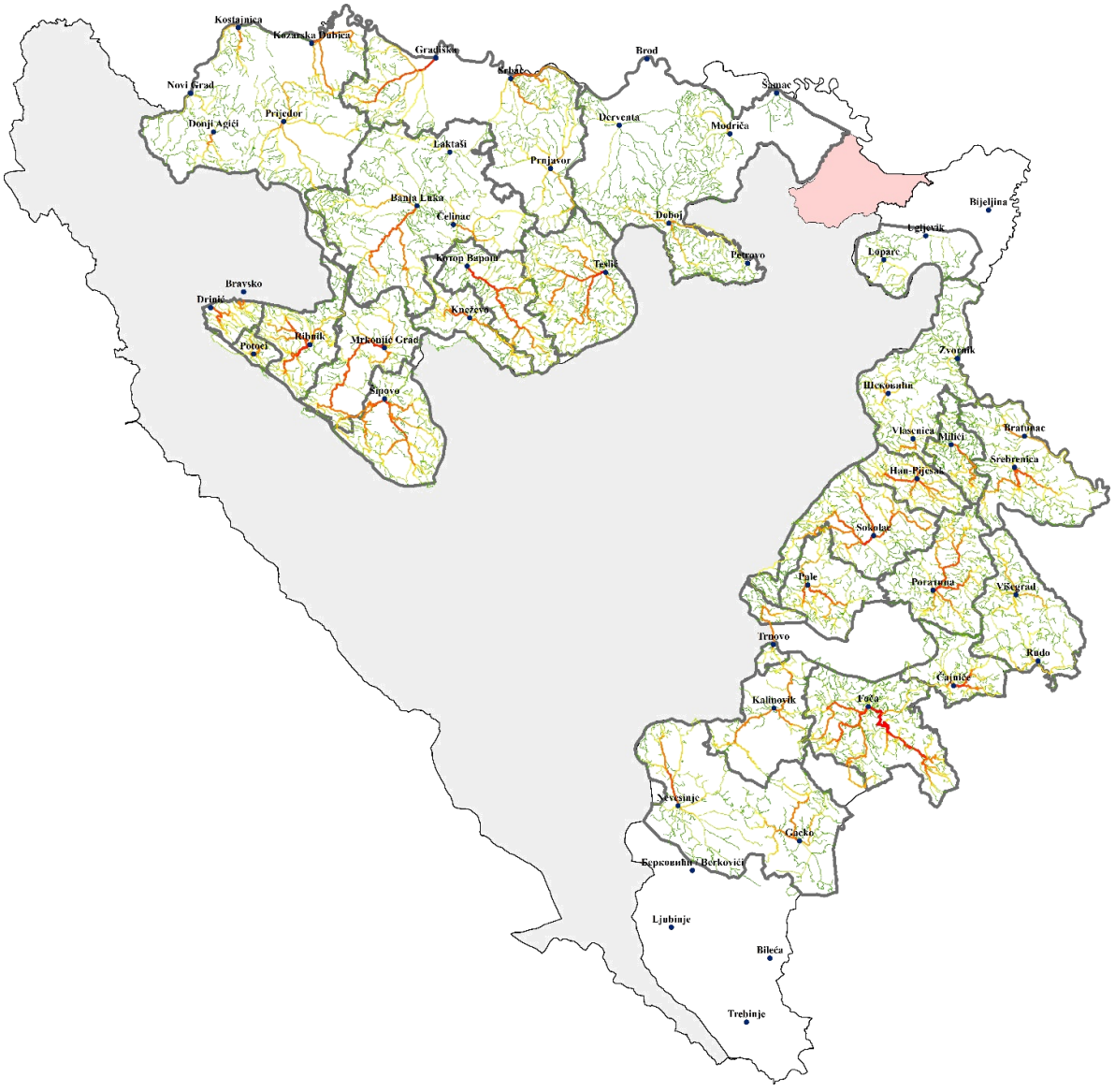
Suma plan – Development researchand projects centre

BANJA LUKA 2019

MASTER PLAN OF FOREST ROADS IN REPUBLIC OF SRPSKA

Synthesis of the plan



Šuma plan
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REPUBLIC OF SRPSKA

MINISTRY OF AGRICULTURE, FORESTRY AND WATER MANAGEMENT

UNIT FOR COORDINATION OF AGRICULTURAL PROJECTS

PROJECT OF SUSTAINABLE FOREST AND LANDSCAPE MANAGEMENT

Project title: **MASTER PLAN OF FOREST ROADS IN REPUBLIC OF SRPSKA**

CONTRACT NUMBER: **BA-SFLM-TF 016646-QCBS-BL-CS-17-015**

PROVIDE BY: Consortium **"Suma plan" ltd. Banja Luka & PFE "Sume Republike Srpske" – Development research and projects center Banja Luka**

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Banja Luka, April, 2019

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Acronyms in the text

PFE	Public forest enterprise
RDPC	Research Develop and Project Centre
FMU	Forest management unit
FMP	Forest management plan
FTR	Forest truck road
GIS	Geographic information systems
FMA	Forest management area
MU	Management unit
jsc	Joint-stock company
RS	Republic of Srpska
GPS	Global position system
*.shp	Digital data processing form
*.TIFF	Raster data form for analysis
FWA	Forest wood assortments
MC	Management class
CLC	Copernicus Land Monitoring Service
MCA	Multi-criteria analysis
KMC	Karst management center
LF	Law on Forests of Republic of Srpska

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1. Introduction

The Master Plan of Forest Roads in the Republic of Srpska is a unique document that for the first time comprehensively and thoroughly analyzes the use of forests, and explains the current problems in the area of opening forests, cutting, making and transporting forest timber assortments to the end user. This is a long-term document, and it is planned that in the next 30 years the forest farms will follow the directions of the strategic plan, implement the planned projects of forest truck roads, as well as directions and guidelines for further development of this sector in forestry.

The Strategic Plan contains detailed analyzes and instructions that were necessary for the preparation of this document:

1. Analysis of the forest roads network in the Republic of Srpska,
2. Analysis of the labor techniques and technologies for the forest exploitation,
3. Analysis of possibilities for achieving additional value of wood processing and biomass,
4. Analysis of the possibilities for achieving additional value by exploiting mushrooms, forest fruits and medicinal herbs,
5. Analysis of the response times to forest fires and forest fire extinguishing capacities, with proposals for improvement measures,
6. Guidance and guidelines for the construction, reconstruction, rehabilitation and maintenance of forest roads,
7. Preliminary feasibility study of the forest roads network in the Republic of Srpska,
8. Model of forest roads in the geographic information system (GIS).

Chapter "Analysis of the network of forest truck roads" is based on the original data gathered from the field, which included recording of all roads with GPS devices and data input based the type, category and state of the road. A survey was conducted simultaneously with the questions to which forestry units (FMU) provided answers and suggestions for improving measures and activities in this area. All data has also been entered and the geographic information system (ArcGIS), based on which were obtained data on absolute and relative openness, as well as other analyzes foreseen in the project task. On the basis of the obtained results it was established that the absolute openness of forests and forest land in the Republic of Srpska is 9,28m/ha, which is quite low in relation to the surrounding and European countries. Within this chapter an analysis of the FWA towing along the slope and down the slope was performed, where results show that an average of 60% FWA is directed down the slope, while about 30% of the FWA is aimed at along the slope.

"Analysis of the labor techniques and technologies for the forest exploitation" shows, based on the collected data by the survey on technologies, technological processes, labor resources and organization of work in the exploitation of forests of the Republic of Srpska, it was realized that there is a great variety in terms of organizational solutions for the realization of forest technology, as a consequence, it is difficult to plan, design, implement and control the realization of technological processes with the risk of damage to the forest and the occurrence of accidents at work, as well as the impact on technology modernization. One positive step in the development of forestry is that the PFE "Sume Republike Srpske" as a user of forests and forest lands operates in accordance with FSC standards.

Chapter "Analysis of the possibilities for achieving additional value for wood processing and biomass" in detail analyzes the current needs for forest biomass in our country and in the world with a cross-cutting of quantity and demand of forest biomass in the domestic and international market. The obtained data show that there is a respectable amount of FWA that can be used as a forest biomass for energy. An annual amount of around 804,779.00 m3/year of forest biomass (fire wood + cellulose wood) could be provided, while the remaining forest mass in the forest (forest residue) is estimated to provide additional up to 562,772.00 m3/year of forest biomass. This forest residue is very difficult to send to the market with the current technology because it is triturated and scattered at the cutting area, and for this reason its collection is very complicated.

In the chapter "Analysis of possibilities for achieving additional value by exploitation of mushrooms, forest fruits and medicinal herbs", was made the requirement analysis for these products. The tendency of the increase in demand on the market for non-wood products was determined. The analysis showed that we do not have adequate data on the quantity and exact location of individual non-primary products, and that the quantities and values in the sphere of estimation are shown. The collection of non-wood forest products in the Republic of Srpska deals with a large number of rural population and this is an important source of income for them, and several large companies, and a number of small, relatively new companies, are involved in the purchase, production and processing of fungi, medicinal and aromatic herbs and forest fruits in the Republic of Srpska. The analysis showed that PFE "Sume Republike Srpske" have negligible benefits from this type of product. Data for a particular area or region are not available because accurate records are not kept and there is no adequate regulatory mechanism. According to the currently available data, we managed to identify only certain private companies that paid the symbolic compensation to PFE "Sume Republike Srpske" for the collection of non-wood forest products.

The chapter "Analysis of response times to forest fires and forest firefighting capacities, with proposal for improvement measures," deals specifically with the entire area of the Republic of Srpska and as a focus separates Herzegovina as the most endangered area of forest fires. Thematic maps of the classification of fire threats according to the degree of

vulnerability as well as the thematic maps of the influence of forest roads on the response time and the amount of forest roads needed for prevention have been developed. Large-scale fires in the area are almost continuously during the recent years managed by the Karst Management Center in Trebinje. The fire cause is a human factor in 90% of cases, so it is proposed that, with the purchase of necessary equipment and construction of fire protection roads, adequate education and familiarization of the population with the dangers and damages caused by forest fires are carried out.

The "Guidelines and directives for the Construction, Reconstruction, Rehabilitation and Maintenance of Forest Roads" aim to provide a clear picture of the type and stages of work during the construction, reconstruction, rehabilitation and maintenance of roads. Structural elements of forest roads, the most frequent damages of these instructions, and the way of construction, reconstruction and tuning of the forest roads network are shown.

The chapter, which is most commonly called the "Qualitative - Quantitative Analysis of the Openness of the Forests of the Republic of Srpska", encompasses multidisciplinary and multi-criteria analysis of the forest roads network in the Republic of Srpska. For each FMA, the two National Parks and the Karst Center describe the geographic position, geological, pedological and characteristics, and the terrain classification of the FMA. Within each FMA, absolute and relative openness of the forests is shown for each economic unit. An analysis of FWA towing along the slope and downhill the slope, the suitability of the area for selecting the transportation vehicle, also was performed the quantity of assortments with cutting and towing prices.

Modern forestry is unthinkable without the use of new information technologies. One of the most significant in this area is GIS. Geographic Information System (GIS) is a system for managing spatial data and properties associated with them. In the strict sense, it is a computer system capable of integrating, recording, editing, analyzing and displaying geographic information. This software package is the most complete working environment for analyzing digital maps, attributive and vector data. The chapter "Model of forest roads in the geographic information system (GIS)" explains the data processing method and visualization of the same, its advantages and time savings in analyzes with a large number of data. Currently are used the well-known and most popular software such as ArcGIS, QGIS, AutoCAD and other less-known GIS software. This chapter describes all activities related to data processing and the formation of output data in a single GIS model.

2. SHORT REVIEW OF FORESTRY SECTOR

Republic of Srpska is one of the two entities that make up Bosnia and Herzegovina. The regulation of Republic Srpska is based on judicial, executive and legislative authority. The executive organs are the President of the Republic of Srpska and the Republic of Srpska government; the court, the Prosecutor's office and the Ombudsman are the judicial authority and the assembly is the legislative authority.

The Master Plan of Forest Roads includes the territory of the Republic of Srpska (without the Brčko District), one of the two entities in Bosnia and Herzegovina. According to the Forest Cadastre (PFE, 2017), the total area of forests and forest land owned by the Republic of Srpska is 1,012,001 ha, and the area of forests and forest land in private ownership is 300,329 ha. According to the categories of forests, high forests with natural renewal occupy an area of 469,855 ha or 46%, highly degraded forests 19,632 ha or 2%, forests of 54,578 ha or 5%, coppice forests 215,382 ha or 21%, areas suitable for afforestation and management 168,123 ha or 17%, areas unfit for afforestation and management of 63,566 ha or 6%, and usurpation of 20,097 ha or 2%. The annual gross production of the FWA is around 2.782.000 m3 in the state forests, while the private forests are about 477,000 m3, which together is 3.259.000 m3. The annual net production of FWA is around 2,033,000 m3, which is mainly realized up to 100%. The share of conifers in total production of FWA is around 45%, while the remaining 55% is made up of hardwoods.

PFE "Sume Republike Srpske" as a user of forests and forest land is organized in 26 forest management units, one development research and planning centre (RDPC) and the Centre for Seedling Plant Production in Doboj and Karst Management Centre in Trebinje.

Buildings owned by PFE "Sume Republike Srpske" are administrative-residential buildings, barns, workers' barracks and other facilities. The administrative and residential buildings amount to 182 with total surface of 38,470 m2, barns 161 or 13,016 m2, workers' barracks 78 or 8,023 m2, and other buildings 229 or 20,707 m2.

From the means of transport, PFE owns 19 trucks, 87 forest tractors, 569 motor chainsaws, 27 construction machines, 31 forestry machines, for nursery production 4 and forest protection 35 vehicles.

The Law on Forests (FL) of 2009 regulates the policy and planning, management and governing of forests and forest land, forest protection, financing and value of forests, forestry and forest land cadastre and information system in forestry, property-legal relations, as well as other issues of importance for forests and forest land in order to promote a sustainable use of forests and forest land and development of forestry.

The forest management plan (FMP) determines the basic guidelines and goals of forest management, measures for improving the state of forests, preservation and strengthening of general forest functions and forest protection. It contains an overview of the state of the forest, as well as the type and scope of works during the 10 year period of the device. Forest management is a planning document with ten year validity. Forest management units are obliged to respect the plans and realization of the FMP and adhere to the rules of forest management and forest land prescribed by this document.

The public forestry enterprise "Sume Republike Srpske" has received a prestigious FSCTM (FSCTM C013091) certificate for forest management.

By definition, "FSC certification of forest management means that forests and forest lands are cultivated according to strict environmental, social and economic standards". By obtaining the FSC certificate, the valuable work of people in the Public Company has been successfully completed, which have invested a lot of effort to bring this process to an end.

The aim of the FSC program is to promote ecologically responsible, socially beneficial and economically sustainable forest management in the world, in order to establish generally recognized standards that will be recognized and respected through the principles of sustainable forest management.

3. Project description

3.1. Scope of project

The purpose of the Master plan and its sub-components (Strategic Plan of Forest Roads) is to help identify the most urgent projects for the rehabilitation of forest roads and the construction of new ones, in order to improve environmental and economic effects and meet the requirements for certification of forests. In order to achieve this, the preparation of the Master Plan for Forest Roads is planned, as well as the drafting and adoption of guidelines for the construction of new ones and the rehabilitation of existing forest roads based on best practices in order to reduce the impact on the environment. These activities are part of the expected efforts of the authorities to improve the network of forest roads in the Republic of Srpska. The resulting guidelines based on best practices would also provide an impact analysis of the environment/society of all road works and support efforts to certify companies in forestry.

3.2. Project goal

The financial sustainability of the exploitation and transport of wood assortments to the final customer is a key task in the process of determining the optimal network of forest roads and defining the optimal technology of cutting, processing, towing wood, FWA transport and defining optimal locations for the warehouses.

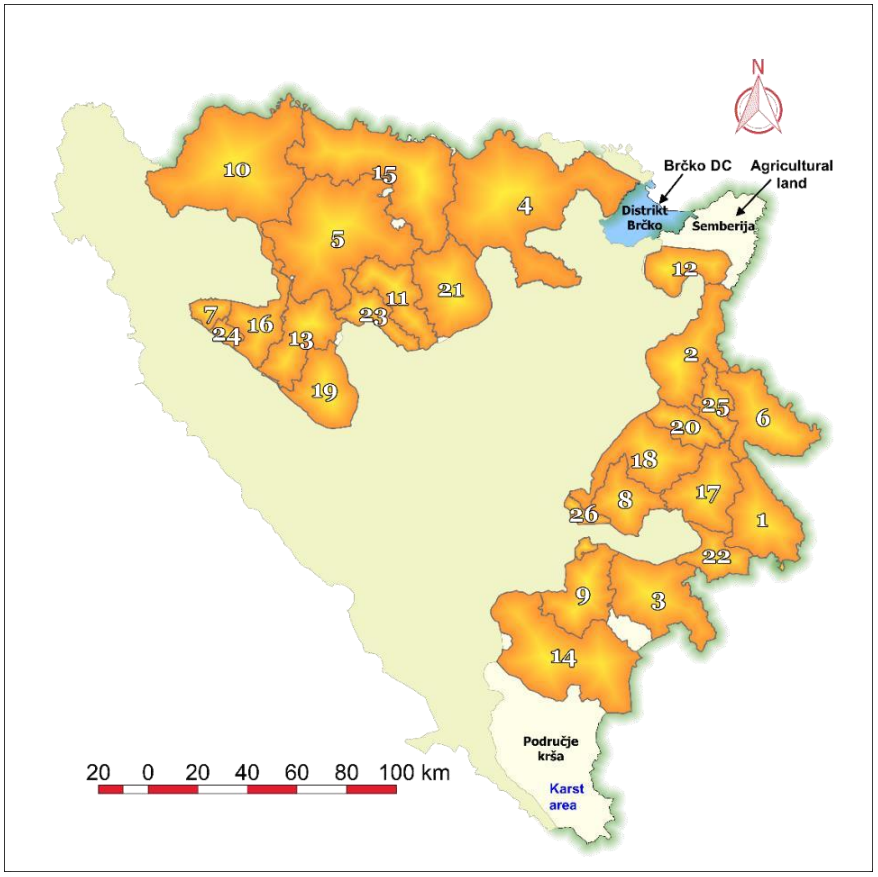
3.3. Scope of research

The research was carried out on the territory of Republic Srpska, one of the two entities in Bosnia and Herzegovina. According to the Forest Cadastre (PFE, 2017), the total area of forests and forest land owned by the Republic of Srpska is 1,012,001 ha, and the area of forests and forest land in private ownership is 300,329 ha.

Table 1 Area overview by forest categories

Forest categories	ha
1000 - High forests with natural regeneration	469,855
2000 - High degraded forests	19,632
3000 - Forest plantations	54,578
4000 – Coppice forests	215,382
5000 - Surfaces suitable for afforestation and management	168,123
6000 - Unsuitable areas for afforestation and management	63,566
7000 - Usurpation	20,097
TOTAL	**1,012,001**

User of forests and forest land owned by the Republic of Srpska is the Public Enterprise „Sume Republike Srpske" within which there are 26 forestry areas and karst area managed by the Karst Management Center with headquarters in Trebinje. Within the forest and forest land, owned by the Republic of Srpska, there are the areas of the National Parks "Kozara" with 3,530 ha and "Sutjeska" with 17,214 ha.



Picture 1 Map of forest management areas in Republic of Srpska

List of FMAs:

1 višegradsko
2 vlaseničko
3 gornje drinsko
4 dobojsko-derventsko
5 donje vrbasko
6 donje drinsko
7 petrovačko
8 jahorinsko
9 kalinovičko
10 kozaračko
11 kotorvaroško
12 majevičko
13 mrkonjićko
14 nevesinjsko-gatačko
15 posavsko
16 ribničko
17 rogatičko
18 romanijsko
19 srednje vrbasko
20 hanpjesačko
21 usorsko-ukrinsko
22 čajničko
23 čemerničko
24 istočnodrvarsko
25 milićko
26 trnovsko

4. Working team and methodology

4.1. Team members, tasks, and key experts

N°	Name	Position
Key experts		
K-1	Duško Topić	Team leader – Transport economist
K-2	Radovan Lučić	Expert for the forest exploitation and usage
K-3	Dubravka Kršić	GIS expert
K-4	Srđan Dražić	Expert for planning and designing Forest road network
K-5	Velibor Blagojević	Environment expert

N°	Name	Position
Non-key experts		
N-1	Srđan Kašić	Assistant K-1
N-1	Danijel Vučković	Assistant K-1
N-1	Velibor Peulić	Assistant K-1
N-4	Radenko Ponjarac	Assistant K-2
N-6	Stamenko Mirković	Assistant K-3
N-7	Predrag Vujančević	Assistant K-3
N-8	Đorđe Topić	Assistant K-3
N-9	Dragan Topić	Assistant K-4
N-10	Vlajko Ilić	Assistant K-4
N-12	Danijela Knežević	Assistant K-5
N-13	Milena Bosnić	Assistant K-5
N-14	Miladin Bačić	Project director
N-15	Aleksandar Jagodić	Secretary/Administration

4.2. Methodology

The openness of the forests and the mean transport distance of the FWA towing are shown in the FMP planning document for each FMA, however, the level of accuracy and the criteria for obtaining data is currently different from the more recent modern techniques and classifications. In this paper, the most modern work methodology is used, based on professional and scientific papers published in our country and in the world.

All analyzes are based on the original data collected from the terrain covering the recording of all roads with GPS devices throughout the territory of the Republic of Srpska, and by entering data based on the type, category and state of the road. A survey was conducted simultaneously with the questions to which forest users (FMUs) provided answers and suggestions for improving measures and activities in this area. To complete databases were entered all data related to management classes, numbering, volume per hectare, cutting volume, increment and all other relevant data to the level of the department.

A very important aspect for the optimization of the analyzed space is a good selection of factors that influence the planning of the network of forest truck roads and forest road infrastructure in general.

There are a number of factors that affect the quality of optimization and some of them are as follows:

- Distance of species from roads, transport distance, timber volume, growth increment, cutting edge, selection of methods and systems of work, age of species,
- Type of geological substrate, land category, slope of the terrain, exposure, even coverage of terrain by roads
- Development of the hydrological network, the presence of water sources, endangerment of torrential watercourses, threats of erosion
- Sensitivity of rare species habitats, vulnerability to the spread of invasive plant species, access to hunting facilities, fire threats
- Possibility to connect with the existing network of roads, connecting settlements, costs of construction and maintenance of forest roads
- Changing the frontal character, embedding in a natural environment
- Tourist content

The inclusion of all these factors in the analysis would require much more time than foreseen in this Master Plan, but can be further elaborated in the Opening Studies for individual areas. For the purposes of this paper, the key and most important impact factors

were taken into account in order to obtain a better picture of the openness of forests and forest lands of the Republic of Srpska.

Based on this, an analysis of the inclination of the terrain, the exposure of the terrain, the existing volume in sections, the average slope of the terrain for each section, the cutting edge, etc. by sections, departments and management units, was performed.

