many practical problems is seen [2], as well as in the development of the theory of digital
economy [3]. The latest innovative technologies enable the use of new digital capabilities that affect
the efficiency of the organization, which provides higher performance [4].

Research on the digital economy in the field of nature conservation [5] is reflected in the works of foreign authors, in which the benefits of the use of the digital economy in environmental protection are justified. The management of the development, introduction and spread of the digital economy in relation to the environmental protection sphere has been studied extensively by authors all over the world [6]. However, a comprehensive analysis with further forecasting of the development of the forest complex in the era of the development of the digital economy was not reflected in the works of domestic and foreign authors, therefore the purpose of this article is of a high degree of novelty and relevance today.

The transition to developed intellectual industrial technologies, new materials and constructing technologies has been indicated within 10-15 years as a prior strategy for scientific and technology development of Russian Federation. This clearly reflects the formation of forecasting methodology of forest complex transition to the advanced digital, intellectual and industrial technologies [7].

Getting new scientific results while modeling and further forecasting of digitalization of forest complex basing on the application of digital economy mechanisms [8] and the newest technologies enables to work out the strategy for its stable development.

Actuality of the research is specified by the transformation of Russian economy to digital space with studying modern digital tendencies and transformation of industrial and managing processes encouraging the enhancement of unpredictability of social and economic development of forest complex in future. The present processes make us forecast the future development directions of digital economy. We need to forecast and plan social and economic development of forest complex as well as scientific and technological development of forest complex which is the object of research. Forest complex of Russia needs urgently transformation not only infrastructural but also digitally from the state of stagnation to the steady growth of competitive ability in the market of Russia and in the world market as well [9].

Given problematic is of special importance for scientific research in Economics. Digital technologies are used as basis for enrichment of precise content for compound research of digitalization [10] being the main regulator connected with time and situation of analysis, planning and forecasting of digital economic development of forest complex.

Scientific novelty of the given research is based on the methodological grounds and formation principles of forecasts of processes digitalization of forest complex development using through technologies of digital economy for obtaining more precise results of analysis, forecasting, validity, conventional extrapolation defining possibilities of the steady growth of competitive ability of sectors of forest complex of Russia and further digital economic development.

Successful implementation of this study requires multidisciplinary approach in addressing the issues of social development, environmental management, economic growth, spatial-temporal environment formation, application of the latest innovative, information and digital technologies taking into account the characteristics of the natural production environment, existing technical and technological processes and digitalization of the economy.

2. Methodological basis of the research
Assessing, evaluating and forecasting of the effect of the technological transformation using quantitative indicators are global challenges of modern economy. Convergence of industrial technologies basing on digitalization shows us a totally new stage of scientific and technical progress. Nothing in the history can be compared to such an influence over mankind. New industrial technologies [11] having colossal potential for changing of technological development direction at the same time have ambiguous social and ecological repercussions [12]. That makes one more challenge that needs to work out management tools for hazards of technological transformation of forest complex basing on forecasting of its development.

Constant monitoring, coordination and forecasting of different social and economic systems development enables to realize the conception of steady development both within the limited local
territory and global areas having the least negative effects.

In the period of actualization of development of digital economy monitoring process and forecasting of the social and economic systems of forest complex have essential meaning for national and regional policy in social and economic, ecologic and other spheres.

Regarding the importance of digital economy formation that accumulates great attention in the developed countries of the world considering it as a meaningful element of state policy for rising the life level of citizens we need to refer to the forecasting [13]. Basic task of forecasting is formation of stable and objective ground for the policy of digital economy development and improvement of efficiency of economy at large in the period of steady development [14].

Forecasting of forest complex development means the system and process of monitoring, assessment analysis, forecasting and strateging of economic and social environment that exists on the territory of forest complex. Considering forest sector of industry we mean special organized systemic monitoring of process and features of changes of selected quantitative and qualitative parameters of j system \{P_j\}, connected with its transformation from one condition to another (according to formula 1):

$$\{P_{j0}\} \rightarrow \cdots \rightarrow \{P_{j1}\} \rightarrow \cdots \rightarrow \{P_{jn}\}$$  (1)

where \(t = 0, \ldots, i, \ldots, n\).

