GUIDELINES ON FOREST FIRE MANAGEMENT ON THE BASIS OF FOREST FIRE ZONING AND ESTIMATED ADMISSIBLE ANNUAL FIRE RATES

A.S. Zakharenkov, E.P. Kuzmichev, M.N. Yagunov

under the general editorship of E.P. Kuzmichev, Corresponding Member, Russian Academy of Sciences

Moscow 2016
EXECUTIVE SUMMARY

In the context of a shortage of funding from the budget, made available for forest fire prevention and fighting, a key role could be played by measures to improve the performance of the forest authorities in this area. A promising way to achieve it is to make a shift in the forest fire control strategy, from efforts to fight all fires towards efforts to manage the forest fire rates within a given location, based on environmental and economic assessments of forest fire implications. However, until recently, this approach has not been widely used for practical forest management purposes, among other things, due to lack of evidence-based and implementable guidelines.

This study is an attempt to bridge this gap and show a practical example of forest zoning based on such criteria as social, economic and environmental values for purposes of selecting forest firefighting strategies.

The proposed original approach consists of consecutive actions to collect and analyze available information and agency-specific data, and may be used by responsible officers and organizations for forest fire zoning at the forest management unit level, estimation of normal/admissible annual fire rates and assessment of losses of social, economic and/or environmental values at the level of a forest management unit.

The proposed approach includes three main stages. The first stage is to identify the following zones of forest fire danger within the forest management unit, basing on criteria associated with social, economic and environmental values of forest parcels: A – the zone of physically and economically inaccessible forest land; B – the zone of accessible forest land which is not leased out; C - the zone of leased out and intensively developed forest land; and D – the zone of forests and/or sites of high or special social, economic and environmental significance.

The second stage is to establish admissible annual fire rates for the forest management unit. To this end, it is necessary to identify those forest formations and/or types of forest with survival and renewal which are directly dependent on forest fire for their survival and renewal. Quantitative characteristics (area, growing stock) of the identified stands are used as variables for estimating the annual normal fire rate (ANFR) for each forest fire zone. It is estimated with the help of the following formula:

\[ \text{ENFR} = \frac{S/T}{s} \times K_{CP}, \]

where:

ENFR (ANFR) is the annual normal forest fire rate (ha); S is the area of forest parcels (ha); T is the time (years) needed for the restoration of the original (pre-fire) forest stand; K_{CP} (CP) is the coefficient of precaution to adjust for the risk of repeated fires and forest growth slowing.

The third stage is to assess the risk of maximum damage from forest fires, using a probability and impact matrix. The toolkit is based on mapping in a GIS environment with the use of special-purpose software (e.g., ArcGIS, Mapinfo, QGIS, etc.).

The approach was tested in two model areas in the Krasnoyarsk and Khabarovsk Krays; and the testing showed that the proposed approach could substantially improve the forest fire management planning, effectiveness and feasibility of drafted regional targeted programs of
forestry development through providing them with new objective performance indicators for evaluation of forest governance and management.

These Guidelines offer a new approach to forest fire management which can substantially improve the efficiency of spending from the public budget and establish objective indicators of assessing the quality of forest governance. The proposed approach would enable to integrate the process of forest fire management unto the broader forest management system with due regard to region-specific social, economic and environmental considerations.
INTRODUCTION (8)

1. Methodological framework (10)
   1.1. Zoning methodology 10
   1.2. Estimation of admissible annual fire rates 11
   1.3. Assessment of risks of unacceptable damage from forest fires 13

2. Methods for forest fire zoning, estimation of normal forest fire rates and assessment of the risk of damage from forest fires at the level of a forest management unit (14)
   2.1. Forest fire zoning at the forest management unit level (14)
   2.2. Data and procedure for fire zoning within a forest management unit (17)
   2.3. Estimation of admissible annual forest fire rates (19)
   2.4. Data and procedure for identifying fire-dependent forest formations (21)
   2.5. Forest fire damage risk assessment (27)

3. Testing of the proposed approach to forest fire zoning, estimation of admissible annual fire rates and forest fire damage risk assessment at the level of a forest management unit (30)
   3.1. Description of the model areas (30)
      3.1.1. The model area in the Primorsky Kray (31)
      3.1.2. The model area in the Krasnoyarsk Kray (32)
   3.2. Testing results from the model area in the Primorsky Kray (35)
      3.2.1. Forest fire zoning at the forest management unit level (35)
      3.2.2. Estimation of admissible annual forest fire rates (39)
         3.2.2.1. Identification of fire-dependent forest formations and/or sub-formations (39)
         3.2.2.2. Key quantitative characteristics of fire-dependent forest formations within the identified forest fire zones (39)
         3.2.2.3. Estimation of annual normal fire (ANFR) for a forest management unit (41)
         3.2.2.4. Cross-validation of the result (41)
      3.2.3. Assessment of the risk of the most severe damage from forest fires (42)
         3.2.3.1. Forest fire risk rating based on the fire hazard index (42)
         3.2.3.2. Weather-based fire risk rating (45)
   3.3. Testing results from the model area in the Krasnoyarsk Kray (46)
      3.3.1. Forest fire zoning at the forest management unit level 47
      3.3.2. Estimation of admissible annual forest fire rates (51)
         3.3.2.1. Identification of fire-dependent forest formations and/or sub-formations (51)
         3.3.2.2. Key quantitative characteristics of fire-dependent forest formations within the identified forest fire zones (51)
         3.3.2.3. Estimation of annual normal fire (ANFR) for a forest management unit (52)
      3.3.3. Assessment of the risk of the most severe damage from forest fires (53)
         3.3.3.1. Forest fire risk rating based on the fire hazard index (53)
         3.3.3.2. Weather-based fire risk rating (55)
      3.3.4. Cross-validation of the result (56)

4. General conclusions from the testing of the approach (59)

Literature (62)