Systematization and data processing was performed by the ArcGIS software package, the US company ESRI (www.esri.com). Spatial and attributable data presented in the form of digital maps and raster are obtained from valid device studies, forest management plans and 20 meter digital elevation model (DEM) for BIH from which the areas of analyzed forest management areas are separated.

Spatial data on management units were obtained by digitizing analogous forest maps, thus forming lines and polygons representing departments, sections, watercourses, forest roads, and so on. Given that this is a large area for analysis (the territory of the Republic of Srpska), and due to the volume of the document, here will be briefly explained the methods by which the results were obtained as well as the thematic maps.

• Determination of the average transport distance was carried out by the *path distance* tool (ArcGIS 10.3.) Where the calculation of the terrain pitch and extension of the distance along the slope was taken into account in the calculation itself and the coefficient of extension of these distances was calculated from 1.1-1.4 on the obtained distance due to the obstruction of obstacles, trees and stumps in the field, depending on the configuration of the terrain.

• In order to analyze the medium transport distance of the FWA, the public roads are not taken into account because the FWA is forbidden to draw on this road category. (Official Gazette of Republic Srpska, No. 89/13)

• For each management unit, digital storage facilities and potential locations for storage facilities are digitized. In this way, the direction of export of FWA is directly oriented towards these points or stockpiles. In this way, more precise data are obtained from the geometric distance (weight method), which has several drawbacks that need to be manually removed, and in this case it would be an additional job.

• For each FMA, there are gaps in the terrain, the exposure of terrain, cutting masses, mined areas and landslides

• Classification according to altitude division and according to field characteristics was performed (Šikić, D. 1989)

• One of the characteristics when determining the average distance of towing is also the direction of export, along the slope or downhill slope. For each FMA at the level of the

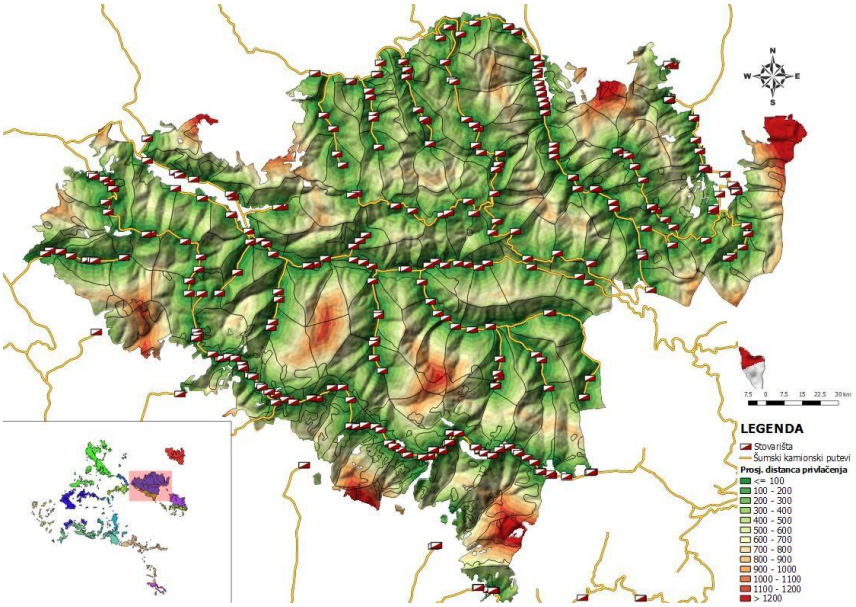
management unit, calculations have been made about the average length of the sloping along the slope and down the slope, and calculate the unit cost of towing.

• With the help of GIS tools and complex algorithms, the analysis and classification of absolute and relative openness

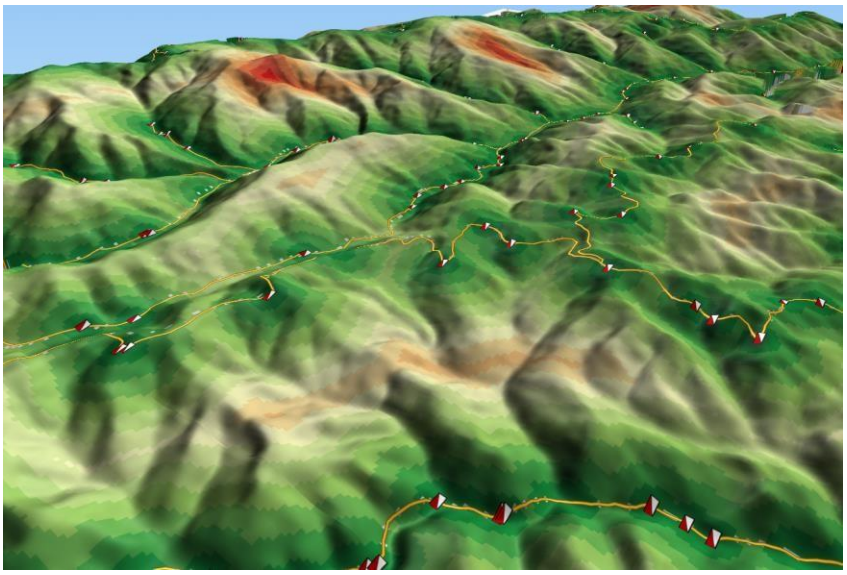
• On the basis of obtained data on openness and determination of the area that is not covered by roads, the design of roads at the level of the preliminary design from the topographic map and DMT was performed.

• For such projected roads from the map, the cost of construction works is shown in terms of work phases.

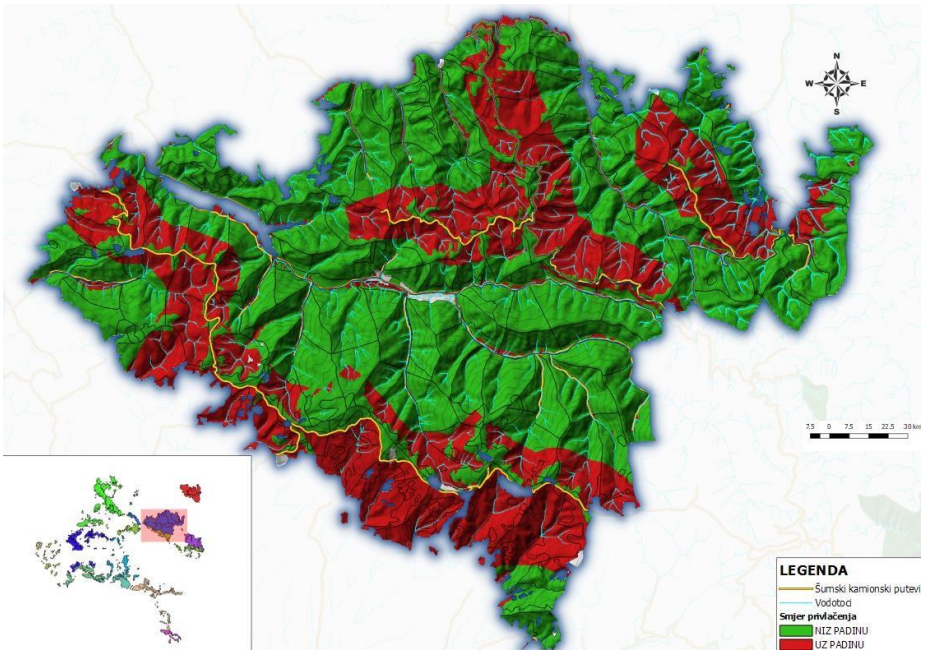
• For this analysis, the experienced data of average prices of the work stages of the company RDPC Banja Luka, which has been analyzing the last few years on the previously designed and built roads, has been used. The database includes over 500 km of designed roads for construction and reconstruction with over 250 road directions.



Picture 2 Path distance method



Picture 3 Three-dimensional view of the terrain from a distance by attracting buffer zones according inter-storage (DMT)



Picture 4 Towing the FWA along the slope and down the slope (algorithm, ArcGIS 10.3.)

4.2.1. Road classification

The data were collected by GPS devices throughout the territory whose user is the PFE "Forests of Republic Srpska", and the recorded tracks were compared with ortho-photos. The roads are divided into public and forest truck roads, and roads with macadam and asphalt cover.

Table 2 Road codes for GIS data base

Road category	Codes	Public	Non categorized
Highway	0	1	0
Main road	1	1	0
Regional road	2	1	0
Local asphalt road	3	1	0
Macadam	4	1	0

A column called "key" means a unique number (ID) of each road.
So the number 1001402147 means that the road belongs to the FMA = 10;
MU = 01; Category = 4; TYPE = 0; ID = 2147
In this way, each travel route has a unique number that is not repeated.

5. Strategic plan for the forest roads of the Republic of Srpska

The basic vision envisaged by the Strategy is to improve the economy and development of the Republic of Srpska, through a sustainable, efficient and safe transportation system in forestry. This document provides the basic prerequisites for the sustainable development of forestry in segments in which forest roads have the greatest importance, with the main goal of maintaining and improving all forest functions. Preservation of forest resources, development of forest functions and realization of the goals defined by the Strategic plan of forest roads establishes a harmonious relationship between forestry and its environment, i.e. economic and social system of the Republic of Srpska.

6. Preliminary feasibility study of the forest roads network in the Republic of Srpska

6.1. Methodological approach to elaboration of the previous feasibility study

The purpose of this project in terms of making a preliminary feasibility study is to define new routes of forest roads, as well as to reconstruct and strengthen maintenance of the abandoned and unserviceable existing forest roads network.

The specific objectives of this study and the whole project are to:

- Analyze the current and forecast situation of existing roads, capacities and traffic volume, based on the planned capacities in the exploitation of forests.
- Examine alternative routes for new roads in forest roads and propose the most favorable ones in order to provide a sustainable and functional solution including the construction phase, and
- To analyze the costs and benefits at the level of forest-economic areas (forest management unit) according to the international guidelines defined by the project task, within which the costs and benefits will be monitored at the departmental and sectional level.

The methodological approach to the study of the subject study was as follows:

- Analysis of the existing primary forest roads network, on the basis of which the GIS model is formed, as part of the activities on this project by which the Forest Paths Model was developed in the geographic information system. This analysis involves defining the length, type and condition of the roadway, the width of the pavement, the condition of the canals and gaps, the state of the bridges, supporting and carrying structures, the minimum radiuses of horizontal and vertical curves applied, longitudinal slopes, etc.)
- Detailed analysis of the current qualitative and quantitative state of the forest roads, with the aim of determining the spatial distribution of forest roads, because only in this way it can be determined who has no access to using the existing roads,
- Based on the previously defined database, optimal routes of new forest road sections have been proposed, with the aim of exploiting sections that are not accessible, which have been analyzed in detail under this project within the framework of the forest roads model in the geographic information system, and with the necessary technical and exploitation characteristics as stated for the existing forest roads network.

- ✓ The GIS has been processed and calculated in detail:
  - the area of the forest belonging to the corresponding road section, according to the primary network of forest roads, whether it is transported uphill or downhill,
  - average distance to the nearest depot,
  - exploitation cost of transport to the depot per km and per m3.
- ✓ The average age of the vehicles, as well as the load capacity of the vehicles, are taken into account, as well as the driving dynamics and exploitation characteristics of the vehicle. For each of the subject road sections, both existing and newly designed, detailed costs are analyzed:
  - construction,
  - reconstruction,
  - maintenance, and
  - residual value.
- ✓ The complete road network has been analyzed from the following points:
  - Impacts on the economy of the society,
  - Impacts on traffic accidents,
  - Impact on exploitation costs,
  - Impacts on air pollution,
  - Impacts on global warming,
  - Impacts on noise, and
  - Other impacts
- ✓ Analysis of the costs and benefits of all forestry areas, as well as the complete forest sector on the territory of the Republic of Srpska, is based on:
  - on the Cost-Benefit Analysis Guide (CBA), (EC, DG Regio-ed 2014),
  - Guidelines for Project Cycle Management in the EU,
  - A harmonized European approach to transportation costs and project evaluation, HEATCO (2014),
  - Updated Handbook on Marginal Transport Costs (2014),
  - Program for the use of forest biomass from the forests of the Republic of Srpska (2013),
  - Uniform norms of works in forestry Sokolac (2002),
  - Technical norms of work in the exploitation of forests (1998),
  - Analysis of cutting, processing, attracting and transport technology with the proposal of measures for the improvement and modernization of technologies (document of the project, 2019),
  - Analysis of possibilities for achieving additional value for wood processing and biomass (document of the project, 2019),

- Analysis of possibilities for achieving additional value of exploitation of mushrooms, forest fruits and medicinal herbs (document of the project, 2019), and
- Model of forest roads in the geographic information system - GIS (document of the subject project, 2019).

✓ Multi-criteria analysis for the purpose of selecting priority forest economic areas, and consequently of relevant forest roads.

✓ Define the following steps, i.e. of the action plan based on the conclusions of the previous preliminary feasibility study.

6.2. Conclusions and recommendations

The objective of elaboration of a preliminary feasibility study involves assessing the needs and possibilities for the development and improvement of forest roads in the territory of the Republic of Srpska, Bosnia and Herzegovina, but also to set recommendations for the implementation of the project in accordance with developmental options that are in line with the needs for exploitation of forests, technical standards and construction process, including cost-benefit analysis (CBA) to demonstrate justification and sustainability of the implementation of this project.

The analysis carried out in this study included:

✓ Determining the needs for the maintenance, reconstruction and construction of forest roads,

✓ Pre-assessment of investment costs

✓ Preliminary assessment of possible transport requirements and

✓ Impact on the environment.

The considered road network covers the whole territory of the Republic of Srpska.

The total length of the roads considered in this project is 12,245,881 km, out of which 5.1% of the roads are planned for construction, 11.5% of roads for reconstruction and the rest of 83.4% for enhanced maintenance.

Traffic analysis included a detailed analysis of the quantities generated by the forests and on this basis a transport request was obtained, as it is very obvious that most of these roads are used exclusively for the exploitation of forests, transport of forest timber assortments, biomass and other forest assortments.

It is expected that new sections that have not been exploited will be opened by constructing the forest road network, and an additional 6,607 sections will be used annually to generate an estimated 73,198 m3 of forest wood assortments and biomass.

For the purpose of cost-benefit analysis, in order to calculate all necessary input data, a developed GIS model was used within this project, which has never been developed by the region and represents an exceptional database for any further work related to the development of strategic documents, but also for the preparation of project documentation for forest roads.

The cost and benefit analysis was done at the level of all forests of the Republic of Srpska, but also at the level of the FMAs. As input data, all road sections with their characteristics previously mentioned in the study are considered, and also found in the GIS model.

Economic analysis of costs and benefits resulted in EISP of 16.42-20.01% (pessimistic-optimistic scenario) while E-BCR is 1.32-1.41, and therefore the project is justified for society, i.e. as a social investment, and as such is desirable for further investment. All analyzed data in this study show that this project is sustainable and accepted from a socio-economic point of view. It still lacks the need to determine whether it is necessary to implement it through borrowing, co-financing or from personal/budgetary funds.

With the aim of self-sustainability of the forest sector in the Republic of Srpska, it is recommended to implement the following activities that could significantly affect the economy of the Republic of Srpska:

- ✓ Development of the cadastral register of forest roads of the Republic of Srpska,
- ✓ Create a financial guide road manager to check the possibility of financing this project without a loan, and determine the proportion that the state could possibly replace as it would inevitably make it profitable
- ✓ Development of feasibility studies for the opening of forest truck roads for each FMA
- ✓ Development of more studies on the optimal utilization of forest roads and different types of forest assortments, with the proposal to implement a public private partnership for the processing of certain forest assortments and benchmark analyzes of potential private partners from the country, region and the world.
- ✓ Develop a system for monitoring relevant transport parameters (traffic flows, speeds, levels of environmental indicators, meteorological data, etc.),
- ✓ Making a decision on incentive measures for the transport of forest timber by intermodal transport, and

To make a benchmark for the analysis of the maintenance of forest roads in the world and the proposal of the contract model for future maintenance of these roads.

7. Analysis of cutting, processing, attracting and transport technology with the proposal of measures for process improvement and technology modernization

Towing wood from stump to truck, i.e. transportation of wood in the first stage represents the hardest and most expensive work in the eradication of forests. It is especially important that the cost of towing is as small as its participation in the total cost of use is proportionately the largest. It can be up to 80% depending on the length of the transport, the way of towing, the field conditions and type of assortment. The main goal is to transport the assorted varieties from the forest in the most economical way i.e. the cheapest and least damaging to the assortment, the land and the rest of the forest material.

Management of the main forest complex, i.e. natural forests, for a long time retained the character of classical forestry, the technology of which rested on animal drag, pulling and transporting of the wood. Due to the lack of manual labor, in our country and in the world, the mechanization of technological processes in all stages of the forestry work was inevitable. The goal of the mechanization of works is to gradually mechanizing all the stages, humanize the work of forest workers and create the conditions for safe operation in all stages in the production of timber assortments. The plan of the necessary means of work for realization of the planned production arises from the quantity and structure of the assortments, and the necessary time of realization based on the technical norms of work in the exploitation of forests.

The production-technical calculation includes all the elements to derive data on productivity, profitability and economy of labor assets, i.e. this calculation directs us into deciding on the choice of type and sort of mechanization to be procured and to be worked with. The calculation-selling price is made on the basis of the calculation:

1. Propulsion material (fuel, lubricant or ointment, hay and similar),
2. Consumables,
3. Depreciation,
4. Repair and maintenance,
5. Insurance, accommodation and taxes,
6. Interest,
7. Personal expenditures,
8. The costs of driving and administrative sales,
9. Profit
10. Sales price of the service

The entire technological process (cutting and manufacturing, towing and transporting) fully responds to the degree of partial mechanization and classical work technology with a significant share of manual labor with little potential for greater productivity, economy and ergonomics; which is a consequence of the low level of availability of investment capital and greater market supply of cheap labor (as opposed to developed countries). On 29th May 2018 PFE "Sume Republike Srpske" passed a decision on adopting calculations of the cost of the labor cost per working day. Based on this decision, in this project, analysis and calculation of transport means were carried out.

7.1. Transport of forest wood assortments

The use of forests, as a process of production of forest assortments, consists of cutting and making and transporting of wood. Transport of wood is divided into its collection, towing and transportation.

Transport of FWA includes all forms of movement of wood (forest wood assortments) from the forest to the end user, that is, to the consumer centers or the market of forest products. Transporting wood is moving parts of trees or entire trees from an auxiliary depot to the user. The transport is distinguished by appropriate means of transport by constructed transport systems (roads, railways) and transport of water by waterways.



Picture 5 Transport of forest wood assortments

Transport distances range from several kilometers to thousands of kilometers, depending on the type of transport of the wood, that is, the value of the cargo. For shorter distances are used trucks, greater distances are done by railroads and the longest distance is achieved by the transport of wood by waterways. In the market of motor vehicles for the transport of cargo, there is no possibility of procuring a truck specifically intended for the transport of FWA, therefore large-sized trucks are processed (upgraded) solely for this

purpose. The basis for the construction of such a truck, which due to its exclusive purpose of transporting the timber can be called a forest truck, is:

- Mounting of forest upgrades,
- mounting a forest crane and
- rear axle matching.

The difference in the types of forest truck upgrades is most often caused by the morphology of the cargo (the length of the assortments), and the selection of the superstructure is conditioned by the appropriate truck assembly. The fundamental difference in the types of upgrades is related to certain characteristics of the forestry, so that some are suitable for shorter lengths of FWA (up to 6 m), while others can be transported with a round wood up to 12 m in length. Transportation of FWA trucks takes place through built-in transport systems (a network of forest and public roads), where trucks transport wood from one depot to another. Forestry depots are areas where the wood is collected, temporarily stored and, if necessary, produced and processed. They distinguish: main and auxiliary stockpiles and inter-depots. The main warehouses are specially arranged with the facilities of primary processing of FWA, interurban areas are most often associated with the use of wood transporting means, while auxiliary storage facilities are naturally suitable or specially decorated areas where the parts of the tree or the entire tree are towed from the forest.

