About technology of risk management in forestry

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Abstract. The article investigates risk management components and specific industry risks of forest management. The risk management model is offered in forestry on the basis of the managed parameter.

1. Introduction
The most relevant specific forestry risks include: forest fires, mass reproduction of forest wreckers, mass development of forest diseases, damage of the woods by wild animals, adverse weather conditions (dead wood, drought, etc.), illegal logging of the wood and other influences (pollution by industrial emissions, etc.).

Realization of these risks negatively affect ability of forests to perform economic, social and ecological functions. The feature of risks consists in recurrence of their manifestation which is caused by recurrence of forest fire danger, death of the woods from wreckers and forest diseases, influence of adverse weather conditions. One more feature of specific risks in forestry is that their manifestations often accept the nature of natural disasters.

Usage by the industries in the constant duty of forecasts and warnings of the dangerous phenomena allows to be prepared beforehand for influence of adverse weather conditions, to reduce vulnerability of the production sphere and its infrastructure and it is essential to prevent economic losses. Specialized geographic information systems corresponds to it most fully, which are oriented to specifics and needs of each specific industry and have selective character.

Adoption of management decisions in the conditions of uncertainty usually is understood as the situation when probabilities of different options of succession of events are in advance unknown to the subject making the risk decision.

According to the concept of sustainable development, control has to be exercised by development of the justified decision directed to search for the best way of the goals achievement taking into account three main components: economic, social and ecological. In this regard, it is appropriate and it is even necessary to consider adoption of management decisions in constant interrelation with the environment [1].

The order of development of control actions in time is determined by efficiency. The category of efficiency and the category of reasonableness are in a dialectically contradictory connection. The desire to provide a more complete justification of the decision will require more time and, therefore, will always lead to a decrease in efficiency. On the other hand, in some conditions, the requirement to increase efficiency will reduce the validity of decisions.
2. Methods and Materials

Let's enter the following definitions.

*Management decision* – conditions ensuring implementation of the purpose of the object with the subject of conditions which it manages, in the meeting situation for the benefit of achievement of the goal of management.

*Situation* – set of factors and conditions in which activity is carried out.

*Information and analytical work* – continuous getting, collecting, studying, display and the analysis of data on the situation.

Only two approaches [2] are possible for creation of model: development on the basis of the analysis and on the basis of synthesis. Analytical approach possesses the essential shortcoming - it does not allow to create processes with beforehand the set properties that is especially important in the conditions of safety from influence of the natural phenomena. The approach based on synthesis allows to obtain the guarantee of goal achievement and is deprived of the main lack of analytical approach, as predetermined need of application of synthesis of model of management for this work.

For decrease in economic losses owing to approach of damage, we will consider risk of emergence of this event on instant. There is the certain interval of values of the natural factor \( C \in [C_{\min}, C_{\max}] \) with which the risk of emergence of relative damage is connected. Borders of the interval are set by the person making decisions and can have gradation. Thus, it is possible to calculate the probability of the exit of accidental process of area \( C \), on the following formula as risk parameter [3]:

\[
R_s = P(x(t) \notin C, t_s)
\]  

(1)

Let's consider area \( C \) as the \( R_s(C) \) parameter and we will analyze behavior of this function (Figure 1).

![Figure 1. Risk function of \( R_s \).](image)

From the schedule it is visible that the risk function decreasing in the parameter \( C \). That is the more the interval, the is less exit probability out of its limits and as a result approach of risk. Otherwise, at the minimum interval, the probability of approach of risk aims at unit [4-11]. The same way, we will consider function of relative damage \( U/U_{\max} \) (Figure 2).
It is possible to observe that in $t_s$ instant, the $C$ interval is less, the damage of $U$ and vice versa, the more the interval is less, the damage increases stronger.

### 3. Results and Discussion

Let's enter designation of relative damage as (2):

$$ I = \frac{U}{U_{\text{max}}} $$

Let's consider the system of equations (3) and we will solve it concerning $C$:

$$ \begin{cases} R_s(C) = f(C) \\ I(C) = \varphi(C) \end{cases} $$

(3)

Apparently from the schedule (Figure 3) crossing of two curves gives us the point of steady management, and the shaded area is the field of admissible management.

As a rule, the risk from parameter can be described exponential function, in too time damage as a first approximation, is described in the form of linear equation:

$$ \begin{cases} y = ac + b \\ y = e^{-mc} \end{cases} $$

(4)
For finding of the point of steady management, we will solve this system concerning value $C$:

$$
C_0 = -\frac{b}{a} + \frac{1}{a} W\left(\frac{a}{e^a} \frac{ba}{a}\right),
$$

(5)

where, $W$ – Lambert’s function.

On condition of stationarity, ergodicity and normality of distribution of the studied process on the time interval $\tau$, we can take analytical estimates of probability of absence of process of the set area. As assessment of $R_{\alpha}(C)$ the formula can be used:

$$
R_{\alpha}(C) = \left[1 - F\left(\frac{C - m_X - r_X(\tau)\left[X_0 - m_X\right]}{\sigma_X\left(1 - r_X(\tau)\right)}\right)\right]^\alpha,
$$

(6)

where: $F(...)$ - Laplace’s function, $m_X$ - mathematical expectation of accidental process $X(t)$, $r_X(\tau)$ – autocorrelation function, $\tau = t_1 - t_0$, $\sigma_X$ – the mean square deviation, $X = X(t)$ – the measured natural parameter, $\tau$ – the forecasting horizon, and $C$ – the managed parameter set by the decision-maker.

4. Conclusion

Today we can oppose scientific approach to risk management in forestry to the objective factor of growth of economic losses, i.e. there is the opportunity for the maximum decrease in the menacing effects of the dangerous phenomena by development and obligatory implementation of effective actions for prevention and protection.

Modern management of forestry has to be conducted with the obligatory using of tools which consider uncertainty of weather conditions and their cyclic nature. For this purpose, it is necessary to develop new methods and approaches to assess impact of natural factors on forest preservation and development. This impact can be estimated by using traditional methods of assessment based on physical analogs of forecasting and also stochastic methods using initial material geodata in the form of accidental processes. Both groups of methods allow to estimate the risks influencing natural and economic indicators of forestry.

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