We need to highlight the definite aggregate of (N) indexes. Since the indexes may contradict with each other in some degree when comparing systems of forest complex. It’s reasonable to compare each index with those of homogeneous. Thus, using the method of pair comparison of each of indexes of the system j, a multitude of scales or axis are formed, the number of which equals to the quantity of indexes under study. We can compare the state of the systems with N-measured orthogonal space. In terms of that value of indexes may exist over a wide range. It’s convenient to normalize them according to the formula (2). The given operation limits the area of comparison by the N –measured unit cube:

$$P_j = \left( p_{ij}/\alpha_i \right)_{i \in N, \alpha_i = \sqrt{\sum_{j=1}^{N} (p_{ij}^2)}}$$  (2)

where \(p_{ij}\) – i-valued index of j-system; \(P_j\) – point, plotted due to the normalized indexes of the j-system.

Recurrent model is taken as a model of forest complex development. Recalculation of indexes is made every year where the forestry sector of economic is taken as an example. Calculation of the current year is based on the last year indexes. Recurrent models can be used if the analyzed object have a cycle period, then cycle period is chosen as a time iteration step \(\Delta t\).

One year recurrence is strongly defined in the forest complex functioning [15, 16] that is connected with the production activity. That is why time iteration step \(\Delta t = 1\) year is the most natural. This kind of recurrent model must have the highest grade of adequacy. Forecast precision based on the recurrence model will rise with the interval extension of the preliminary observation of the forest complex system. It reflects the stage of getting the analytic dependences

3. Results

With the help of recurrent model it is possible to imitate the development of forest complex in the conditions of digital economy formation during long time (10 – 20 years) having stable macro economical parameters (the level of the year 2018). In that case the parameters and indexes gradually transit to the constant value. The table 1 shows the coming 5 year forecast drown up with the help of the model.

Recurrent model imitating the development of forest complex allows us to assess the level of influence of various random events upon the implementation level of mechanisms of digital economy, upon the degree of investment attractiveness of forest complex objects, upon the level of scientific and technical and technological personnel potential. The obtained results were approximated by the quadric surface (Figure 1)
Table 1. Long term forecast of indexes of forest complex development in the period of digital economy formation.

| Year | Level of implementation of digital economy mechanisms | Level of investment attractiveness of forest complex objects | Level of science and technical personnel potential | Assessment of confidence interval |
|------|------------------------------------------------------|----------------------------------------------------------|--------------------------------------------------|---------------------------------|
| 2019 | 0.03                                                 | 0.20                                                     | 0.01                                             | ± 15 %                          |
| 2020 | 0.17                                                 | 0.19                                                     | 0.02                                             | ± 25 %                          |
| 2021 | 0.35                                                 | 0.59                                                     | 0.04                                             | ± 33 %                          |
| 2022 | 0.34                                                 | 0.30                                                     | 0.12                                             | ± 38 %                          |
| 2023 | 0.77                                                 | 0.86                                                     | 0.23                                             | ± 41 %                          |

Figure 1. Results, approximated by quadric surface.

Based on the obtained data we have made the cartogram of optimization (figure 2) in MathCAD 14 system. Nine computer experiments with a recurrent model have been conducted to determine the investigated functions ED, SP and SP2, in which the data varied at the levels of 5,000, 10,000, 15,000 thousand rubles, and the corresponding values of the resulting profits have been found. Dependency plots are made in the form of cartograms to conduct a quantitative analysis, on which functions are depicted using level lines.
Figure 2. The map of forecast of forest complex development.

We describe the obtained cartogram from the point of view of separation of two predicted parts: favorable and unfavorable (darkened) areas. In favorable areas, the function values are more than 340 million rubles (figure 2), functions with darkened area - less than 240 million rubles. The intersection of favorable areas is general optimal area in which both volume indicators are high. The region of optimal control has a triangular shape and it is rather extensive. Judging by the location of the optimal area for the next 5 years, the development of the forest complex will be 5,000–10,000 thousand m³, and the profit will be 900–1,100 million rubles.

Judging by the diagram, dark parts crossing means the part where parameters $P_j$ give simultaneously high level of implementation mechanisms of digital economy and the level of investment attractiveness of forest complex objects in the year of 2023.

Forecasting should have target oriented information processes, maximal objectivity of conclusions which are formulated at each stage of data processing. The following directions of local forecasting can be marked out: ecological, economic, social and political, social and others. Each system is characterized by the point with its coordinates in the given cube that equals to normalized value of its indexes. That enables to compare the distance from one system to another in space. Characteristics of system condition of forest complex development are carried out by the means of indicators and analyses of indicators system.