Table 3 Quantity of produced FWA per year (Statistical Office of the Republic of Srpska

PRODUCED FOREST ASSORTMENTS IN STATE FORESTS **(m^3/ha)**										
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
TOTAL	**1,958,000.00**	**1,750,000.00**	**1,772,000.00**	**1,894,000.00**	**1,849,000.00**	**1,925,000.00**	**1,945,000.00**	**2,063,000.00**	**2,101,000.00**	**2,033,000.00**
Conifers	784,000.00	666,000.00	715,000.00	800,000.00	830,000.00	875,000.00	942,000.00	962,000.00	1,010,000.00	924,000.00
Logs Conifers	619,000.00	497,000.00	483,000.00	526,000.00	554,000.00	586,000.00	623,000.00	651,000.00	670,000.00	638,000.00
Pitprops, coniferous	40,000.00	35,000.00	36,000.00	57,000.00	59,000.00	57,000.00	53,000.00	55,000.00	56,000.00	53,000.00
Other long Conifers wood	5,000.00	3,000.00	5,000.00	8,000.00	7,000.00	14,000.00	17,000.00	12,000.00	18,000.00	15,000.00
Coniferous stock wood	117,000.00	130,000.00	190,000.00	209,000.00	210,000.00	217,000.00	249,000.00	243,000.00	266,000.00	218,000.00
Coniferous firewood	2,000.00	-	-	-	-	-	1,000.00	-	-	-
Broadleaves	1,174,000.00	1,085,000.00	1,056,000.00	1,093,000.00	1,019,000.00	1,050,000.00	1,003,000.00	1,101,000.00	1,091,000.00	1,110,000.00
Broadleaves logs	388,000.00	315,000.00	328,000.00	341,000.00	309,000.00	345,000.00	321,000.00	363,000.00	352,000.00	364,000.00
Pitprops, Broadleaf	2,000.00	2,000.00	1,000.00	1,000.00	1,000.00	-	1,000.00	2,000.00	-	-
Other long Broadleaf wood	12,000.00	13,000.00	15,000.00	16,000.00	17,000.00	16,000.00	18,000.00	17,000.00	19,000.00	20,000.00
Broadleaf stock wood	91,000.00	96,000.00	151,000.00	144,000.00	130,000.00	81,000.00	79,000.00	85,000.00	86,000.00	88,000.00
Firewood Broadleaf	680,000.00	658,000.00	560,000.00	590,000.00	560,000.00	607,000.00	584,000.00	633,000.00	633,000.00	636,000.00
Other roughly worked wood	-	1,000.00	1,000.00	1,000.00	-	-	-	-	-	-

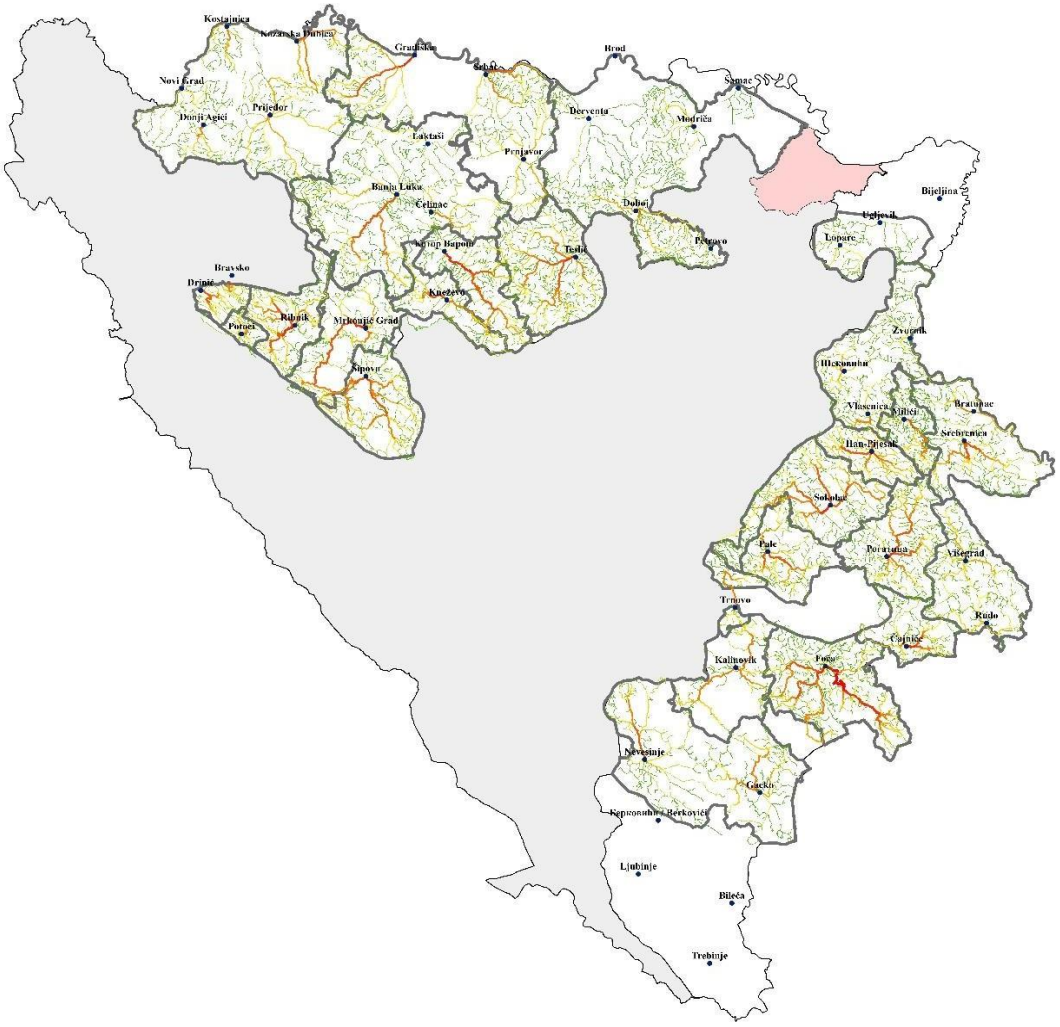


Figure 6 Loads of the road network for transportation by FWA according to processing capacities

7.2. The technology of attracting forest tractors

In the forests of the Republic of Srpska, in the first stage of transport, forestry tractors LKT-81T and Timberjack 240C are used. In conditions of small openness and large terrain cutting, towing is done by animal congestion to the area of attraction by a tractor with a winch, and then by a tractor to the truck road. In each new cut, it is necessary to mark the existing and designed new tractor roads and trails.



Picture 6 LKT 81 - Skidder - articulated tractor

Tractor trails together with forest roads are one of the major causes of erosion, compaction and damage to forest land. They can cause sedimentation of surface waters (Akbarimehr et al., 2012).

Construction of tractor roads implies the execution of earthworks for the purpose of forest exploitation. Land works are not carried out on tractor trains, except for the possible sewage and land placement on shorter sections. Tractor roads and trails constitute a secondary network of forest communications and as such form the basis for determining gravity zones and making projects for the execution of works in forestry. The project of the tractor road and trails is an integral part of the execution project for the given department.

The cost of harvesting and towing varies in each FMA and shifts from 27.30KM/m3 in Han Pjesak FMA to 36.68 KM/m3 in Vlasenica FMA. The average price of these two phases is 33.04 KM/m3.

By analyzing the mean transport distance of towing, it has been found that the average transport distance in the Republic of Srpska is about 595m. Transport distance in high forests with natural renewal is about 405m. This average distance of 595m is too large, but given that the calculation of transport distances has included all categories of forests, as well as the territory of Herzegovina with extensive management, it is concluded that more attention in the opening of forests was taken into account exclusively the category of high forests with natural renewal.

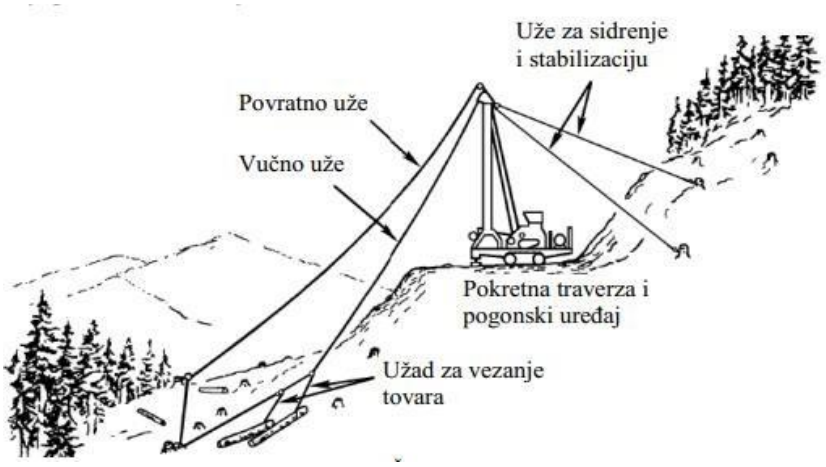
7.3. Technology of towing by forest ropeways

This system is suitable for working on steep terrain for the trunk exploitation method. Cutting is carried out by a motor chainsaw or some other mechanized means, and by the ropeway the whole trees are attracted to the warehouse where the shredding and production of assortments are carried out by a processor integrated with the ropeway or separately. The remainder remains concentrated in the warehouse, which is suitable for either chipping or making rolling shovels (banding) and further transport.

The basic characteristic of forest ropeways is at least two ropes, one of which is used for towing loads and the other for carrying loads. According to the Trzesinowski (1998), we divide them into ropeways with one, two, three, four, five and more ropes, and according to the same functionality we have: a carrying rope, a tow rope, a return rope, lifting rope, auxiliary rope, anchoring and stabilizing rope, and multi-purpose rope.

According to Dykstra and Henrich (1996), the characteristics of ropeways are as follows:

- The load-bearing rope is lifted from the ground with its entire length and represents the track of the ropeway connecting two or more supports. The supports are usually pillars (natural and artificial), trees, hives or appropriate anchorages.
- The extraction of wood is carried out by means of trolleys that move along the carrying rope. The timber is carried on the trolley.
- Extension of the rope to the load is provided by an additional device.
- When extracting the wood it is completely or partially raised from the ground, which prevents or reduces soil degradation and damages of the youngsters along the cableway.
- The drive unit does not move on the ground, as is the case with other wood removal procedures (except with a helicopter).





Picture 7 Forest ropeway- Yarder

Forest roads often do not leave enough space to store materials and work of machines.

Table 3 Market prices of some ropeways

Ropeway type	Price €
Small moveable ropeway	
TST 400	40,000
Koller K300	37,000
Middle moveable ropeway	
Wanderfalke	63,000
Koller K303	99,000
Koller K501-2	103,000
Adler DSK 25	66,000
Adler MS 500 uni	125,000
Combined ropeway processor	
Mounty 4000	224,000
Koller K507	213,000
Koller K301-4	169,000
Koller K301-2	135,000
Motor trolley	
Woodliner 1000	28,000
Woodliner 2000	46,000

In Europe, less than 3% of the cut wood is pulled out with ropeways. The exception is Austria where around 17% of the cut tree is exported by ropeways, and this trend is increasing year by year. With the development of the skidders, as the economically more cost-effective means of towing wood, the use of the ropeways gradually decreased.

Table 4 Number of ropeways used in Europe and in our country

Country	**Number of ropeways in use**	Wood mass drawn by rope (in% of total cut wood)
Austria	Unknown	17
Croatia	Unknown	<3
Czech Republic	90	2
Ireland	6	<1
Italy	Unknown	4.5
Slovakia	60	1.5
Spain	2	<1
Gr. Britain	38	<2.5
Ukraine	10	3
Serbia	**0**	**0**
Republic of Srpska	**0**	**0**

Key reasons for the weaker use of ropeways in relation to transport means by country are:

- high cost of ropeways,
- Low productivity of ropeways,
- the need for recruitment of skilled labor and regular implementation of training of workers,
- Need for anchoring masts for surrounding trees. A special problem is the cuttings in the stands of the species with shallow root system,
- problems with mounting and moving ropeways, especially in wetland plains,
- long lifting time of the ropeways and a lot of supporting equipment necessary for mounting, for which the transport often requires the existence of private vehicles.

In the Entity of the Federation of Bosnia and Herzegovina, in 2017, a ropeway transport was experimentally done in FWA Fojnica, and a seminar was held on this subject (the Czech government program). Even though it was a small surface that is not representative for the performance data, the cost of forest ropeway costs per unit of measure is 40 BAM/m3. This price is higher in relation to the transport of FWA with forest tractors, which ranges around 15-30 BAM/m3.

The fairly high purchase costs of ropeway with other large expenditures (depreciation, salaries for workers, etc.) result in a very high cost of towing per m3. These factors have contributed to a significant reduction in the use of ropeway systems in the past in the territory of Europe.

However, regardless of the high purchase prices and the costs of transporting wood, the fact is that the ropeways have minimal negative effects on forest ecosystems. The use of wood mass from steep and terrain-prone terrain is possible without major adverse effects only with the use of the ropeway.

7.3.1. Modern tools for cutting, production and transporting of FWA

Assortment processing	Harvesters		
Assembling assortments	Forwarders		



Picture 8 **Harvester** *(source: www.tigercat.com)*

The harvester's computer system controls the work of the harvester head, length and diameter measurements, decision making on the cut point for the maximal exploitation of the trunk, or the creation of assortments of the given dimensions according to the requirements of the customers.

When harvesting trees, the harvester performs a controlled fall, whereby the damage to the remaining standing trees is reduced. In pure logging, the harvester moves freely along the cutting edge, while other types of logging (spinning, shredding) require infrastructure. The maximum distance between the trails is 20m, because harvesters with a hydraulic crane have a reach of up to 10m. In this mode of operation, the harvester leaves the raised branches in front of the wheels of the vehicle, which improves the conditions of the load bearing capacity, i.e. reduces the pressure on the ground. At intervals greater than 20 m, the work of harvesters is combined with motor saws. When harvesting trees, harvesters carry out controlled felling, whereby the damage of the remaining standing trees is reduced. In pure logging, harvesters move freely along the cutting edge, while other types of logging (sparse, weathering) require infrastructure. The trail 3.5 to 4 meters wide, harvester makes itself during his work (Krpan A., Poršinsky T., 2001.)[1]

The harvester's effect ranges from a wide range of 5.5 to 30 m3 per operating hour (Bensch and Urbaniak, 2001). The effect on the harvester has the blade volume, i.e. number of trees per unit area. In addition to the cutting volume per hectare, its effect and costs are directly influenced by the average volume of the pieces, as its effect with the growth of the breast diameter of the allocated tree, i.e. the volume of the tree increases with the simultaneous reduction of the labor costs (Tufts, 1997, Bulley, 1999 and Meek, 2000).

[1] *Harvester TIMBERJACK 1070 in Croatia*

The main disadvantage of the unacceptable harvester is its complexity, for which drivers must be top-trained. Driver training is expensive and can last up to two years, while the driver is completely skilled for handling the machine. However, in a few months, most drivers acquire satisfactory knowledge and skills (Hoss 2001). One of the basic tasks of mechanized felling and making is the release of people from severe, fatigued and dangerous forest work. The physical load in the work of the harvester is incomparably less than when working with a saw. The operator in modern machines of cutting-edge mechanical and computer technology is located in a pleasant environment of the air-conditioned cab and control panel, free of all unpleasant external factors. The best results of the harvester are achieved in pure clusters of coniferous forests, and according to the Scandinavian data, the annual effect is in their conditions up to 40,000m3 (Wasterlund 1996). In Central Europe, the harvester is used in deciduous trees, but its performance in relation to the work in conifers is less than about 25% (Pausch, 1999).



Picture 9 Forwarder LOGSET 4F

Forwarder is a special forest vehicle designed to export FWA from the forest to the inter-depot and to transport FWA on shorter distances to forest trucks or public roads. Application of forwarders for transport of FWA has as a condition and application of technology of production of forest wood assortments in the forest, that is, the sorting method of wood production.

Purchase price: 180,000 – 270,000 € Load capacity: 10 - 14 t Max inclination: 30 - 35% Length of logs: up to 6 m Effect: 12-20 m3/h	Fuel consumption per hour: 7 - 11 L Costs: 65 - 80 €/h

The joint work of harvesters and forwarders with a sort method represents a closed circle. Harvester performs cutting of trees, pruning, cutting the trunk, measuring

assortments and its stocking in the stack to be loaded by forwarder and exported to inter-storage. Due to the weight of forwarders, there are also major damages on forest roads, which is one of the disadvantages. An example of the analysis in the lowland oak forests of Croatia (Z. Pandur et al., 2014) stating that the landing exceeds 30% of the observed area.



Picture 10 Damage on forest roads using forwarders in FMA Hanpjesačko (photo: S. Dražić, 2016).)

In the Republic of Srpska, the most commonly used means of transportation in the first phase of the transport of FWA are dominant, forestry articulated tractors. Considering the small number of this means of transport owned by the PFE "Sume Republike Srpske" it is difficult to talk about the selection of the most favorable means of transport for forestry management areas because it depends a lot on the contractor.

Private entrepreneurs, who have a license (according to the rules for the execution of works), are mainly performing services of cutting and transporting of FWA from the stump to the end user. We are aware of the modernization of these means of transportation (ropeways, harvesters, forwarders, etc.), but it is hard to influence private owners (contractors) to modernize their machinery if they are unable to acquire and apply it in adequate conditions. All newer and more modern means of transportation, besides a number of advantages, have some limiting factors and requirements, which are usually the cutting edge per hectare, the slope of the terrain, the logging system and the high purchase price of these assets. Namely, many authors in the world have published scientific and expert papers on this topic, but the most common logging systems were: clean cuttings and sparse cuttings so that the obtained results can hardly be compared with our working conditions and would be in the sphere of speculation and estimation. Also, the harvester has the highest performance in coniferous forests, while in the deciduous forests, this product is very little used and the effect is lower by about 25% compared to the cutting of conifers.

In the PFE "Sume Republike Srpske", the group-selective system is represented in the forest management, which implies selective tree logging, i.e. removing of trees that are usually not concentrated in groups, so the harvester needs to move from tree to tree, and thus its effect decreases significantly. The spatial arrangement of the tree itself is not

properly arranged in the space, so the harvester is often limited to the approach of the trees that have been assigned to it, in this case a parallel transport vehicle.

According to FSC standards, it is forbidden to leave tractor roads and trails to any mechanized means of transport, or to move freely on the cutting edge. In this case, harvesters and forwarders are limited only to the reach of a hydraulic crane up to 10m, while the forest tractors with a winch and rope can reach FWA up to 60m. In this case, the density of tractor or harvester roads should be considerably denser, therefore additional land damage would be inevitable. Forest roads for harvesters and forwarders are wider than tractor roads, and due to the weight of these transportation vehicles, there are also more damages in relation to damage caused by forest tractors. Naturally, with all the positive and negative effects of these means of transportation, the PFE "Sume Republike Srpske" should at least experimentally, buy or rent adequate forest lifts, harvesters or forwarders, and research work to demonstrate the application and cost-effectiveness of such resources in our area and to eliminate the doubts about this question.

7.4. Conclusion

On the basis of the data collected through the survey on technologies, technological processes, working methods and organization of work in the exploitation of the forests of the Republic of Srpska, the following knowledge related to technologies in the exploitation of forests has been developed:

■ A variety of organizational solutions for the implementation of forest utilization technologies results in difficult planning, design, implementation and control of the implementation of technological processes with the risk of damage to the forest and the occurrence of accidents at work; the impact on the modernization of technologies is limited,

■ the engagement of public enterprises in all three phases of forest exploitation is an acceptable solution because of the continuity of management and management of technological processes using the previously acquired machinery and employment of own working and professional capacities (social aspect); the engagement of private entrepreneurs is needed for competitiveness (economic aspect),

■ Partial maintenance of the means of work in its own direction enables control of the correctness of machinery and equipment (ergonomic aspect) and reduction of waiting for repairs (economic aspect),

■ production on the cuticle is conditioned by the method of work; as a consequence there is a lower level of mechanization of the work, more difficult conditions for work (ergonomic aspect); limited opportunities for productivity growth and cost-effectiveness; and can be justified by environmental factors related to the method of work,

■ The sorting method is ecologically justified considering the preparation of the load to attract; conditioned by low degree of mechanization and a large fraction of manual labor

(ergonomic aspect); may be the cause of poor exploitation of wood mass (spatial wood); gives small opportunities to increase productivity and economy of work in the technological process of forest exploitation.

An analysis of the current state of technological processes, which included the means and organization of work, points to the following conclusions, i.e. pointing to the overall assessment of the dominant technological process in the utilization of the forests of the Republic of Srpska.

■ cutting and making with the use of chainsaw and hand tools results in a large share of the engine - manual and manual operation; working on vaccination splint is easier (and still a lot of manual work),

■ the existing organization (1 + 1) is suitable for cutting and crop production in a sorting method with low share of splitting,

■ animal adherence is associated with the assortment of methods (primarily for ecological reasons); admitting a tractor with a winch justifies the use of adaptable forest and special tractors with longer assortments (higher productivity and cost-effectiveness); Animal tractor with winch is a compromise solution,

■ Special forest tractors in attracting wood, given the built-in capacities for difficult working conditions and heavy loads, ensure the highest increase in productivity and cost-effectiveness if proper preparation and control of work is ensured (otherwise damages),

■ The use of adapted forestry tractors gives the best results in organized admission (animal or tractor with winch) in easier terrain and in the drawing of assortments (non-adhered tractors with a basket or trailer can be used for the export of fine wood and biomass)

■ the prevailing work organization for tractor traction (1 + 1) is acceptable for medium distance; for medium loads and tractor with winch.

8. ANALYSIS OF THE POSSIBILITY FOR EXERCISE OF ADDITIONAL VALUE WITH WOOD AND WOOD BIOMASS

With the growth of the Earth's population, many questions are being raised, and one of the primary issues is energy. Numerous analyzes of the relationship between the technological and social development of mankind have shown that changes have always been related to the use of energy. The new economic order is actually an energy order. For a new energy order, it is necessary to know the global assessment of wealth assets of the state in terms of more just, more productive and environmentally responsible management of global energy resources.

The energy crises of the early seventies, the knowledge that the reserves of fossil fuels were limited and finite, and pollution of the environment in the use of fossil fuels, intensified the research of new renewable energy sources. Fossil fuels (coal, gas, oils) are currently participating in global energy consumption with around 79%, nuclear power takes a 7% share, and renewable energy sources account for around 14% (www.iea.org).

The potential for bioenergy is very large and very widespread throughout the world. Today, biomass is already a major source of global energy needs, of all available renewable energy sources. The use of biomass is mainly based on the remains of agriculture and forestry. Because of the bioenergy properties that can be used in small, medium and large plants, it is applied in a large number of process and user schemes.

Wood biomass as a renewable energy source can be a good substitute for fossil fuels with high ecological and economic effects. Wood biomass also appears as wood residue after cutting, spinning and other activities in forestry, as raw material from energy crops, wood residue from the wood industry, the remains in fruit growing and viticulture, wood waste from urban areas and other forms of appearance.

The goal of the European Union is that renewable energy sources reach the amount of 12% in the total energy needs by 2010 and 20% by 2020. Between solar energy, geothermal energy and wind energy biomass has the greatest potential and prospect at the current level of development of technologies for the use of new renewable energy sources.

Biomass is an organic substance of vegetable or animal origin and is one of the sources of renewable energy used in combustion processes or is converted into energy production systems (heat and electricity). According to EU Directive 2003/30/EC dated 08/05/2003, Article 2, BIOMASS is a biodegradable fraction of products, waste and residues from agriculture (including plant and animal substances), forestry and timber industry, as

well as biodegradable fractions from municipal and industrial waste whose use in energy is permitted, in accordance with the relevant regulation in the field of environmental protection.

Forests are a source of affordable, environmentally-friendly renewable environments. Forest biomass is considered a renewable energy source, carbon neutral because, in the event of combustion, released CO2 is absorbed again during physiological processes in plants where a new biomass is created. The use must be sustainable on an ecological, economic and social basis.

8.1. State and characteristics of the forest fund in the Republic of Srpska

Of the total area of forests and forest land, 48.68% are the forests with natural renewal, which is the highest representation of a certain forest category. 21.67% of the area is suitable for afforestation areas, while the share of the areas on which are conifers are 16.69%. The area under cultivation is 6.26%, the area of unsuitable for afforestation is 5.31%, and the presence of degraded forests is 2.34% (Danilović et al., 2013).

Of the total area of high forests, 37.49% of the forests are high beech forests and 46.69% are high forests of fir and spruce or spruce and beech. Pine forests account for 7.51%, and 7.94% are oak forests and the rest is 0.37%.

Highly degraded beech forests in the total area of high degraded forests account for 62.93%, high degraded forests of oak with 35.62% and other forests with 1.45%. On the territory of the Republic of Srpska in the past, forests were planted. The most frequent are forest pine cultures with a share of 51.25% and a spruce culture with a representation of 37.69%. There are other forest cultures of different types of trees, such as pseudotsuga, pine, spruce, ash, oak, etc. The participation of forest cultures of these types of trees amounts to 11.06%.

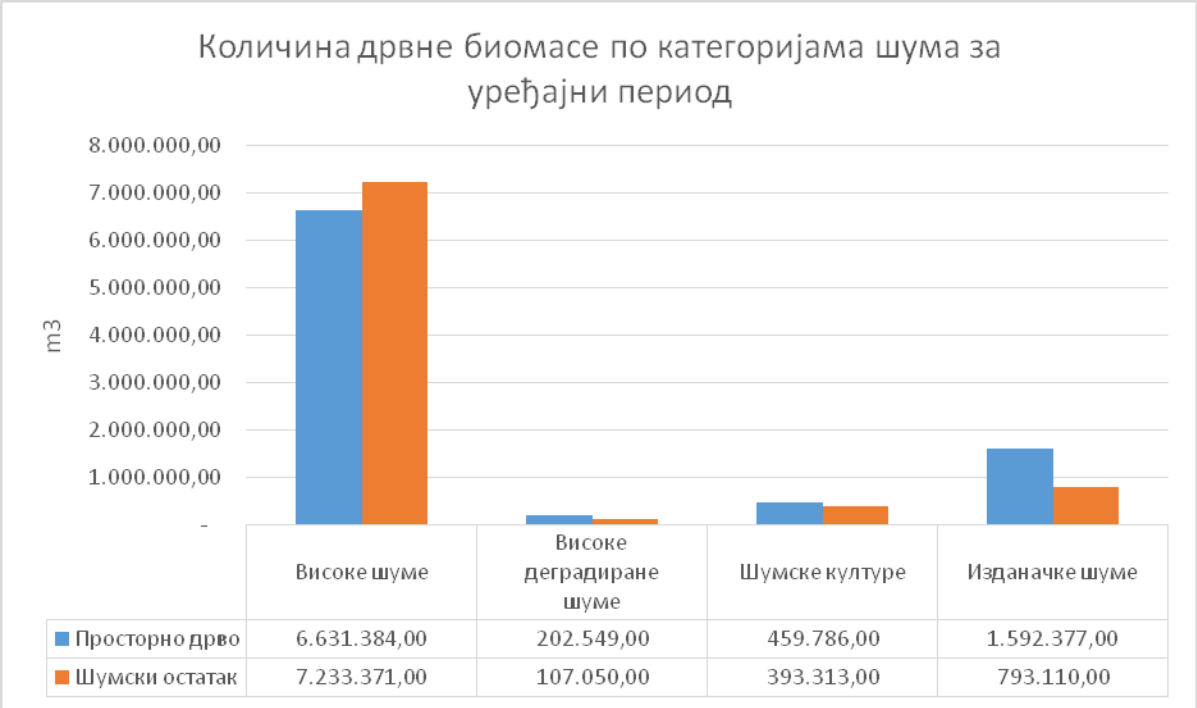


Chart 1 Total amount of wood biomass by category of forests in the Republic of Srpska

Table 5 Amount of wood biomass that would be available for use

	Name	m^3/year
1	FMA Trnovsko	10,292.02
2	FMA Majevičko	10,576.16
3	FMA Posavsko	12,740.64
4	FMA Čajničko	13,015.24
5	FMA Milićko	13,222.86
6	FMA Donjedrinsko	14,133.60
7	FMA Čemerničko	14,336.47
8	FMA Jahorinsko	19,805.44
9	FMA Istočnodrvarsko	19,845.19
10	FMA Kalinovičko	24,252.15
11	FMA Dobojsko - derventsko	25,896.32
12	FMA Višegradsko	26,369.08
13	FMA Kotorvaroško	26,971.60
14	FMA Donjevrbasko	27,740.00
15	FMA Petrovačko	28,498.00
16	FMA Mrkonjićko	28,630.00
17	FMA Vlaseničko	30,524.00
18	FMA Gornjedrinsko	34,513.32
19	FMA Srednjevrbasko	43,326.00
20	FMA Usorsko - ukrinsko	48,397.84
21	FMA Kozaračko	48,397.84
22	FMA Ribničko	48,584.39
23	FMA Hanpjesačko	49,300.00
24	FMA Rogatičko	55,339.96
25	FMA Nevesinjsko-gatačko	63,761.20
26	FMA Romanijsko	66,310.00
Total		**804,779.32**

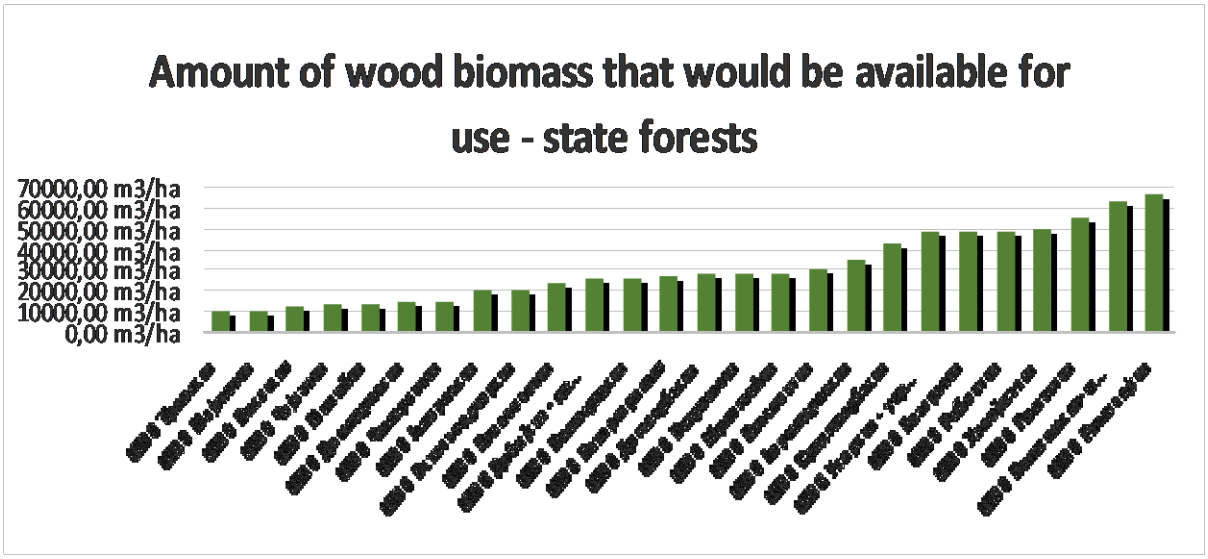


Chart 2 Amount of wood biomass by FMA



Picture 11 Harvesting of cutter residues by Timberjack 1210 forwarder



Picture 12 John Deer 1490D roller making machine





Picture 13 Tractor with crane and trailers with clamping sides

In the world and in our country, numerous studies were conducted aimed at assessing the potential of wood biomass. The data that came about is the result of computational analyzes from the planning documents. Such data has limited use, since they do not represent real facts about the amount of forest biomass for energy that can be offered to the market.

Technical constraints can prevent collection in particular areas, such as steep slopes or inaccessible forest areas. Similarly, in some cases, the cost of biomass collection may be higher than the revenue that can be generated using the collected biomass, which again diminishes the actual availability of biomass for use. Areas that are protected by national or international laws may have prescribed provisions prohibiting the collection of vegetation, and in some cases the use of biomass can significantly impair the biological balance. All such restrictions reduce the total amount of biomass available for bioenergy needs.

Determining the type and location of the power generation plant is a matter of a comprehensive optimization of the energy production chain. Previous production was based primarily on firewood as a raw material. However, these volumes are not enough for the growing needs of the wood biomass market as a raw material. Pellet production plants in the Republic of Srpska and the region, in addition to the wood industry residue; use spruce wood as a raw material for the production of pellets, primarily firewood and cellulose wood, which significantly participates in the total quantity of large wood. The demand for this raw material in the future will grow, which will significantly change the structure of customers of this forest product.

Nowadays, there is a more unequivocal interest of inventors for investment in power generation plants. However, it is necessary to answer the question about the quantity of raw material that can be offered from the forests managed by the PFE "Sume Republike Srpske" a.d. Sokolac and from private forests. Such questions cannot be answered without detailed analysis, which implies a multidisciplinary approach, or by including all relevant factors involved in the production chain of forest biomass for energy.

In addition to the lack of restrictions on trade in this product, the amount of wood biomass that gravitates from a certain area is very important for the choice of location and capacity of power plants. According to all the previous studies, the transport distance is one of the most important factors in the supply chain of the wood chip plant (chipboard).

Table 6 Heating systems

Fuel	Unit prices		Heat value		The price of energy	The efficiency of the boiler	The cost of the thermal energy	Dosage mode
	unit		**Unit.**		**€/GJ**	**%**	**€/GJ**	
Coal	€/t	61	GJ/t	15.0	4,1	75	5.5	Manual
Firewood	€/t	51	GJ/t	10.3	5,0	75	6.6	Manual
Fuel oil	€/t	973	GJ/t	42.0	23,2	88	26.3	Automatic
Natural gas	€/1000 m3	419	GJ/1000 m^3	10.0	11,6	92	12.7	Automatic
Wood chip	€/t	46	GJ/t	10.3	4,5	85	5.3	Automatic
Wood briquettes	€/t	72	GJA	15.0	4,8	85	5.6	Manual
Wood pellets	€/t	143	GJA	17.0	8,4	92	9.2	Automatic
El. Energy	€/MWh	77	MWh	1.0	21,3	100	21.3	Automatic

Source: Analysis of the potential of wood residues in BiH, with a special focus on the municipalities of Srebrenica, Bratunac and Milici UNDP 2011.

8.2. Market and demand

The need for this raw material is increasingly influenced by the changes in the previous approach to the use of forests. The influence of various structures of society on decisions is increasing, since energy is a common denominator for different sectors of the economy. The problem of energy security, and especially energy from renewable sources, is becoming a problem of international importance, regardless of whether it is production, trade of biofuels or environmental protection.

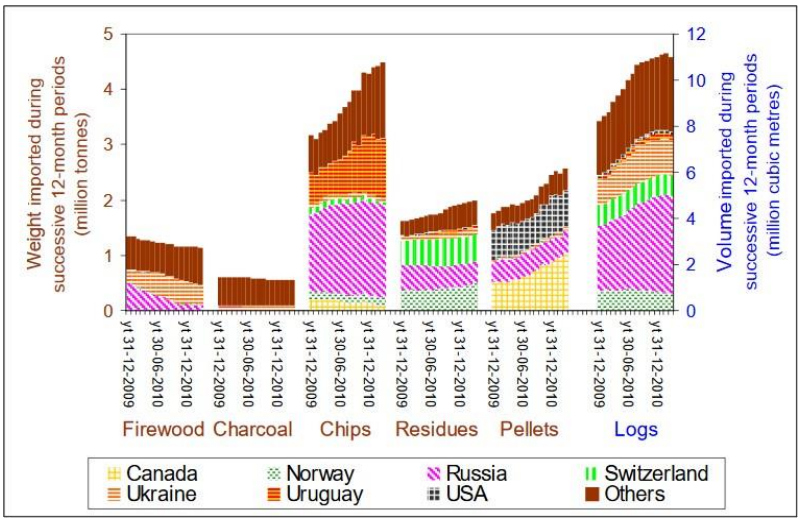


Chart 3 Periodic dynamics of imports of FWA and biomass into the European Union from other countries outside the European Union

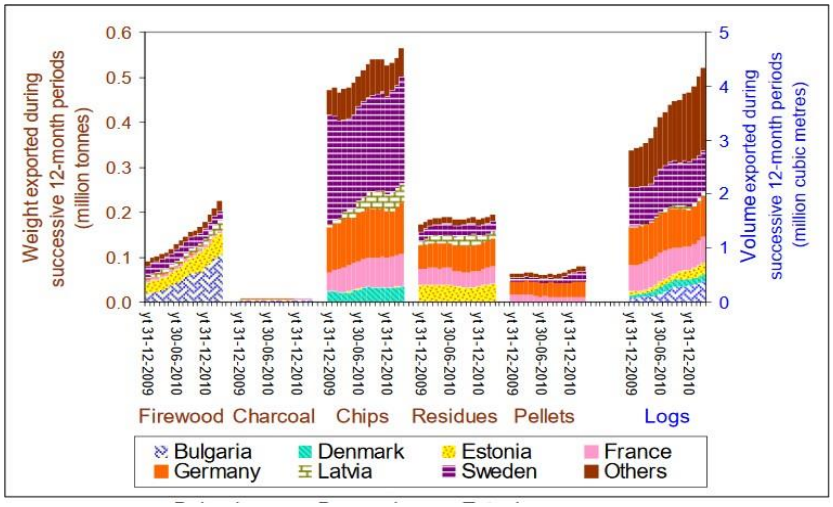


Chart 4 Export of wood biomass from the European Union (data according to exporters)

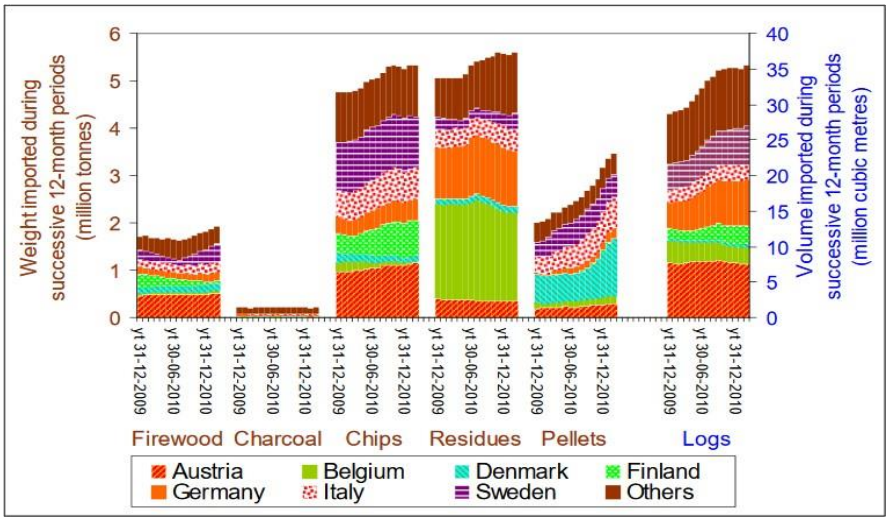


Chart 5 Interchange of wood biomass in the European Union (data by importers)

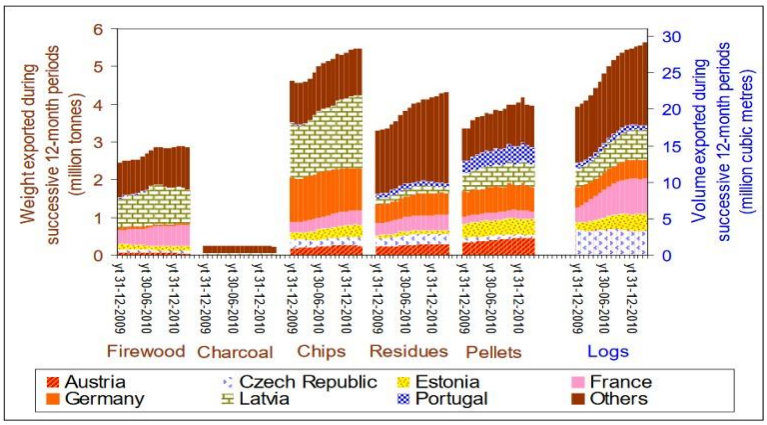


Chart 6 Interchange of wood biomass in the European Union (data according to exporters)

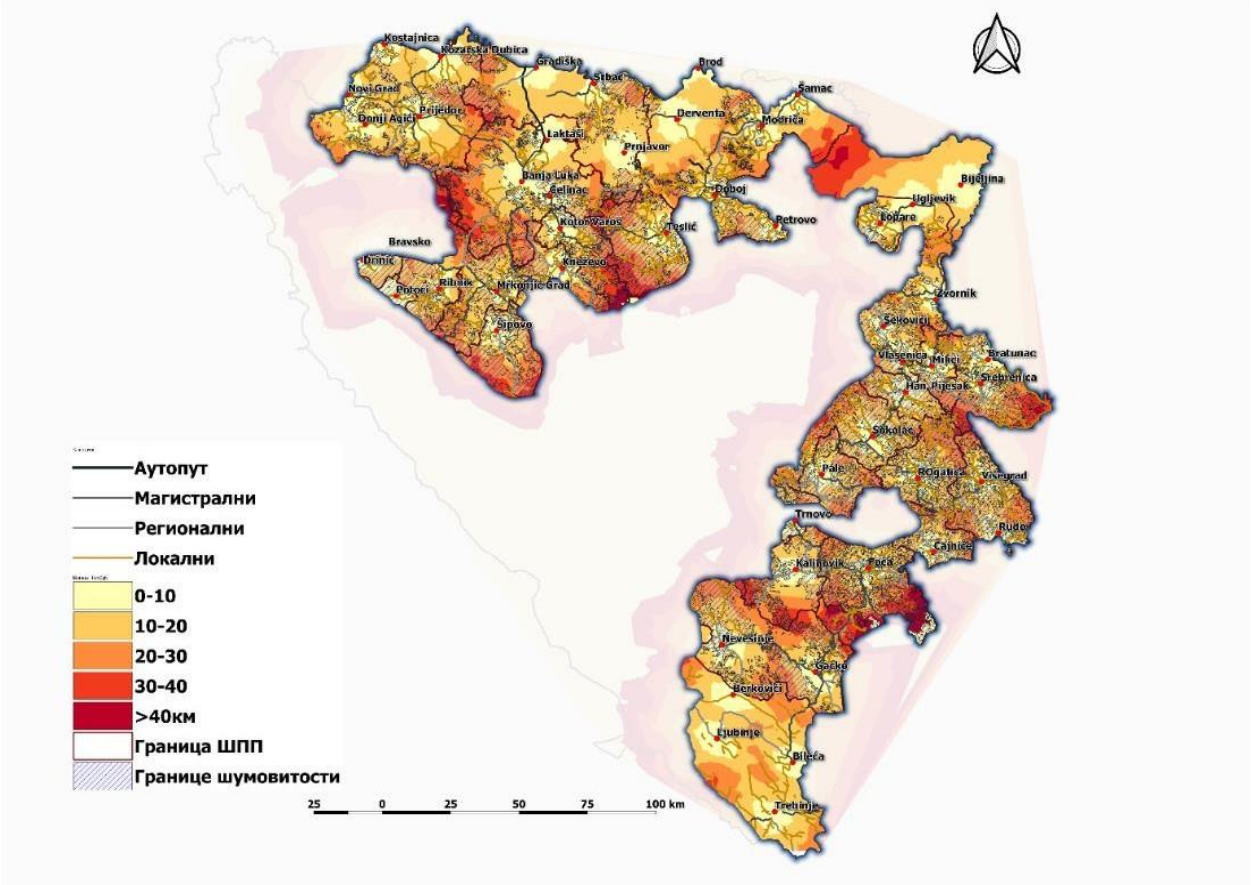
According to Chart 4, import of wood biomass into the European Union is significant, especially timber cutting and FWA. The largest exporter of wood biomass is Russia, which supplies more than 3 million tons of this energy annually.

Chart 5 shows a very small amount of exports of wood biomass outside the European Union. When comparing Chart 1 and Chart 2, EU biomass needs are 10 times higher than exports. Most of the wood biomass is exported by Germany and Sweden, which in one way were among the first in Europe to start and promote biomass as an energy source.

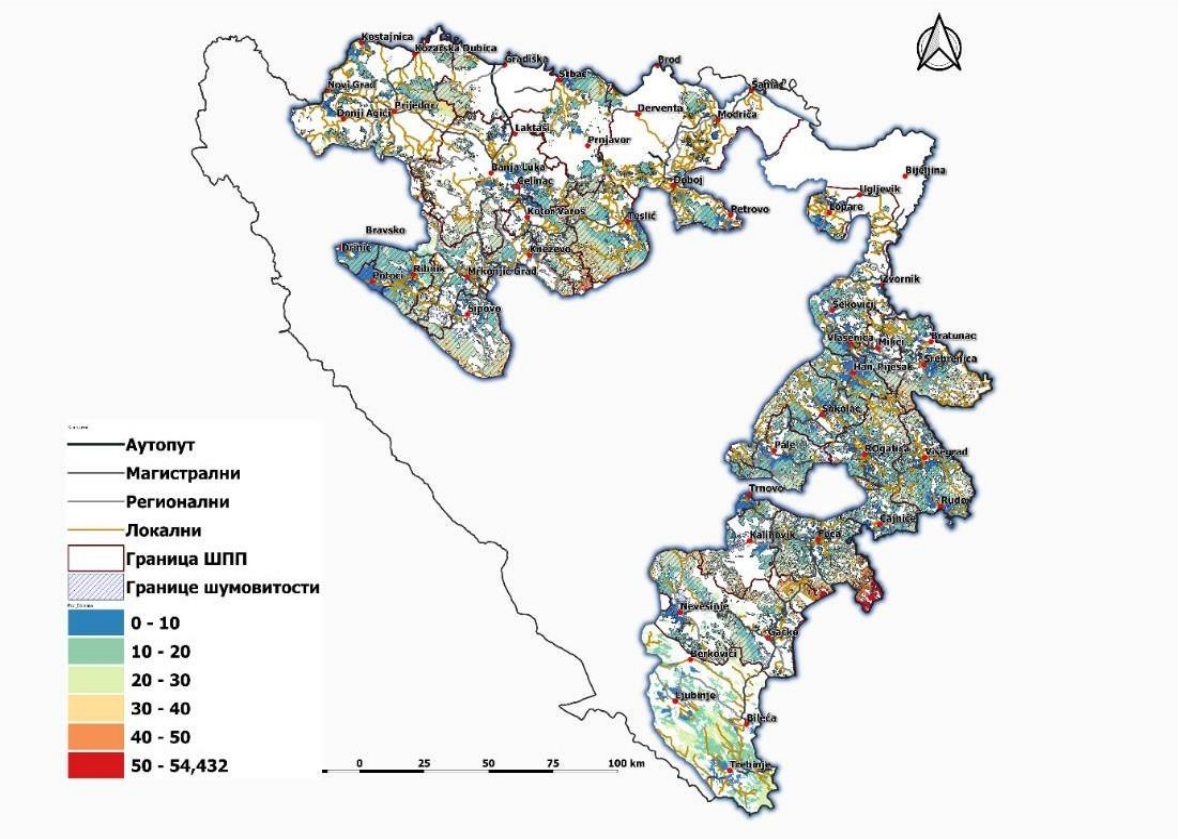
As for the interchange of wood biomass, the largest exporters are Latvia and Germany, while France and Estonia are also present with a slightly smaller share. According to the graphs shown, the demand for wood biomass is constantly increasing. Forests in the Republic of Srpska have significant quantities of forest wood biomass, as well as forest residue, which are not used today due to the more difficult collection of this assortment. This analysis covers the available quantities of wood that can be used as wood biomass for energy.

8.3. Forests roads

A well-developed network of forest roads is a basic precondition for rational and functional use of forest biomass. The picture shows the availability of forest biomass from the collection point to the final beneficiaries, in this case to the larger towns of the Republic of Srpska.



Picture 14 Availability of forest biomass



Picture 15 Transport distances in the acquisition of forest biomass

Table 7 Participation of forest surfaces by forest classes for the displayed transport distances

	Distances (km)					
Management class	0-10	10-20	20-30	30-40	40-50	>50
1000	13.10%	41.26%	33.97%	9.08%	2.04%	0.56%
2000	26.38%	44.08%	24.55%	4.38%	0.61%	0.00%
3000	20.28%	44.72%	27.60%	6.63%	0.77%	0.00%
4000	19.99%	49.07%	26.42%	4.03%	0.50%	0.00%
6000	10.64%	37.99%	34.76%	10.83%	3.07%	2.69%
7000	18.55%	44.75%	26.31%	9.36%	0.98%	0.05%

According to the data presented in Table 8, the availability of forest biomass (FWA), when public roads are included, the dominant transport distance is about 10-20 km with a significant share of areas at a distance of 20-30 km. It can be said that the average distance is about 20 km.