4. Recommendations

Basing on the forecasting lets regard possible ways of forest complex development in the period of digital economy. Present condition of forest complex of Russia can be characterized as following:

- Forest industry is developing faster in comparison with the economy growth in a whole;
- Integrated processing of forest raw materials is fully provided, including procession of low quality timber. This can be done on the base of forest engineering clusters organized in the area of cellulose and paper plants;
- Deep processing of produced timber is provided (based on the extension of present and construction of new wood processing enterprises).

The main directions of this sector development are: bigger scale export oriented cellulose production; container board production and sanitation goods production to meet the domestic market demands, export oriented lumber production, plywood board, and wood house building production [17].

To achieve steady development of digital space within the forest complex we propose the methodology of forest complex development in the period of digital economy formation consisting of
the following directions:
  – Projects support of forest complex development;
  – Formation of competitive sale market;
  – Providing the accessibility of the current base of wood raw material;
  – Effective forest maintenance and usage;
  – Formation of effective system of forest defense and protection;
  – Forest ecological potential stimulation;
  – Development of scientific and technical and technological personnel potential.

The following activities are necessary to reach the steady development of digital space of forest complex:
  – To provide the enterprise attractiveness for working and new employed staff [18];
  – Conditions must be created providing young specialists inflow to the forest sector, measures must be worked out and realized to support forest complex workers and to provide the necessary living standards.
  – Support of genetic, species, eco system and landscape diversity of forests that enables to keep up ecological and environmental functions of forest.

The realization of the worked out methodology of forest complex development forecasting in the period of digital economy formation enables to develop the strategy, to highlight the directions priority for transformation of forest complex system with analysis, modeling, forecasting and planning of digital economic development of production and management processes creating a new forest and ecological and economic digital platform.

It is necessary to implement the following sets of measures which are quite essence in the period of digitalizing of economic space of Russia for the purpose of the strategy for steady development of forest complex enterprises and the whole forest complex [19]. We propose seven strategy measures for forest complex development in the period of digital economy implementation (figure 3).

Seven strategy measures for forest complex development are the following:
  – Implementation of digital economy mechanisms;
  – Attractiveness of forest complex objects for investment;
  – Projects support of forest complex development;
  – Formation of competitive sale market;
  – Development of scientific and technical and technological personnel potential;
  – Providing the accessibility of current forest raw materials;
  – Encouraging the implementation results of innovation activity.

It is possible to use the following target operations To provide the steady of forest complex development in Russia:
  1. Gradual, onward, overall and steady economic growth.
  2. Formation of stable infrastructure, total and sustainable industrialization assistance and commercialization of results of innovation activity.
  3. Assisting the transition to the rational models of consumption and production.
  4. Guaranteed access to justice and formation of effective, accountable enterprises based on wide activity.
  5. Consolidation of means, implementation and realization of activity in the frame of global partnership considering the steady development.

The items devoted to the forest complex development strategy given in the article should be used in accordance with modern tendencies and current condition of the Russian economy [20].
5. Conclusion
The suggested points of strategy of forest complex development are based on the recurrent model of forest complex in the period of digital economy formation. Thus, it is possible to forecast data of implementation level of digital economy mechanisms, level of investment attractiveness for forest complex objects and level of development of scientific and technical and technological personnel potential for some years ahead.

The presented scientific research depicts the fundamental economic features of the studied forest complex system. The most natural data of its development within stable outer conditions have been defined. Short term and long term forecasting of forest complex in the period of digital economy formation has been fulfilled. The research of the existing forest complex system and its fundamental data with adding new data of normalization of digital economy mechanisms implementation in the condition of many-valued original data has been proved.

The scientific research is aimed to modernization of traditional producing forest complex branches by means of coordination of forest and ecological and economic platform and allied financial and logistic operations. The suggested research is also aimed to coordinate forest and ecological and economic platform and changes of consumption structure, to achieve the effective strategy of forest complex development in the period of digital economy formation with penetration of information technologies into industrial spheres of Russia and abroad.

The results of the research paper enables to develop a strategy, identifying priority areas for the transformation of the forestry complex with analysis, modeling, forecasting and planning of digital economic development of production and management processes with the proposal to create a new forest-ecological-economic digital platform.

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