8.4. Measures proposals

When planning energy production from biomass, planners should consider all stakeholders within the bioenergy chain, such as: biomass resources, transport, conversion and final energy. Also, planners should take into account social interests, environmental protection and economic impacts related to the establishment of a biomass system and the specific problems facing each country. In order to overcome these problems, there is a need of support systems for making important decisions. It is precisely for this purpose that there are different levels for the planning and implementation of bioenergy production.

Today, we have numerous support systems that take into account the environmental and economic side, and at the same time use the opportunities provided by GIS. However, these systems are mostly made for one type of biomass, depending on which aspect it is viewed, whether it is an ecological, environmental or social aspect, and the focus is on one level of decision-making. All of this requires the need for a system that addresses the objectives of all stakeholders in the production of bioenergy, both at the local and national levels of decision-making.

The goals of national planners who propose a country-wide biomass strategy are different from those of local planners and executors, which are to a certain extent limited by some factors, such as resource availability, topological constraints and energy needs. These differences must be taken into account when systems for efficient planning and implementation of bioenergy production are being developed. At the macro level of planning (such as national planners), the rough cost of the model is sufficient, as their main problems are: defining the available biomass in the whole country, defining energy to convert biomass into bioenergy, economic effects (e.g. energy production costs) and the benefits of the application of emission prevention laws.

Based on the planners' decision at the strategic level, local designers should execute:

- The optimum size of each biomass plant,
- The amount of biomass to be used,
- Location for the collection and production of biomass.

The forests of the Republic of Srpska have a large amount of wood biomass to be used in a way and to the extent that it would provide the largest amount of energy.

Although forest resources in BiH represent an important resource for economic growth, and primarily in rural areas, the traditional approach to managing and using them is still dominant. The characteristic of this approach is tree based logging as the main product of forestry, while other forest products are largely neglected and their economic valorization is often absent. In addition, a certain amount of wood biomass is left in the forest, although

it could be economically valued, i.e. offered to the market with minimal investments in infrastructure and technological solutions that enable it's more efficient export from the forest.

In this regard, it can be concluded that for the economic valorization of all forest products and services it is necessary to conduct a detailed analysis of the financial indicators, which is especially expressed in the case of commitment to intensify the use of forest biomass for energy production. This primarily refers to the question of the use and economic valorization of the wood residue resulting from the operational activities of harvesting and production of FWA.

The biomass shown represents the amount that is included in the amount of forest timber assortments and is thus taken into account.

9. ANALYSIS OF POSSIBILITIES FOR REALIZATION OF ADDITIONAL VALUE BY EXPLOITATION OF NON-FOREST PRODUCTS

In forest practice and literature, forest products are divided into major and secondary. Major are wood (logs, round logs of fine technical wood and other forest assortments), and in secondary: resin, raw materials for obtaining tanning substances (except for tannin trees), forest fruits, seeds, medicinal herbs, edible mushrooms, and etc.

• Use of non-wood forest products belongs to production functions of forests

• Non-wood products are all material benefits from forests that are not wood and can be sold on the market

• In some forest areas, the non-wood product was more important than wood, i.e. "Main" e.g. grazing in Slavonian oak forests, bedding in Bela Krajina (Slovenia) or bark from the oak tree

• In most forest-rich countries, the importance of non-primary products is reflected in their importance for the local population

• To apply, for example, for grazing in forests below the Himalayas, for bamboo and rhubarb in south-east Asia, for the bark of the oak tree in Portugal, for bed in undeveloped countries, etc. (Danilović, 2013)

Our forests are considered inexhaustible mines of medicinal, edible and aromatic herbs, various types of game, and significant mineral resources, which we collectively name secondary forest products. From the aspect of distribution and market value, the most important group of other forest products is certainly medicinal and edible plant species. Knowing the actual supply of medicinal and edible herbs in our forests is the starting point for making decisions about the organized exploitation of this natural treasure and an important point in planning the volume and collection assortment, both from the aspect of the longevity of natural production and from the aspect of the protection of certain species.

According to European Union study at the beginning of 2002, it is estimated that in Bosnia and Herzegovina the total market value of non-wood forest products was BAM 200 million, of which the market value of medicinal and aromatic herbs was BAM 50 million per year. Since then, demand has increased for medicinal and aromatic herbs, especially for raw materials and essential oils.

The collection of non-wood forest products in the Republic of Srpska is done by a large number of rural population and is an important source of income for them, and several large companies, and a number of small, relatively new companies, are involved in the

purchase, production and processing of fungi, medicinal and aromatic herbs and forest fruits in the Republic of Srpska. About 50 companies in BiH are economically important for this sector. Still, a large number of BiH companies are only engaged in the purchase and trade of raw plant material, forest fruits and fungi. Nevertheless, the findings of numerous experts show that only a small number of these goods were used.

Table 8 Main non-wood forest products in some European countries by leading manufacturers

Product	Leading manufacturer	Quantity in thousands of tons	Value in millions of dollars
Christmas tree	Germany	20	235.3
	France	5.6	75.4
	Great Brittan	3	66.7
	Denmark	7	24.1
Mushrooms and truffles	Czech Republic	23.9	39.1
	Belarus	10.1	15.2
	Sweden	8.5	31.8
	France	8.2	107.7
	Finland	6	14.1
	Italy	2.4	44.7
Fruits and berries	Albania	60	114
	Finland	40	67.1
	Norway	25	45,3
	Czech Republic	22.7	39.2
Meat game	Sweden	17.1	76.1
	Poland	8.1	-
	Finland	7.9	64

9.1. Mushrooms (fungi)

Forests and forest lands of the Republic of Srpska inhabit a large number of species of wild mushrooms (higher mushrooms with a hat and a handle or a rather similar appearance). It is believed that over 100 species are edible or conditionally edible (after cooking or after drying). For the needs of domestic and foreign markets, a very small number of species are collected: Caesar's mushroom, penny bun, golden chanterelle, the horn of plenty, red pine mushroom and morels. About 1,060 tons of fresh mushrooms are purchased annually in BIH, of which about 700 tons are exported in various forms of finishing and processing, and about 15% of the purchase (about 125 tons) is completed in the domestic market. The export assortment in 2017 consisted of: 274 t of fresh mushrooms, about 263 t of frozen mushrooms, about 65 t of canned mushrooms and about 92 t of dried mushrooms (equivalent to 456 t of fresh mushrooms).

In the aforementioned data, Republic of Srpska participates with about 50%. In addition, about 874 tons of artificially grown mushrooms are produced annually in the Republic of Srpska, about 830 tons is the first class of penny bun, and then about 44 tons of pearl oyster mushroom, while lately in the market is popular the mushroom of rice straw, the Japanese mushroom Shi-take (Tanović et al., 2010).






The estimation is that the collection of fungi compared to the potential and the assumption of a rational, sustainable collection is used only with 15-20%. Therefore, there is a possibility of greater participation of all the structures and categories of the population in a significant inclusion in the mushroom collection sector. None of the economically important fungi are in the status of rare, risky, and protected mushrooms.

9.2. Medical herbs

The natural potentials of medicinal and edible plants are expressed in the amount of a dry substance that has a usable and market value, expressed in kilograms per hectare (kg/ha), for each plant species and for each wider ecological and vegetation whole (stratum) in which this species is registered. This display allows natural suppression to be calculated for any spatial unit in forestry in any area.

Belts with forest communications and averages below the transmission line are registered in lower, middle and higher positions, evenly distributed across all exposure categories, and in a schedule that is inversely proportional to the pitch and degree of the circuit. In the aforementioned environmental conditions described in the bands along with forest communications and on the cutting lines below the transmission line there are 37 species investigated, 24 terrestrial and 13 woody species that occur individually. Also, 21 species have been found which have a medicinal or edible property, which for some reason were not included in the recording sheets (S. Ljubojević, ANURS 2012).

The medical significance of some plants is indisputable. This is the case with the genus *Digitalis, Adonis, Convallaria, Nerium, Scilla, Artemisia, Achillea* and many others. Aromatic plants and vegetable essential oils are increasingly being sought and used for aromatization of cosmetic and hygienic preparations for the widest use. Aromatic plants are also used as culinary spices, preservatives in the food industry, for making various extracts for the production of beverages, and alike. Due to its geographical position, diversity of climate, relief, land and other natural conditions, the Republic of Srpska is very rich in

medicinal and aromatic plants as well as fruit trees. Many of them have the status of official drugs, such as, for example, mallow, wormwood, belladonna, great yellow gentian, chamomile, sage, valerian and others.



Birch



rowan



blueberry



Wild pear



nettle



belladonna



Saint John's worth



primrose



Chamomile

9.3. Purchase and distribution of non-wood products

Data for a particular area or region are not available because accurate records are not kept and there is no adequate regulatory mechanism. According to the currently available data, we managed to identify only certain companies that paid symbolic compensation to the PFE "Sume Republike Srpske" for the collection of mushrooms and medicinal herbs.

Companies that are registered for the purchase of medicinal herbs and forest fruits in the Republic of Srpska for a fresh kilo of elderberry are paying BAM 1.5 and for the same amount of drier elderberry between BAM 8 and 12. A kilogram of wild garlic costs between eight and nine, and a fungus of five to ten marks. The RS Ministry of Agriculture, Forestry and Water Management say that organic production in Republic Srpska occupies about 300 hectares.

Based on the analysis of the Foreign Trade Chamber of B&H, last year was exported medicinal herbs and forest fruits worth 29 million KM, while the import of these products amounted to about 9 million KM.

The production potential of the forest is not only used through the wood volume, but through potentials for the production of various fruits, mushrooms, medicinal herbs, wood coal, hunting and fishing, then the use of peat, stone, sand, gravel etc. It estimates that the forests of the Republic of Srpska has in dry condition about 1.5 kg/ha of quality medicinal herbs, aromatic and edible herbs about 6 kg/ha of forest fruits, about 500 tons/year of fungi and other plant raw materials (Forest Development and Conservation Project - Financial Sustainability Strategy for Forest Management, 2007).

10. ANALYSIS OF THE RESPONSE TIMES ON FOREST FIRE AND CAPACITY FOR FORESTRY FIRE FIGHTING, WITH A PROPOSAL FOR A MEASURE OF IMPROVEMENT

Many terms used for fire in nature carry a number of meanings that depend on the socio-cultural environment, the nature of the land and vegetation that is affected, and the legal framework that is used. Fire is described differently as a fire of a landscape, a forest fire, a village fire, or a fire of vegetation. This is just one number among other terms used by various agencies around the world.

In Europe, where many countries suffer the effects of fire on various types of land cover, the terminology currently in use in the European Forest Fire Information System (EFFIS) is a "forest fire"; however, due to the spread of fire in non-forest areas of Europe, it includes a broader notion of forest fires (IUFRO 2018). The term "Fire" is also used in the Global Fire Information System (GWIS), which aims to provide coordinated information on the activities and impacts of fire at global level.

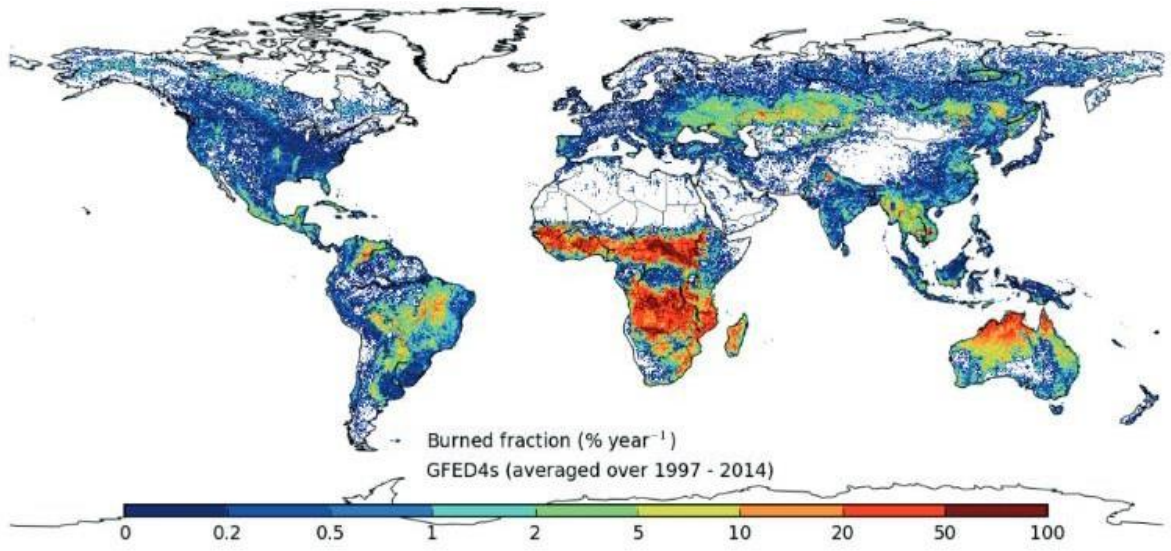


Figure 1: Global distribution of annual area burned, averaged over 1997-2014. White areas show no fire activity. Source: Global Fire Emission Database version 4, Giglio et al. 2013

Forest fires represent the worst form of devastation of forest ecosystems. In a very short period of time, large areas of the forest with catastrophic environmental consequences can disappear. In addition to direct damages due to the destroyed wood mass, all other functions of the forest are disturbed, so the total damage is multiplied a lot.

After the fire, we often note the escalation of other destructive factors, such as insect over-breeding and plant diseases, which additionally destabilize the fired and non-burned surfaces, thus increasing the damage considerably. With the reduction of the area under the forest is increased the danger of torrential flows in the mountainous regions and floods in the lower.

In order to prevent damage to forests and to society as a whole, it is necessary to build a modern fire protection system that would minimize the harmful effects. This system must provide a forecast of a fire hazard on the basis of which it is possible to allocate human and material resources necessary for rapid and effective fire extinguishing from areas with lower risk to areas with higher risk. When areas of increased fire hazard are identified in this way, the intensification of the observation will allow for early detection of the resulting fire, which results in a reduction in the areas affected by fire due to faster firefighter's intervention.

Roads in the forest represent projected and constructed infrastructure facilities which spatial and constructive solution depends on the shape of the terrain, the purpose of the forest, the habitat and the occasional opportunities of forest ecosystems, the planned works in the forest, as well as the reduced forests, such as forest fires.

The forest path network influences the reduction of the occurrence and spread of large-scale fires (Lugo A.E. Gucinski H. 2000). The importance of forest roads in fire protection is great because they provide preventive and repressive protection. Preventive protection is not only reflected in the prevention of the occurrence of fires, but also by eliminating the conditions for their occurrence (Ratkinis M. et al, 2006b), as well as through constant monitoring of endangered forest areas, and repressive through the creation of conditions for timely extinguishing of the fire.

Preventive fire protection reduces the risks of fire outbreaks, which can reduce total damage from fire to one tenth in relation to the existing state (Stipanicev D., Hrastnik B., 2004). The impact of the density of the network of forest roads on the initial forest fires is large because the higher density of the road network influences faster detection of fire and formation of the defense line to prevent the spread of terrestrial fires (Larjavaara M., 2005). However, in addition to forest roads and paths, they form lines of defense against forest fires, by which excursions and campers move, which increases the risk of fire (Chuvieco E., Congalton RG, 1989), so there is a significant correlation between the incidence of fire and density of the network of forest roads (Arienti CM, et al, 2009).

10.1. Regulations in the field of firefighting and fire protection in the Republic of Srpska

- Law on Protection and Rescue in Emergencies of Republic of Srpska
- ("Official Gazette of Republic of Srpska" number: 121/12);
- Republic of Srpska Fire Protection Act ("Official Gazette of the Republic of Srpska" 71/12);
- Law on Forests of Republic of Srpska ("Official Gazette of Republic of Srpska" 66/03, 75/08, 30/10));
- Law on Forests of the Brčko District of B&H ("Official Gazette of Brčko District BiH" No. 14/10)
- Rulebook on the content and procedure for the development of a forest fire protection plan (Official Gazette of Republic of Srpska, No. 107/09)

Forest fire defense represents a specific issue of the forestry economy. Forest resources, an ever more intense development of the economy and society, are gaining increasing value, and their vulnerability and fire defense conditions are becoming more and more complicated. Special attention is paid to the preventive protection of forests from the fire, education of the local population and others who work and reside in the forest, the selection of trees, biological types of forests, the schedule of forests, etc. However, particular efforts must be directed towards systematic work with the population, and to improve forest control and fire protection of the territory of the forestry unit.

In order to prevent and eliminate the risk of fire and rescue of people and material goods endangered by fire, the possibility of occurrence of a wide-range fire of endangering human lives and material property as a danger of permanent environmental damage affects that certain procedures and activities are to be properly selected and directed, in order to first and foremost, preventive action of the risk of forest fires is minimized, and when a fire occurs, prepare an adequate response to the occurrence of the event and reduce the harmful consequences of the resulting fire. Forest fire involves burning trees, forest rugs, forest dead material, grass, leaves, humus, trestle, tree roots, as well as other fuel matrix located in the forest.

Social - political communities, companies, as well as citizens organize and provide protection from fire, and participate in its implementation. Fire protection includes a set of measures and actions of administrative, organizational, technical, and educational and propaganda nature undertaken with the aim of preventing, spreading and spreading fire of its detection and extinguishing, and rescue of people and material goods endangered by fire. Fire protection is an activity of special social interest. Every forest farm within PFE “Sume

Republike Srpske" has a special fire protection plan. The fire protection plan includes measures and activities undertaken with the aim of preventing the outbreaks and spreading of the fire, its detection and firefighting, and the rescue of people and material goods endangered by fire, as well as the obligations and tasks of the Company's authorities in this regard. Fire protection plan covers:

- Assessment of the degree of threat to forest
- Preventive forest-breeding measures
- Organizational, material and personnel requirements for the implementation of the plan
- Necessary activities based on the assessment of the degree of forest vulnerability
- Plan of informative-propaganda activities
- Training plan for staff

By the principles of the FSC-standard, i.e. the Forest Protection Guide, the high protection value is defined as the "Forests that provide fire protection". By the principle it is emphasized that these are forests that can represent a natural obstacle to the spread of fire. This usually involves the natural occurrence of leafs in softwood forests that are very sensitive to the occurrence of fire. It is further noted that this area is not generally at high risk of fire, but this also does not mean that they are not frequent, in addition, the process of global warming is under way, which in particular increases the risk of fire.

Although there are no materials strictly separated for this purpose, the principle of protection and the concept is known in practice and has been applied for many years. It is of great importance to bring in conifers in unconnected smaller areas that will be crushed by autochthonous deciduous vegetation. Also, the VZV-4a principle defines forests that are important for water supply. In such stands, besides other protective functions they perform, there are also sources of drinking water, which are also used for water supply in the event of firefighting. It is very important to indicate these sources on the map and in practice apply the protection prescribed by FSC principles

The area managed by the Trebinje Management Center is extremely specific and as such has a special management method. In the area of Trebinje, Ljubinje, Bileća and Berkovići, the area of forests and forest land is relatively large and amounts to 138,142 ha (forests owned by the Republic) and 35,152 ha (privately owned forests). Of the total forest area and forest land, the high forests occupy only about 3.5%, which is the reason why more attention is paid to their protection. The largest area is occupied by bushes and thickets, which occupy about 53% of the total area of the state forests. Thickets, although economically almost worthless ecologically, represent the true richness of karst. Every bush

in Herzegovina is extremely important in the purification of air, soil binding, and prevention of erosion and regulation of the water regime.

Global warming and an increase in average annual air temperatures cause more frequent outbreaks of fire. The fires in the past period, and especially those from 2003, 2007, 2012, 2017, have greatly reduced the green cover of the Herzegovina Karst. We are aware of the fact that we are losing ever larger areas under the forest by fire, which greatly affects the natural environment of this area.

Man is the most frequent forest user, and when it comes to forest fires, the biggest enemy of the forest; because it is most often cause of fires (more than 90% of forest fires are the result of human negligence). For such behavior, one should look for reasons in his low level of knowledge about the importance of forests, not just for the country's economy, but also for the life and survival of man, as well as how the forest should be protected and protected from fire.

10.2. Measures to combat forest fires

In the fight against fire we think on all preventive measures that are implemented in order to prevent the fire and all the activities that prepare the fire extinguishing. Finally, the work of extinguishing a fire is also included; starting from the time it was discovered.

Fire protection includes a set of measures and actions of administrative, organizational, technical, and educational and propaganda nature undertaken with the aim of preventing, starting and spreading of fire and its detection and extinguishing, and rescue of people and material goods endangered by fire. Fire protection is an activity of special social interest. The work on preventing forest fires is long-term. We must follow certain principles. We will never fail to prevent the occurrence of any forest fire. Theoretically, almost all fires can be prevented directly or indirectly by humans, and this makes 99% of all fires in our areas. The basic measures in preventing forest fires, therefore, should be directed to the education of people and to the legal provisions related to the fight against fire.

10.3. Analysis of forest fires in the Republic of Srpska

The public forestry company "Sume Republike Srpske" has received the FSC certificate for forest management, which means that forests and forest land are cultivated according to strict ecological, social and economic standards. The FSC certificate of the PFE "Sume Republike Srpske" was issued for a period of five years, which is subject to annual monitoring visits. The goal of this certification process was to promote ecologically responsible and socially beneficial standards for sustainable forest management.

Every forest management unit within the Public Enterprise "Sume Republike Srpske" has a special fire protection plan. The fire protection plan includes measures and activities undertaken with the aim of preventing the outbreaks and spreading of the fire, its detection and firefighting, and the rescue of people and material goods endangered by fire, as well as the obligations and tasks of the Company's authorities in this regard. The forest assortments are categorized by the Public Forest Company "Sume Republike Srpske" by the degree of fire danger, with particularly endangered areas under coniferous forests of pines, fir and spruce. Climate changes results in significantly longer and more intensive dry periods with increased and high fire risk index.

In Republic of Srpska as well as in B&H, the fire hazard index is not calculated or reported as exact warnings tables, unlike neighboring countries, Serbia and Croatia. It is particularly unfavorable when the fire develops in areas mapped and identified as high-risk areas, coupled with long-lasting drought and stronger winds, which in these circumstances is another danger, which multiplies the existing risk manually. PFE "Sume Republike Srpske" is concerned with the protection of forests, including the protection of forests from fire. The company develops annual plans in accordance with the Instruction and methodology for the development of protection plans in the Public Company. In forest management, in the part of the needs of exploitation and protection, new ones are being developed and existing firefighting routes and cutting areas are maintained. Forest labeling is carried out according to the degree of vulnerability, mapping by degree of vulnerability, water intakes, roads, warehouses of firefighting equipment and other elements.

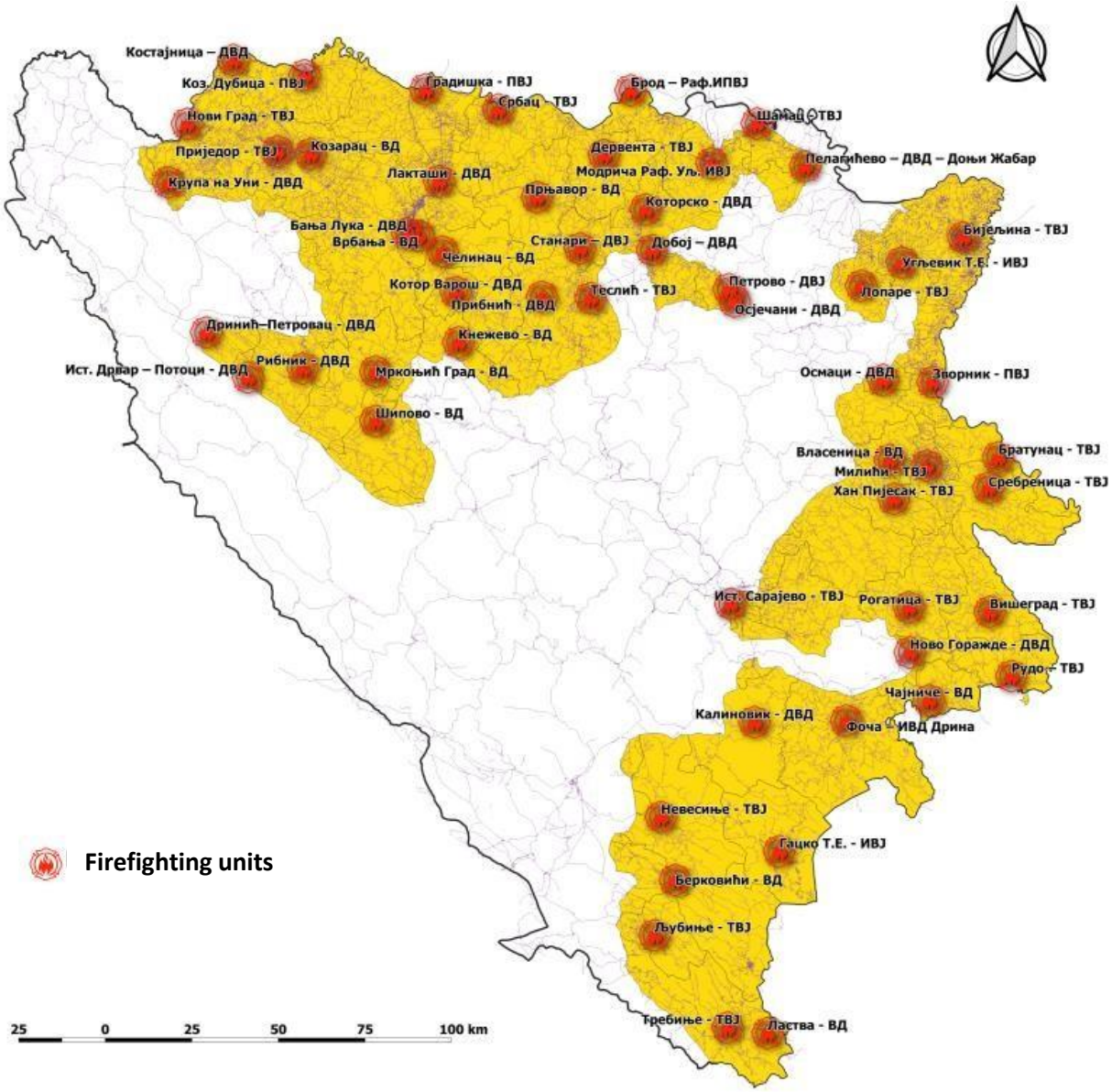
10.4. Situation in the field of firefighting activities

All fire brigade units in the Republic of Srpska are professionally and well trained in firefighting, especially those units that regularly have more fire in their area, as well as other interventions. In the case of large-scale fire, in most cases, firefighting units would not be able to adequately respond with available human and material resources, so they would be forced to seek help.

Vehicles in most firefighting units (in more than 70% of cases) are over 20 years old and even 30 years old. In addition to age, in most firefighting units there is a problem with insufficient number of fire vehicles. In the last 7 years, fire brigade units Banja Luka, Bijeljina, Istočno Sarajevo, Gradiška, Prijedor and Doboj have purchased from one to three vehicles and other firefighting equipment, which significantly contributed to the higher efficiency of firefighting units in firefighting and other interventions.

Most of the firefighting units are not sufficiently equipped or trained to protect and rescue in case of floods as well as for technical interventions. A number of local communities have

no established professional fire brigade units or voluntary fire brigades, and a number of fire brigades have no minimum number of firefighters prescribed by the Fire Protection Act. Most municipalities do not have a fire safety plan.



Picture 16 Fire brigade units in Republic of Srpska

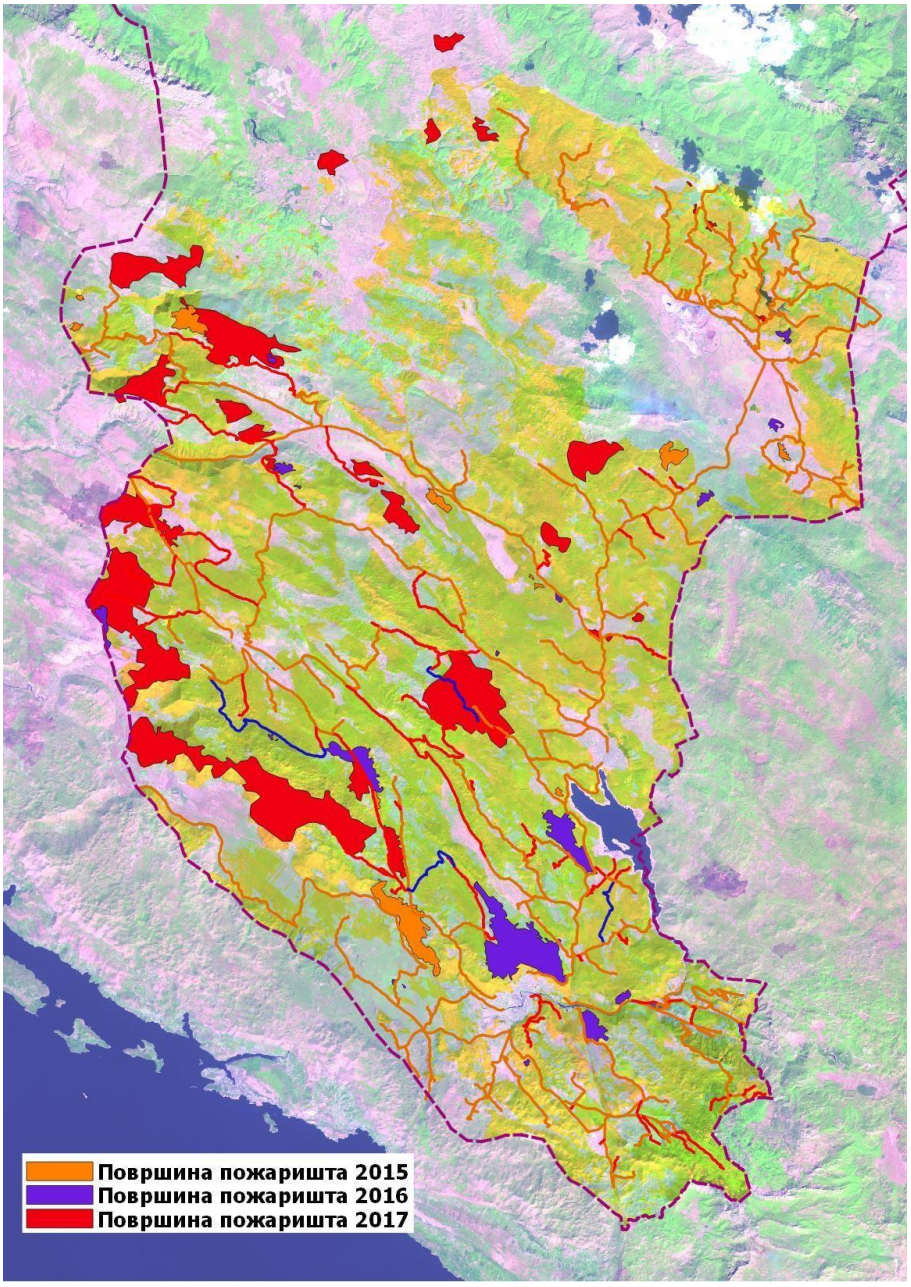
Members of the Fire Brigade of Republic of Srpska

1	Banja Luka – PTVJ	8	Čelinac – VD	15	Gacko – TPVJ
2	Banja Luka – DVD	9	Derventa - TVJ	16	Gacko T.E. – IVJ
3	Berkovići – VD	10	Doboj - TVJ	17	Gradiška – PVJ
4	Bijeljina – TVJ	11	Doboj - DVD	18	Han Pijesak – TVJ
5	Bileća – TVJ	12	Drinić–Petrovac – DVD	19	Kalinovik – DVD
6	Bratunac – TVJ	13	Brod – TVJ	20	Kneževo – VD
7	Čajniče - VD	14	Brod – Raf. Ulja -IPVJ	21	Kotor Varoš – DVD

22	Kotorsko – DVD	39	Novo Goražde – DVD	57	Foča – IVD Drina
23	Kozarac – VD	40	Osmaci – DVD	58	Šamac – TVJ
24	Kostajnica – DVD	41	Oštra Luka – DVD	59	Šipovo – VD
25	Koz. Dubica – PVJ	42	Osječani – DVD	60	Teslić – TVJ
26	Krupa na Uni – DVD	43	Petrovo – DVJ	61	Trebinje – TVJ
27	Laktaši – DVD	44	Prijedor – TVJ	62	Ugljevik – TVJ
28	Lastva – VD	45	Prnjavor – TVJ	63	Ugljevik T.E. – IVJ
29	Lopare – TVJ	46	Prnjavor - VD	64	Višegrad – TVJ
30	Ljubinje – TVJ	47	Pribnić – DVD	65	Vlasenica – VD/TVJ
31	Milići – TVJ	48	Pelagićevo – DVD –	66	Vrbanja – VD
32	Modriča – TVJ	49	Donji Žabar	67	Zvornik - PVJ
33	Modriča Raf. Ulj. – IVJ	50	Ribnik – DVD	68	Jezero – VD
34	Mrkonjić Grad – VD	51	Rogatica – TVJ	69	Stanari – TVJ
35	Nevesinje – TVJ	52	Rudo – DVD		
36	Ist. Sarajevo – TVJ	53	Srbac – TVJ		
37	Ist. Drvar – Potoci –	54	Srebrenica – TVJ		
DVD		55	Foča – VD		
38	Novi Grad - TVJ	56	Foča – TVJ		

10.4.1. Analysis of statistical data on fires

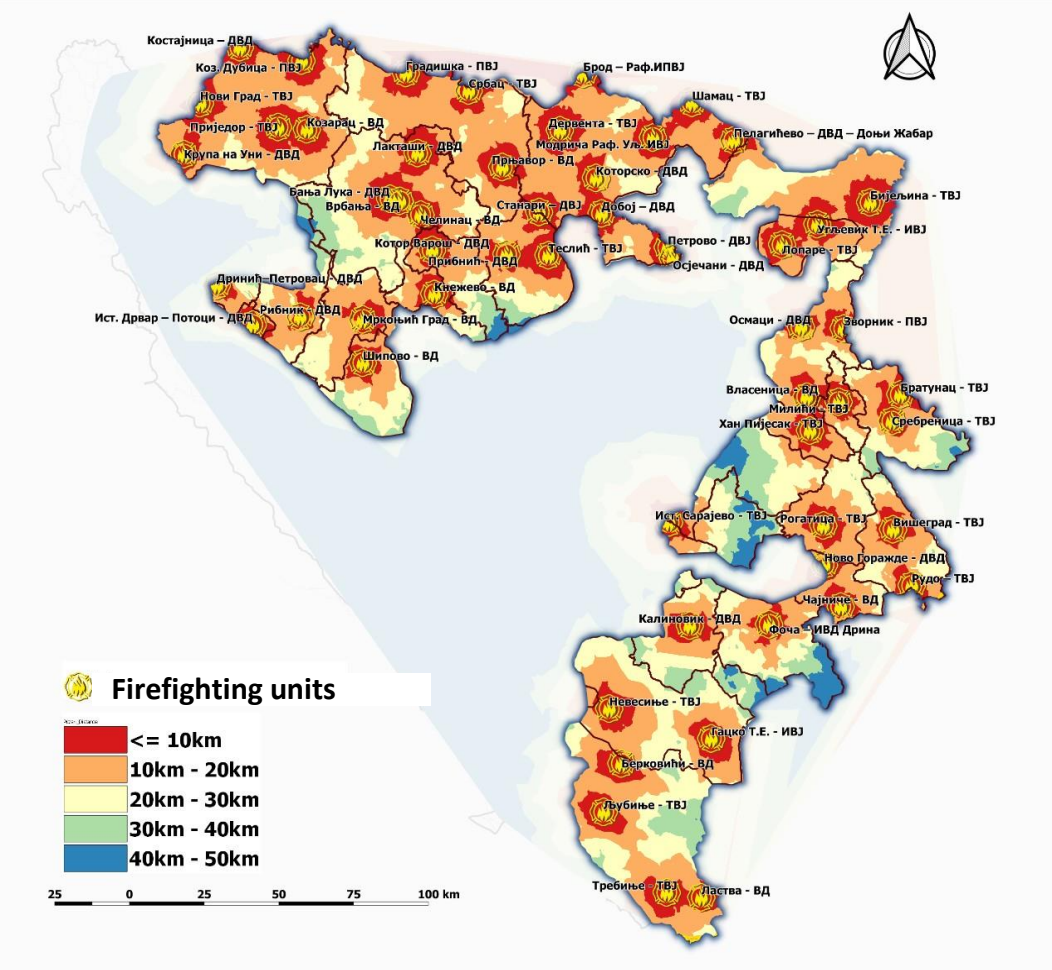
It should be emphasized that statistical data on fires and the scorched surface are not conducted in detail, so it is practically impossible to make a quality analysis based on the data submitted. For example, data from the Republic of Srpska, which are the most systematic, with precise data on the number of fires and wider locations of the fire, however, they exist only in the last few years and the locations are not precisely determined except for the area of the Trebinje Center for Karst Management for the years 2015, 2016, 2017.



Picture 17 Spatial representation of registered fires by age in Trebinje Center for Karst Management (S. Dražić, 2017)

10.4.2. Response time to the occurrence of fire

The response time to the fire, which is the sum of all individual times related to the activities involved in the time budget of the arrival of fire extinguishing agents to the spot and the discharge of water.



Picture 18 The coverage of the space and the reaction time of the Republic Srpska fire brigade units (S. Dražić, 2018)

According to the data of the "Republic of Srpska Fire Brigade" in the Republic of Srpska, there are 69 fire stations that are organized into professional and voluntary units.

10.4.3. Criteria for assessing the threat of forest fire

The criteria for estimating the threat of forest fire were made in accordance with the following parameters:

1. vegetation,
2. anthropogenic factor,
3. climate,
4. habitat (parent substrate and type of land),
5. orography and
6. Forest line and arrangement of assortments.

Table 9 . Scoring of threats to forest surfaces from fire

Degree of threat		Number of points
I	very large	> 480
II	large	381-480
III	moderate	281-380
IV	small	150-280
V	very small	<150

Table 10 Table of threats to forest fires by FMA

FMA	Degree of threat
CFKM	large
FMA Nevesinjskogatačko	large
FMA Ribničko	moderate / large
FMA Srednjevrbasko	moderate / large
FMA Romanijsko	moderate / large
FMA Dobojskoderventsko	moderate
FMA Mrkonjićko	moderate
FMA Petrovačko	moderate
FMA Hanpjesačko	moderate
FMA Višegradsko	small / moderate
FMA Vlaseničko	small / moderate
FMA Gornjedrinsko	small / moderate
FMA Donjedrinsko	small / moderate
FMA Jahorinsko	small / moderate
FMA Kalinovičko	small / moderate
FMA Milićko	small / moderate
FMA Rogatičko	small / moderate
FMA Čajničko	small / moderate
FMA Trnovsko	small / moderate
FMA Donjevrbasko	small
FMA Istočnodrvarsko	small
FMA Kotorvaroško	small
FMA Majevičko	small
FMA Posavsko	small
FMA Usorskoukrinsko	small
FMA Čemerničko	small
FMA Kozaračko	very small / small

11. Guidelines for building, reconstructing rehabilitation and maintenance of the network of forest roads

These guidelines aim to provide a clear picture of the type and stages of work during the construction, reconstruction, rehabilitation and maintenance of roads. Structural elements of forest roads, the most frequent damages of these instructions, and the way of construction, reconstruction and tuning of the forest roads network are shown.

11.1. Maintenance of forest roads

Maintenance of forest roads is a series of construction and technical actions that need to be done from time to time in order to maintain the road in a technically-planned state. The main forest roads need to be maintained continuously, while the work on the secondary and intersecting roads is carried out occasionally according to traffic needs. Maintenance of forest roads in good and proper condition represents a very important sector of forest business activity, since the state of the forest paths depends to a large extent on the success of the entire organization of forest production and the economy of operations, primarily in relation to the costs of forest transport.

The maintenance and protection of forest roads are carried out on the basis of the Annual Road Maintenance and Protection Plan, which is an integral part of the Annual Production and Financial Plan. The annual plans for regular and winter maintenance and protection of forest truck roads determine the road directions that will be maintained and their priorities, type, scope and estimated value of the works that will be carried out individually for each planned route, as well as the road directions that will be temporarily preserved (protection against surface water damage) and not being used.

The type, scope and value of works on the maintenance and protection of forest truck roads is planned on the basis of the compiled case and the projection of these works individually for each planned route. Works on the maintenance and protection of forest truck roads determined in the Annual Plan shall be allocated for the performance of the enterprises registered for the execution of those works. The maintenance of forest trucks (macadam and asphalt) roads includes works that ensure unhindered and safe traffic for the purpose of forest management and the needs of the local population.

Within the framework of maintenance of forest truck roads they differ:

- works on maintenance of the lower and
- works on maintenance of the upper road bed.

Maintenance work on the lower road bed includes:

- Repair on the earth's hull of the road:
  - repair of the landslide,
  - escarpment
  - and other damage
- objects that are part of the lower road bed,
  - repair of supporting and coating walls,
  - cleaning of surface water drainage facilities (channels, flaws and crossings),
  - strengthening and replacing worn-out gaps and bridges,
  - renovation of supporting and coating walls.

Considering that the Public Forest Enterprise "Sume Republike Srpske" does not have any data on the average values of maintaining one kilometer of the road, we used the "Price List of Works on the Maintenance of Forest Truck Roads" of the PFE Sume Republike Srpske. In a conversation with employees from the Public Safety Corps who are in contact with this issue, we have learned that the maintenance of forest truck roads in the Republic of Srpska is carried out periodically, i.e. in the area where the exploitation of forests is carried out. During the exploitation of the forest there is a stronger and more intensive decay of the roads, and as such they are running for maintenance. In the period of 10 years, the duration of the operating period, all the above roads will be maintained at least once and some even a few times. The assessment of road damage is carried out by persons on the ground, mostly unprofessional for such type of assessment, so these prices are very unreliable.

11.1.1. Damage to road construction

Road damages are deformations and malfunctions that prevent normal use of the road, with reduced safety or driving comfort. The causes of damage and collapse of pavement structures are different:

- instability of the soil and the lower road bed,
- shortcomings in the design of roadway construction,
- insufficient quality of materials and shortcomings in construction,
- insufficient and untimely maintenance and
- system and composition of road construction.

The irregular, not timely, incomplete, and sometimes improper maintenance of the carriageway, the lower road bed and the accompanying facilities, as well as the untimely implementation of preventive measures, along with the repair of the resulting damage and the measures for reinforcing the roadway construction, are the frequent causes of its decay. Damages of the lower and upper road bed are indicated in the framework of the processed maintenance of the lower and upper road bed.

For the repair of damaged parts of gravel, road metal, macadam or earthen pavements, there is a gravel, stone snail, pebbles and stone rubbish.

The pebbles for repair and reinforcement of pebbles or gravel pavements must comply with the technical regulations and standards for making the tampon coating in the pavement construction.

Stone crumbs for the maintenance of macadam and earthen pavements must contain stone material of different grain sizes with maximum grain size up to 60 mm and clay up to 5%.

For the maintenance of gravel or road crumb pavements, there is a permanent existence of stocks of stone material in the amount of at least 10% of the total annual amount envisaged for the maintenance of this road route.

11.1.2. The most common road maintenance works

Annual maintenance usually includes:

• Control of the state of forest roads: it is mostly done at the end of winter, after storm or abundant precipitation;

• cleaning of drainage systems;

• the design of the roadway profile is successive where the crown profile is not in the function of drainage / drainage;

• hole control;

• cleaning the path from the vegetation;

• maintenance of road objects (walls, bridges);

• Monitoring weathercast (if needed).

Some of this can be done manually (filling holes or cleaning vegetation), but work is generally done using machinery.

When the pavements cannot be maintained every year, or when the upper layer of the road disappears or is significantly damaged (many holes, large erosions, etc.), the upper layer must be reconstructed with new material / gravel. This reconstruction (periodic maintenance) has several phases:

- Removing residue from cutting, stones and other obstacles from the pavement
- attaching the upper layer with a riper (a riper can be a grader or tractor attachment);
- laying of gravel to a thickness of 6-10 cm, after the compression phase;
- distribution of materials by trucks or graders (preferably the latter);
- shaping the profile of the pavement and the channel line;

• compression of the profile.

Reconstruction of the road can be done at once or successively. If properly maintained after reconstruction, the reconstructed carriageway can be in good condition for 5-10 years.

This depends mainly on the line of maintenance, traffic, conditions and precipitation. During periodic maintenance, all structures and drainage / drainage systems must be controlled and, if necessary, repaired or replaced. (JURIJ BEGUŠ; EWALD PERTLIK FAO 2017)

11.1.2.1. Bumps

The holes appear on forest roads with longitudinal slope of 0-3%, which makes them very often on the flat parts of unrelated pathways. The holes are caused by increasing pressure in the pores of the water on the pavement, especially on impermeable formations, which results in the removal of fine material from the roadway (Ryan et al., 2004)



Picture 19 Road bumps

11.1.2.2. Erosion of the roadway due to the water drainage

Erosion of roadways is mainly a consequence of damage to the drainage system of the forest path (or the absence of the drainage system), and causes the erosion of the channel in the upper layer of the roadway, which sometimes leads to serious damage to the road. Solutions include repair of drainage system, construction of gravel embankment, handling and compaction.



Picture 20 Erosion of the carriageway due to water leakage

11.2. Reconstruction and construction of forest roads

By the Rulebook on the Construction, Reconstruction, Maintenance and Protection of Forest Truck Roads of the PFE "Sume Republike Srpske" no. 02-8010 / 16 of 24/11/2016, in Article 6 under the reconstruction of forest truck roads means that change the basic characteristics of the existing road in order to increase the capacity of the road or level of services (work on increasing the load capacity of the carriageway including the works on increasing the load capacity bridges and gaps, roadway extensions, construction of new supporting and coating walls, increase of curvature radius, asphalting and similar operations). Reconstruction, in full width and length, renews the pavement (as a rule in its entirety) and the banks, most often along the existing route, including the drainage system and the change of the geometric elements of the road, that is, the axle, the level and the transverse road profile.

According to the data from the field, the roads that are damaged and their damages exceed 5% of the value of one kilometer of the newly built road should be planned for reconstruction. Based on that, the roads are proposed for reconstruction, because this value exceeds the maintenance value. Serious damages in terms of displacement of the route, the roads and damages caused by the activity of torrential watercourses are not stated to exist.



Picture 21 Extreme damage on forest roads (Forest road "Tisovica" Š.G. Banja Luka, 2015.) (photo: S. Dražić)

11.2.1. Procedures required for the construction and reconstruction of forest roads

The construction and reconstruction of the forest truck roads is carried out on the basis of the Annual Investment Plan, which follows the opening program and the construction plan envisaged by the Forest Economic Basis as a long-term forest management plan.

The plan for the construction and reconstruction of the forest truck roads includes: the scope of construction and reconstruction according to the names of the routes, the departments that opens the road or for the reconstruction of existing roads, with the basic data (timber stock, volume of cutting and other data), the reasons for the construction and reconstruction, the dynamics of works, the way of financing and other necessary planning data.

The plan for the construction and reconstruction of the forest truck roads must be completed at least a year earlier than planned timber harvesting and export of forest timber from the planned divisions.

Prior to the construction and reconstruction of the forest truck roads, the following activities should be carried out:

- resolving property-legal relations on the provided road route if there is a need for this,

- decision making of the management bodies on the construction or reconstruction of the planned projected road,

- submitting a request for the preparation of a study on Urban-technical conditions,

- submitting a request to the local self-government unit or to the Ministry for the issuance of location conditions,

- decision of the preparation of the main (implementation) project,

- performing field design and development of the main (implementation) project in accordance with the Ordinance on the development of projects for forest communications ("Official Gazette of the Republic of Srpska" No. 60/09),

- performing a project audit,

- after the development of Urban-technical conditions, location conditions and development of the main project, submission of a request to the local self-government unit for approval for construction

- construction permit,

- project is performed by a registered legal entity that owns the License on fulfillment of the conditions for the preparation of technical documentation, the phase of construction

for the forest truck roads issued by the Ministry of Physical Planning, Construction and Ecology,

- Call for bids for the selection of the most favorable contractor,

- concluding a contract for the execution of works on the construction of a forest truck road between the investor and the contractor,

- appointment of a supervisory body that will monitor the execution of works and verify the diaries, the building book and be in contact with the investor and the contractor, to make a temporary and final situation and the final report.

Prior to the introduction of construction machinery in the reconstruction of a forest truck, the following activities should be carried out on the preparation of the route:

- renewal of the projected route if there is a need for the team, or if the pickets were damaged by the axis of the route and the corners of the turning angles.
- execution of cutting of forest in the belt of the planned forest truck road in a width that depends on the transverse inclination of the terrain through which the route passes and the removal of wood assortments and other waste materials outside the hull.
- the introduction of the selected contractor into the work by the supervisory authority with the presence of representatives of the investor and the contractor, while keeping the Minutes of the execution of the contractor in the work.

Construction and reconstruction of forest truck roads can be done by the company, or other legal person registered for carrying out these works.

Works on the construction and reconstruction of the road are grouped according to the course of construction in the following groups: preparatory works, bottom road bed, upper road bed, objects and equipment on the road.

11.3. Special technical conditions

11.3.1. Geodetic works

Geodetic works include:

- the marking of the route and other objects,
- all measurements related to the transfer of data from project documentation to nature or from nature in the appropriate technical documentation,
- Maintenance of marked labels on the field for the entire period from the beginning of works to the handover of all works to the customer.

Geodetic works include also the acquisition and maintenance of all basic geodetic bases and plans and contours on the field which the contracting authority hands over to the

contractor at the beginning of the works. The contractor of geodetic works should inform the supervising engineer about all works and allow him to cooperate in them.

The scope of geodetic works should satisfy in everything the needs of construction, control of works, turn-around and other things that make the conditions for the realization of jobs. Geodetic works include the production of technical documentation of the finally populated and built road and/or object. The technical documentation should be prepared before the technical inspection of the constructed road and/or facility.

11.3.1.1. Mode of performance

The contracting authority shall require the contractor to submit:

- on the ground, the trace of the road, the regulation and/or the marked object with all the necessary written data. However, the marked axis of the road, regulation and/or object at intervals that determine the characteristics of the terrain in no more than 25 m. As a rule, the attachments are surrounded by markings for braking or acceleration or sidewalks, that is, along the edge of the connection itself

- in the field marked polygon points. The polygon trail should be tied to the trigonometric points, calculated according to Gauss-Krüger, with allowed deviations according to the rules for the 1st order polygon network

- in the area of a certain height point (reaper) - the route plan containing the following annexes

- situation a 1: 1000 scale with axis marked, mileage and guiding the elements of the route; in the situation are shown drawings of the main points of connection to the polygon with the necessary data for skidding

- calculation of the main points, i.e. in the electronic calculation of the coordinates of the main points with the stationing

- list of polygon points with coordinates and topography of these points - list of benchmarks with altitudes and topography of rapper.

For less important supporting objects such as deviations of less important roads, regulations, and the like, other measurement procedures can be used, adapted to the type of facility and terrain so that the contractor will be able to carry out these works without interruption. At the end of the work on the placental plan, the contractor should restore the axis (situation and height) on the basis of a sketch from the polygon points. The correctness of the restored axle is checked by the supervising engineer. The axle must be restored before the installation of the carriageway coating.

11.3.1.2. Performance quality

The accuracy of the measurements should be in accordance with the geodetic standards for the appropriate types of measurements and in accordance with the required quality of the individual works according to the special technical conditions.

In the event that the supervising engineer determines that the measurements do not guarantee the performance of the works according to the project documentation, it may stop the work on the measurements. At that time, the contractor should take measures for more precise measurements, or the measurements required by the supervising engineer.

11.3.2. Cleaning the terrain

Cleaning the terrain includes:

- removal of shrubs, trees, branches and stumps
- removal of traffic signals and equipment
- demolition and removal of pavement structures - demolition and removal of objects.

11.3.2.1. Removal of shrubs, trees, branches and stumps

This job includes:

- cutting and removing shrubs and trees
- removal of branches from previously cut trees
- removal of stubble of old and newly felled trees
- cleaning or excavating areas that include cutting and removal of shrubs, trees and branches, excavation of stumps and roots, excavation of hives from humus, removal of organic material that has remained after the removal of shrubs, trees, branches and hives and removal of everything to certain landfills outside the route .

Areas that need to be cleaned and / or excavated should be shown in the plans or be determined by the supervising engineer before the commencement of work.

11.3.3. Earthwork and foundation

Excavations include:

- surface digging of fertile soil (humus) of appropriate thickness (up to a depth of 40 cm) with pushing up to 50 m or loading for disposal to landfills,

- all wide-scale excavations of all categories of earthen materials and rocks, which are planned according to the plan, together with pushing up to 50 m or for the removal of excavated material into embankments, pits, wedges and/or landfills, as material will be used during the execution of works. These works include all excavations for stairs, for cuttings, in borrowings and similar works, and on deviations of roads and regulation of water courses, and all the wide excavations in the construction of buildings,

- all excavations for the foundations of structures, canal and other trenches (for omissions, shafts, drainage) in all categories of materials and all depths,

- width up to 1, 0 m,

- widths exceeding 1,0 to 2,0 m. This job also includes

- all that is necessary for raising the excavated material to the required height,

- all construction site excavations for facilities, which are more than 2.0 m wide, in all material categories and at all depths, with the removal of surplus material to landfills or to installations in embankments, wedges or wedges. This job also involves raising surplus material to the required height,

- all excavations for melioration and regulation channels and similar works in all material categories, which are of various depths and widths. These include deepening and extending existing channels,

- all excavations for the drainage channels and water flows alongside the roadway, the finished plane or the existing road, with the discarding of the excavated material and / or loading and removal to the landfill,

- all excavations for cobbles and coatings on surfaces, where they are planned according to the plan, with the discarding of material and / or loading and removal to landfills and arrangement of the plan.

These works include:

- all necessary measures, which are prescribed and determined by applicable occupational safety regulations, such as support (including plan, or static calculation), slopes, extensions, etc.,
- all works for drainage of precipitation, spring and ground water during construction, in order to ensure continuous and controlled separation and prevention of water retention and wetting of abutting materials. These works also include all additional works due to the redirection of surface, ie water source flows,
- all excavations, loading and unloading of inadequate or excess material on landfills outside the facility. Surfaces outside the route (building) and arrangement (drawing, grassing, and drainage) should be provided by the contractor.

All works under this item should be included in the unit price of the material and the contractor is not entitled to any extra charge.

11.3.3.1. Quality

Prior to commencement of operation and during operation, all material quality changes should be taken of suitable samples for testing the usability of materials for the intended purpose. The contractor must obtain expert opinion regarding the usability of the material from any significant excavation or location where it would be possible to obtain local material for the mixture of stone grains for unbound and / or bonded layers of roads that are wearing. If the use of excavated material is planned for this purpose, the clay mud must be removed before blasting and used for embankments or postponed to the appropriate place proposed by the contractor, and accepted by the supervising engineer.

11.3.4. Covering of the road bed

The arrangement of the road bed plan includes:

- Preparation of the bed of the road for embankments, floods, after a surface excavation of fertile ground or a wide excavation in earthen material or rock, which includes - rough planning and
- compaction of the surface layers of the bed of the road,
- in the case of enhancement, fixation and/or stabilization with binders and
- maintenance of the plan of the road to the upgrade.

The covering of natural, enhanced, fortified or stabilized road beds can be arranged in earthen materials and rocks, which do not contain materials, which in time due to biochemical processes will change their mechanical and physical properties to such an extent that would adversely affect the stability of the carcass of the road. Earth materials and rocks in the bed of the road should allow such compaction of the bed of the road, so that it will also be able to take over all the loads planned with the project documentation.

11.3.5. Embankments, dikes, wedges, and road bed

Work includes:

- machining of materials for embankments,
- mechanical and/or manual disinfection of materials in foundation silt, duct trench, construction pit, channel reclamation, regulation and drainage channels,
- mechanical and/or manual dismantling of material in wedges for objects or at crossings from excavations to embankments,

- mechanical and/or manual dismantling of bedding material, all in accordance with the requirements in the project documentation and / or supervisory engineer and in accordance with these technical conditions,
- wetting, mixing, rough planning and compaction of materials in dikes, fillings and pins in the measures and quality, specified in the project documentation and with these technical conditions,
- mechanical dismantling of the material for the previous load and the previous loading in the places where it is planned in the design documentation and in accordance with these technical conditions,
- making a bed in the measures and quality specified in the project documentation and technical conditions,
- arrangement of the planes of the upper layers of embankments, piles, pins and as specified in the design documentation and in accordance with these technical conditions.

11.3.5.1. Basic materials

For embankments, the filling-in, the wedges and the placenta in accordance with the design documentation can use a proper coherent and incoherent earthen materials, soft and hard rock, electrified ash from power plants and heating plants and corresponding secondary raw materials (slag, recycled building materials)..

In backfilling, wedges and placenta cannot be installed fertile or poor load-bearing soil and other materials, which could over time due to the biochemical processes, change their mechanical and physical properties. Materials for embankments, the filling-in, the wedges and the placenta can be obtained with the excavation in the alignment and / or to borrow.

11.3.6. Bends and green surfaces

The work includes decoration and erosion protection of surfaces of natural slopes, burial and embankments and green areas with

- humus and sowing grass,
- planting ornamental trees and shrubs,
- networks,
- stone embankment,
- rolling,

- prefabricated elements (granules, hollow elements of cement concrete, straw plates and similar elements).

This work is included

- all materials, including loading, transport and unloading,
- preparing the substrate,
- planting and planting,
- embedding and twisting of materials.

The execution of these works is conditioned by the use of appropriate materials for various methods of arrangement and protection of slopes and green surfaces. For the vegetation protection of slopes and green areas, the following materials are used:

- humus,
- straw and shade for bedding,
- wickers, seedlings,
- trees and shrubs and
- Grass seeds.

Other protection of slopes is possible

- knitted net,
- stone burst,
- rolling with stone, - by turning and
- mounting elements.

11.4. Road construction

11.4.1. Supporting layers

Supporting layers are parts of pavement structures between the wearing layer and the placenta. The Supporting layers are unbound or bound with hydraulic or organic binders. Installation must be in the ratio specified in the project documentation and in accordance with these technical conditions.

11.4.2. Unbound supporting layers

The production of an unbound (mechanically compressed, buffer) layer (NNS) involves the procurement and installation of an appropriate mixture of fractions for the unbound bearing layer at the locations specified by the project documentation.

Work should be performed at a time when the air temperature is above 2 ° C and without precipitation. Unbound bearing layers (NNS) can be incorporated into pavement structures for all traffic load groups, usually between the placenta and the bound supporting layer.

11.4.2.1. Basic materials

Basic materials for NNS are mixtures of natural, crushed or mixed grains. Mixtures of natural grains contain fractions with rounded edges, which became during the natural decomposition of massive stone. Mixtures of crushed grains contain grains, which are formed by crushing rocks, artificial stone or rough natural grains.

The combined mixtures contain fractions of natural and crushed grains.

11.4.2.2. Stone aggregates

Mixtures of natural or crushed aggregates and mixtures of mixed aggregates constitute fractions of gravel or crushed stone, that is, gravel and small particles, sand and fillers, which ensures the composition of the aggregates.

The proportion of crushed stone grains in the mixture for the unbreakable carrier layer must be determined (according to EN 933-5) as part of the dimensioning of the pavement structure with regard to the distribution in EN 13242 (category $C_{90/3}$ or $C_{50/10}$).

11.4.2.3. Wearing layers

Represent a part of the wearing course of roadway structure above the substrate layers to the pavement surface.

Wearing layer are unbounded or bonded with organic or hydraulic binders. Installation must be carried out according to the conditions in the project documentation and in accordance with these technical conditions.

11.4.2.4. Unbreakable wearing layers

The production of an unbound (mechanically fixed, macadam) wear layer (NHS) includes the procurement and installation of an appropriate stone aggregate on an unbreakable wearing layer at the locations specified by the project documentation. These works should be carried out in conditions when there is no precipitation during the installation and when the air temperature is above 2°C. Unbreakable wearing layers (NHS) are typically installed only in pavement structures with very low traffic loads or for temporary detection of the running surface.

11.4.2.5. Basic materials

Basic materials for NHS are crushed or naturally crushed gravel aggregates, mixed aggregates and secondary raw materials. Fractions 0/22 mm, 0/32 mm and 0/45 mm are used as basic and fractions 0/8 mm for closing and fixing.

11.4.2.6. Material quality

Crushed or natural aggregates, mixed aggregates and secondary raw materials for the NHS must be assembled

- from the best skeletal (large grain) basis
- from the factions that serve for closing and fixing

The appropriate area of the particle composition of the aggregate for closing and fixing is determined by the boundary curves. For the closing and fixing, mixtures of crushed stone grains are used, while only in exceptional cases, mixtures of natural crushed grains can be used. For stone aggregates for filling and fixing, the sand equivalent must be at least 40%.

11.5. Drainage

In various projects for the drainage may be used similar materials. All materials considered have to be used in accordance with the requirements of the design document file and these technical requirements. The choice of materials and any change must be pre-approved supervision.

Materials, which are mostly used in the drainage system works, are:

- a mixture of stone grain for the substrate layer,

- a mixture of cement concrete on the substrate layer and the elements for drainage and - cement mortars

Mixtures of stone grains for underlying layers in drainage can consist of natural and/or crushed stone fractions.

- Cement concrete
- Mixtures of stone grains

Mixtures of stone grains for cement concrete mixtures for subsoil layers and for prefabricated drainage elements can be composed of natural and/or crushed fractions. In the case of a mixture of natural and crushed grains, then in cement concrete with a compressive strength of C 30/37 or a higher proportion of crushed grains, it must be at least 50 m-%.

11.5.1. Binders

For mixture of cement concrete brand C 30/37 and higher which are already in accordance with the EN 206-1 standard, may be used

- Portland cements and

- Portland cements with the addition of blast furnace slag.

To a mixture of cement concrete for the substrate layer may be used and the addition of Portland cement, tress. Type of cement should be determined depending on the quality of cement and cement concrete conditions of use, which must meet the requirements of the project documentation and these technical conditions. With the approval of the control, the contractor may use other hydraulic binders based on Portland cement, if appropriate with evidence demonstrates their usefulness.

11.5.2. Water

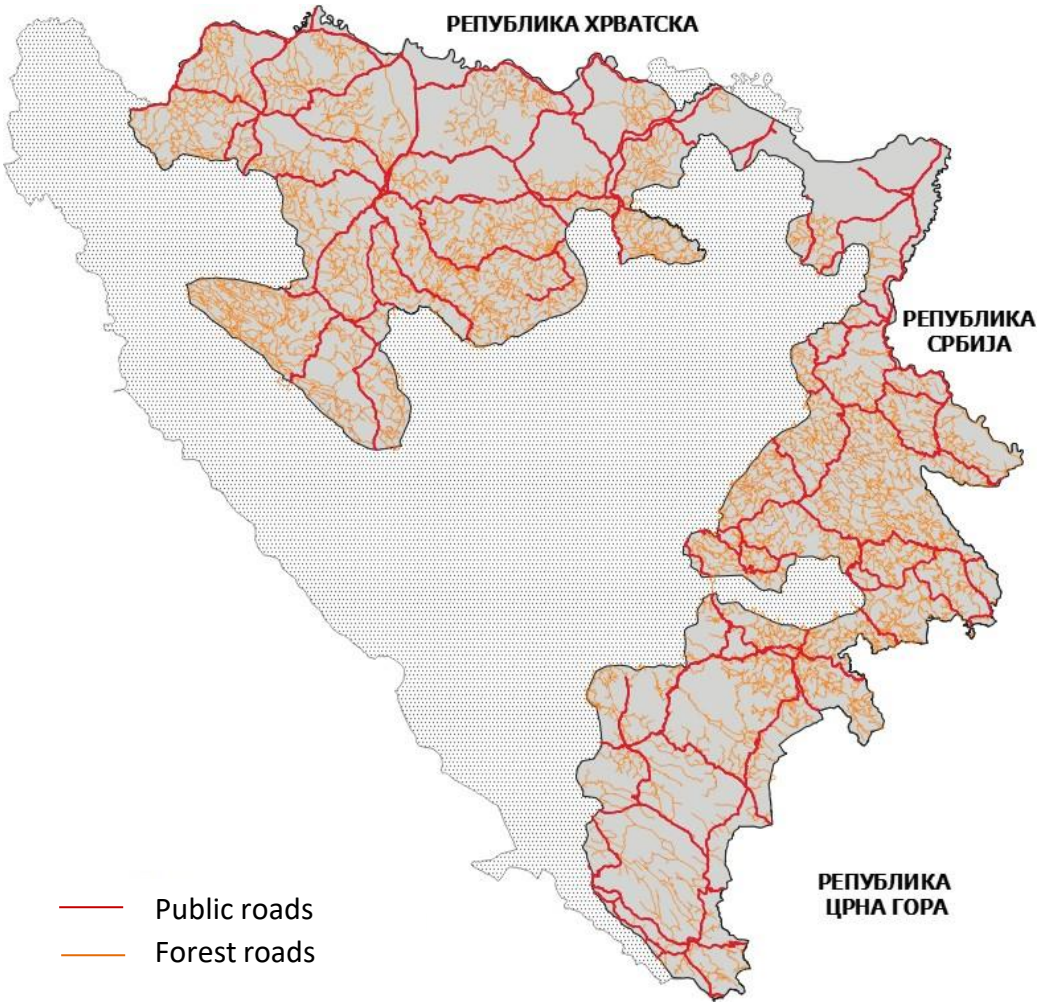
For the preparation of a mixture of cement concrete for drainage works, plain or processed water can be used, for which there is evidence to fit its intent. Drinking water can be used without any evidence for use in the preparation of cement concrete.

11.5.3. Chemical additives

Various chemical additives for plasticization, aerating and other changes in the properties of cement concrete can be used to improve certain properties of mixtures of fresh and / or hardened cement concrete. The use of add-ons must be approved by the supervisor. When using additives you must observe provisions of EN 206-1 and the manufacturer's instructions for chemical additives.

12. MODEL OF FOREST ROADS IN GEOGRAPHIC INFORMATION SYSTEM (GIS)

Geographic Information System (GIS) is a system for managing spatial data and properties associated with them. In the strict sense, it is a computer system capable of integrating, recording, editing, analyzing and displaying geographic information. The application of the geographic information system in the process of planning the opening of forest space in recent times is an indispensable tool that enables a more comprehensive analysis of all the factors important for the opening of forests. Currently are used the most known and most popular software's such as ArcGIS, QGIS, AutoCAD and other less-known GIS software.



Picture 22 Digitized roads in the Republic of Srpska

During the work on the project has collected a huge amount of data and performed extensive analysis. Each roadway has got its own unique number, length of road, road

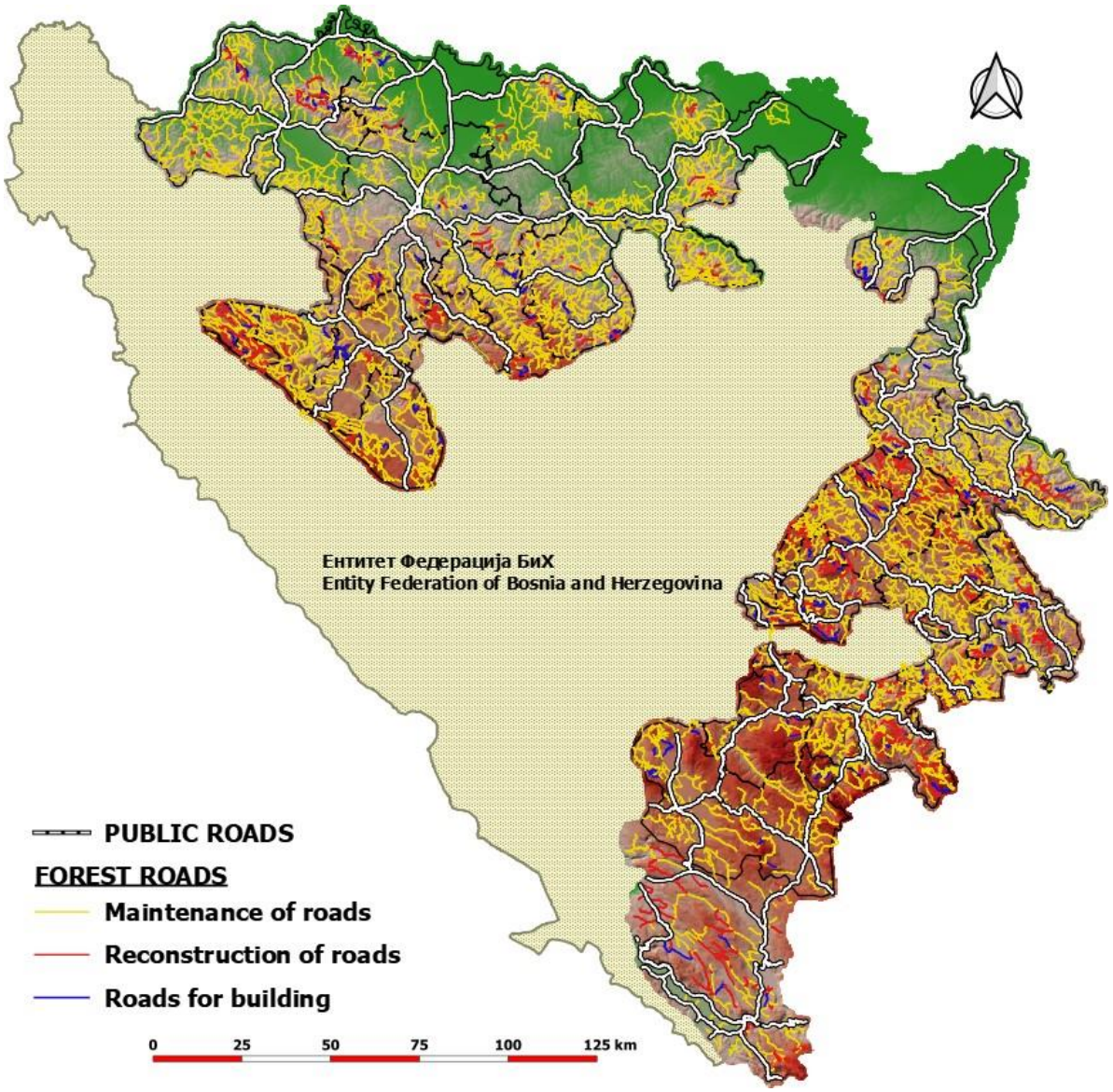
affiliations to FMA and MU. According to the category they are divided into categorized and uncategorized (highway, main road, regional, roads of lower order and the carriageway on the roadway with an asphalt surfacing. The roads have their own nodes (nodes) with a unique number, are used for analysis of isochrones as time distances, the shortest distance from FWA to processing facilities, fire units to the fire, etc. Each route is associated with the data requested by the project task and is related to the quantities of FWA that are available to each road. The data are collected from the following data: annual cutting volume, amount of biomass, increase, amount of FWA which attracts down the slope and along the slope and gravitates along this path, the cost of attracting FWA attractiveness and the average longitudinal slope of the existing road level as well as the average transverse inclination of the terrain through which the road is developing. Also, the age of the road, the condition of the road, the axle load, the maximum permissible speed of the vehicle, the type of pavement and the smallest horizontal and vertical curve are indicated. From raster data, data on digital terrain model, altitude classification, landslides, hydrology, geological bases are included.

Data on maintenance, reconstruction and road construction are included in the construction works. So we have shown the cost of collecting project documentation, permits and taxes needed to start reconstruction or road construction. The activity to be done is indicated for each route. Depending on the construction work required, data on the cost of maintenance, reconstruction or construction by stages of work, such as preparatory works, earthworks, pavement structures, roads, etc. are shown.

The GIS model also includes a large number of data relating to the area of forests and forest lands, as well as data on forest roads.

	SPP	PJ	PJ_naziv	ODJEL	KROZ	ODSJEK	OdsjekBr	GKL	UKAT	SKAT	MINIRANO	Kljuc	ha	m3_ha
1	02	01	Sapna - Lokanjska rijeka	040	0	a	01	1101	1100	1000	1	0201040001	13,15	155,38
2	02	01	Sapna - Lokanjska rijeka	024	0	a	01	1101	1100	1000	1	0201024001	7,85	143,46
3	02	01	Sapna - Lokanjska rijeka	023	0	b	02	1101	1100	1000		0201023002	1,05	174,67
4	02	01	Sapna - Lokanjska rijeka	036	0	a	01	1101	1100	1000		0201036001	4,27	122,40
5	02	01	Sapna - Lokanjska rijeka	173	0	00	00	1101	1100	1000	1	0201173000	18,63	199,11
6	02	01	Sapna - Lokanjska rijeka	192	0	a	01	1101	1100	1000		0201192001	3,30	268,20
7	02	01	Sapna - Lokanjska rijeka	191	0	00	00	1101	1100	1000		0201191000	4,64	130,64
8	02	01	Sapna - Lokanjska rijeka	192	0	b	02	1101	1100	1000		0201192002	2,43	232,29
9	02	01	Sapna - Lokanjska rijeka	196	0	a	01	1415	1400	1000		0201196001	5,88	227,81
10	02	01	Sapna - Lokanjska rijeka	154	0	a	01	1104	1100	1000		0201154001	11,63	113,63
11	02	01	Sapna - Lokanjska rijeka	196	0	b	02	1415	1400	1000		0201196002	5,44	176,89
12	02	01	Sapna - Lokanjska rijeka	187	0	b	02	1101	1100	1000		0201187002	3,61	247,83
13	02	01	Sapna - Lokanjska rijeka	187	0	c	03	1101	1100	1000		0201187003	2,21	112,21
14	02	01	Sapna - Lokanjska rijeka	197	0	00	00	1415	1400	1000		0201197000	9,07	100,82

UkupZaliha	Intenzitet	SjecaSveuk	Sortim_Pr	Sortim_m3_	ProsjCij	Vrijednost
2043,25	16,58	338,77	70,81	239,88	74,74	17928,63
1126,16	16,58	186,72	70,81	132,22	74,74	9882,12
183,40	16,58	30,41	70,81	21,53	74,74	1609,15
522,65	16,58	86,66	70,81	61,36	74,74	4586,05



Picture 23 Spatial overview of roads with a type of construction

13. FINANCING CONSTRUCTION

The Law on Forests of the Republic of Srpska (LoF) defined the way of financing long-term goals based on the principles of sustainable forest management established in the Forestry Program of the Republic, the Strategy for Forestry Development and Forest Management Plans (Fundamentals), which foresees financial resources for forest protection, policy and planning, management and management of forests, unification of forest cadastre and improvement of forests, as means of special purposes for forests.

Special funds for forests are managed by the Ministry, and through account of special purposes for forests that are in the system of the single account of the Treasury. Special purpose forests are used for the sustainable development of forestry in accordance with the Law.

The manner of calculation, procedure and deadlines for calculation and payment, the method of directing paid fees and funds of this law at the expense of special purposes for forests, shall be prescribed by the Government at the proposal of the Ministry.

Funds for special purposes for forests in accordance with LoF are provided from:

- remuneration for improving the commonly used forest functions,
- fees for the lease of forest land in the ownership of the Republic and compensation for the exclusion of land from forestry production,
- funds generated by the seizure and sale of unlawfully acquired benefits from the forest and the objects for which the illegal act has been committed,
- collected funds for the disembarked forest in the course of changing the purpose of forests and forest land,
- Budget of Republic of Srpska and
- other sources in accordance with the law.

The fees for the use of forests and forest lands owned by the Republic (funds for simple renewal) are separated from the realized total income of the users of forests and forest land in the ownership of the Republic, with the funds allocated cannot be less than 10% of the value of sold forest assortments determined at prices in the forest on the stump, according to the price list of forest users and forest land owned by the Republic.

The compensation is paid to a special account of forest users and forest land owned by the Republic of Srpska per month, and is used in the forest management area or forestry unit where they are realized.

Unused means for free renewal are used for extended forest reproduction.

These funds are used for the preparation of land for natural rejuvenation, afforestation, filling of newly developed forest cultures, care of forest crops and forest species, first cropping of forest crops, protection of forests from plant diseases, pests and fires, design, construction, reconstruction and maintenance of forest truck roads and for the development of forest management bases.

Control of payment and expenditure of funds is carried out by the Ministry. The user of the forest and forest land owned by the Republic is obliged to pay compensation for the development of the undeveloped parts of the municipality from which they encourage the sale of assortments in the amount of 10% of the financial assets realized by sale of forest timber assortments determined by the price list, at the prices of the freight truck road.

A part of the funds of a local self-government unit in whose territory protected areas are located are obliged to allocate for the sustainable development of protected areas, and according to the annual plan on the use of dedicated funds.

Compensation is paid at the expense of municipal or city public revenue, and is used for the construction, reconstruction and maintenance of infrastructure and other facilities in rural areas of the local self-government unit, from which they encourage the sale of assortments, based on the annual plan for the use of dedicated funds issued by the competent unit body local self-government, with the consent of the Ministry of Agriculture, Forestry and Water Management

Compensation for improving the general nature of forest functions in accordance with the LoF at the expense of public revenues of the Republic of Srpska shall be paid semi-annual and by final account all legal persons performing their activities on the territory of the Republic, as well as business units or parts of legal entities whose headquarters are outside the Republic.

The basis for determining the level of fees is the total revenue to which the rate of 0.07% applies.

A closer regulation on the method of collecting and spending compensation is prescribed by the Minister.

The leaseholder is obliged to pay the fee for leasing the forest land in the ownership of the Republic to the account of public revenues of the Republic of Srpska. The basis for the calculation of these funds is the amount of rent paid, which will be regulated by the Lease Agreement, which will be concluded based on the regulations issued by the Minister. The beneficiary of the expropriation of forests and forest land in the ownership of the Republic, in accordance with the law, shall pay compensation for excluding land from forest

production at the expense of public revenues of the Republic. Control of the calculation of funds for all fees, in accordance with the law, is performed by the administrative body competent for tax matters.

Funds for special purposes for forests are used to finance the development and implementation of the Forestry Program of the Republic, the Forest Development Strategy of the Republic, the FMP, the long-term program of management of the Karst area, the activities of the Forestry Council of the Republic and the implementation of forest improvement projects regardless of the form of forests and forest land , and among other things for "design, construction, reconstruction and maintenance of forest truck roads and for the development of forest management bases".

The total value of all collected funds according to these bases is about 17 (seventeen) million KM per year, if we take into account that the value of special purpose funds for forests is constantly increasing from year to year by about 10%, we come to the conclusion that in thirty years after this the basis for the RS budget is more than 500 million KM, which, among other things, is spent on the design, construction, reconstruction and maintenance of forest truck roads and for the development of forest management bases. It would be necessary to allocate 10% of the total, collected funds on this basis annually for the realization of this program.

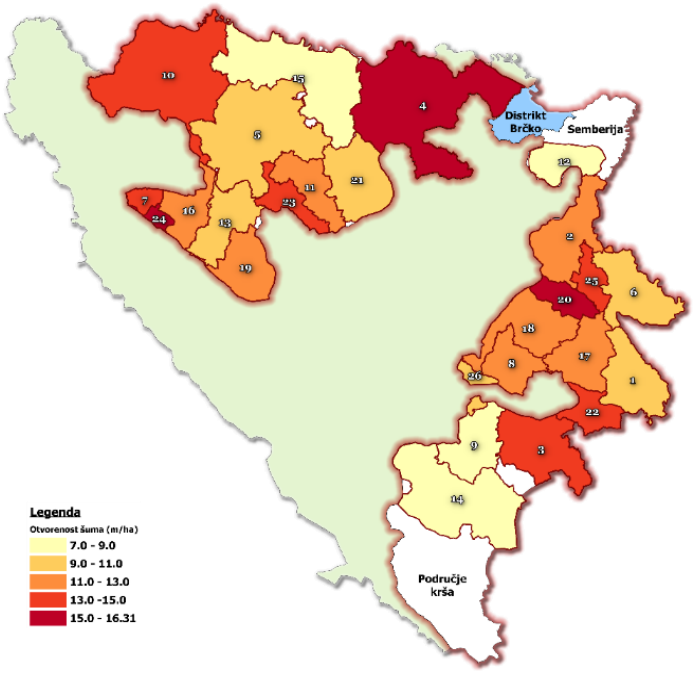
Forest user in state PFE "Sume Republike Srpske" a.d. Sokolac In the last 3 (three) years, had on average at disposal 13 million KM (data from PFE "Sume of the Republic of Srpska"), resulting in the fact that in the next 30 years the repayment of this investment would cost about 400 million KM, only under this law mandatory items financed the realization of the total investment for this program, it would be necessary to separate from the funds of the free reproduction of forest 10% of the value on the stump of sold forest timber assortments of about 20%, which would amount to approximately 80,000,000 KM, which in practice meant that forestry from its own f on that day, could only finance this program.

Therefore, funding of this program would not additionally burden the current operations of the company, but would be only intended and correct. European Pre-Accession Funds, grants from various international organizations can also be used to a large extent in the implementation of this program.

14. CONCLUSIONS

According to the categorization of roads, roads that pass through forestry areas in the Republic of Srpska are classified into public and forest roads. So far, forest management has not separated the roads into categories of public and forest roads, but is shown aggregated data for both categories. The total length of all roads in the Republic of Srpska for the analyzed area affecting openness according to the given criteria is 9,453.73 km, while public roads make 1,628.16 km or 17.22%, and the forest roads are 7.825,57 km or 82.78 %. Based on these data and the applied methodology for calculating the density of the network of forest truck roads, it has been found that the average density of the network of forest truck roads in the Republic of Srpska is 11.21 m/ha, or 9.28 m/ha if only the forest is considered, without public roads. If this project and the proposed construction paths are realized in the future, then the openness will amount to 9.36 m/ha, which makes about 8% of the increase of the primary network of roads in relation to the existing.

Despite significant investments in the construction of forest roads in recent years, the density of the network of forest truck roads in the Republic of Srpska is still not at a satisfactory level. About 50 km of forest truck roads are built annually on the territory of the Republic of Srpska.



Overview of the absolute openness of forests in the Republic of Srpska

However, in addition to the insufficiently developed network of forest truck roads, the relatively poor qualitative state of the network of forest truck roads, as well as the uneven density of the network of roads in the forestry areas, is a major drawback. In planning documents (forest management plans for forest management) for all forestry areas, the construction and the defined dynamics of construction of forest truck roads for the ten-year operating period are foreseen. It can be noticed that in the last few years the most forest roads were built in the Rogatica and Ribnik forestry area, while in the forestry areas the Doboj - Derventa, Trnovo, Majevica and Milici forest roads were not built.

According to the data from the Development Research and Projects Center in Banja Luka for the period from 2006 to 2017, on the territory of the Republic of Srpska, an average of 47.20 km was built annually, and this trend continued. The total length of the projected and built forest roads for this period is 519.21 km. The average price of construction of forestry roads in the period from 2006 to 2017 was 61,694 BAM/km (31,541 €/km).

- By data processing and detailed analysis of the road network of forest truck roads we found that the average price of road reconstruction in the Republic of Srpska is 22,010.98 BAM/km, while the average price of road construction is 66,157.15 BAM/km. If other costs such as project documentation, issuance of permits and surveillance, geodetic record, etc. are included. This price will be 75,250.59 BAM/km. In this calculation, the market prices from 2018 are taken.
- By analyzing the mean transport distance, we reached the data that the average transport distance in the Republic of Srpska is about 595m. Transport distance in high forests with natural renewal is about 405m. The average distance of 595m is too large, but given that the calculation of transport distances has included all categories of forests, as well as the territory of Herzegovina with extensive management, it is concluded that more attention in the opening of forests was taken into account exclusively for category of high forests with natural renewal.
- The cost of harvesting and cutting varies from FMA to FMA and shifts from 27.30 BAM/m^3 in Han Pijesak FMA up to 36.68 BAM/m3 in Vlasenica FMA. The average price is 33.04 BAM/m^3.
- The mechanization applied in PFE "Sume Republike Srpske" is dominantly light skidder tractors. The age of the mechanization exceeds 20 years, with the exception of twenty tractors that were acquired in 2009-2010 and are owned by the PFE "Sume Republike Srpske".
- Given the high prices of cutting and towing, it is necessary to start thinking about the introduction of more modern mechanization in forest use, such as harvesters, forwarders, forest ropeways, etc.

- This project has shown that there is a space for this mechanization to be cost-effective, so we believe that in the first phase, a certain number of these mechanized assets should be

experimentally procured or rented, and definitively to determine their justification in our area.

- It is also necessary to include The Plans for the opening of forests, which in the future should be elaborated; it is necessary to include many more parameters in the planning of the road network in order to obtain "optimal openness" and pay more attention to less quality forests such as high degraded and abandoned forests.
- The realization of strategic goals in the field of development of the forest transport network cannot be achieved only by the one-dimensional sequence of activities. Many factors that act simultaneously can simultaneously slow down or accelerate reaching of goals. These factors may arise from an internal or external environment and may manifest themselves in different periods and in different ways. In the strategic approach to the development of transport, the advantages and opportunities to be pointed out should be exploited, the weaknesses should be eliminated and any problems that threaten the achievement of the planned goals should be avoided.
- In the past period, significant improvements have been made on quality of the forest roads network in PFE "Sume Republike Srpske", but due to the failure to engage the significant financial resources, we can conclude that the assessment of the quality of the forest road network is below the satisfactory level. First of all, the exploitation has outperformed technically, so the investment in maintenance is below economic justification.
- The current state of the forest road network is estimated with the maximum effort of the employees of the PFE "Sume Republike Srpske", but still the current state of the network is not satisfactory, and among the worst in Europe.
- This assessment prevents a planned approach to the development and expansion of forest timber assortments, because as a bottleneck, or resultant, the poor quality of forest roads is in direct correlation with the costs resulting from improvement or better performed maintenance of the minimum criteria for the quality of exploitation of forest timber assortments and logistic activities represents the burden and conflict in the transport process.
- The development of the network of forest roads of the Republic of Srpska is a backbone and key to the improvement of the road transport system in the management of the supply chain, and on the other hand it is the driver of new services and the improvement of the operations of the PFE "Sume Republike Srpske".

- The Spatial Plan of the Republic of Srpska provides a framework for the medium and long-term strategic planning. Taking this into account, the improvement of the forest roads network of the PFE "Sume Republike Srpske" will primarily focus on improving the existing network, level of services, construction of additional forest roads in the context of improving the state of the current network through the reconstruction, maintenance and removal of high-risk road sections.

- Special attention should be paid to the facilities of the PFE"Sume Republike Srpske", the transport infrastructure and their protection.

- Good transport integration, viewed through the prism of strengthening the infrastructure necessary for access and exploitation of wood assortments, will have a stimulating effect on the economy of the Republic of Srpska. In the long term, transport integration in international frameworks will increase the state's budgetary potential. This transport integration will also enable a balanced design of the transport network and better transport networks between individual areas within the FMA and the regional linking of the areas and those economically underdeveloped ones.

- Bearing in mind the geographical position, the potentials for the development of tourism and the economy, and the development of economic relations in the region, the Republic of Srpska has the chance to timely and adequate development measures, i.e. replacing forest roads in closed worksites, and turning them into the paths for tourist users and national parks, creates preconditions for attracting international tourist flows.

- Integrated environment, based on the application of modern information and communication technologies, using forest management tools roads should provide at all levels the widest possible use of modern ITC applications for monitoring relevant transport parameters (flows, speed and density, levels of environmental indicators, meteorological data, etc.).

- It is necessary to establish a center for the collection, processing and distribution of relevant data and standardize the application of ITC, information and communication technologies.

- The basis of the forest roads network consists of the openness of forest areas for exploitation, that is, the forest corridor and the lines of the Basic Network, which enable the Public Enterprise "Sume Republike Srpske" to connect with the environment and become part of the network system of roads.

- Condition of objects - the criterion is used only for objects. Indicates the overall assessment of the state of auxiliary and bridge construction. Age of the object - A criterion used only for objects on roads. Apart from indirectly indicating the state and reliability of the construction, this is a data that tells us by which regulations the object is designed and implemented, i.e. the designed load capacity and the required minimum reliability requirement.

- The realization of strategic goals in the field of development of the forest transport network cannot be achieved only by the one-dimensional sequence of activities.

- Many factors that act simultaneously can simultaneously slow down or accelerate achievement of goals. These factors may arise from an internal or external environment and may manifest themselves in different periods and in different ways. In the strategic approach to the development of transport, the advantages and opportunities to be pointed out should be exploited, the weaknesses should be eliminated and any problems that threaten the achievement of the planned goals should be avoided.

- Correlation is the interconnection between different phenomena, represented by the values of the two variables. In addition, the connection implies that the value of one variable can be predicted with a certain probability based on the knowledge of the value of another variable.

- Correlation is part of the regression analysis. In observing the reciprocal relations and the connection of two or more phenomena, the scientific analysis is most often focused on finding and expressing the degree (strength) and the direction of their interconnection and relationship.

- In order to improve the quality of forest roads as close to those in the developed countries in the domain of exploitation, only the management of the network of forest roads of the Republic of Srpska through the implementation of the strategy through operational and pertinent planning activities in the operation and realization itself should be improved.

- The basic prerequisite for achieving this strategic planning, and its consistent implementation. Strategy for the development of forest roads in the PFE "Sume Republike Srpske" by 2049.
- The program for the implementation of the Strategy will serve the Ministry in cooperation with the PFE "Sume Republic of Srpska" that is in charge of the management of forest roads, as well as international financial institutions, starts an investment cycle on the construction of forest roads that would represent the current minimum of meeting the needs and expectations for the cycle of exploitation of wood products of the PFE "Sume Republike Srpske".
- PFE "Sume Republike Srpske", as a measure to improve the network of forest roads, with emphasis on traffic safety, sustainable financing and environmental protection, will initiate the development of their own application software for monitoring, data collection on lenses, traffic and economic indicators, transport and exploitation parameters of the network of forest roads of the Republic of Srpska.
- Considering that the Strategy is foreseen for a thirty-year planning period, means that during that period programs will be introduced in which the real situation needs to be defined, and that the Program be aligned with the Strategy, the Spatial Plan, the previous Program and the situation on the ground the possibility of connecting with local communities especially in

terms of where some of the routes go from the area of forest roads into categorized and even regional roads.

- It is necessary to build facilities on roads, bridges, trails in the amount of BAM 617,190.00.
- Serious problems should be reported to the top management through the report. Management must: - timely evaluate the findings of the strategy, including the deficiencies and recommendations contained, and identify the appropriate activities in response to the recommendations of the strategy, and urgently draft the Program of Action for the implementation of the measures and recommendations of the Strategy.
- Market risks are: the risk of increasing the cost of exploitation due to an inadequate network of forest roads, price changes, the risk of settlement of liabilities and counterparty risk and currency risk.

- The risk of price changes is the risk that due to changes in prices in the market, the value of the Company's assets is reduced. The risk of settlement of liabilities and the counterparty's risk are the risks of loss arising from non-fulfillment of obligations of the other contracting party.

- Liquidity risk: the company's liquidity is the ability of the Company to settle its short-term liabilities on time, that it is solvent and able to settle its long-term liabilities - long-term stability. Risk of liquidity of payments: refers to deterioration in the ability of the Company to properly settle its obligations. Liquidity risk: it represents a situation where the Company cannot collect its claims in its entirety. On a daily basis, the company measures liquidity by comparing the balance of its liquid assets and current liabilities. Operational risk is the risk of loss due to errors, interruptions or damages, injuries at work, environmental impacts and information security that may occur due to inadequate procedures, actions of persons, systems or external events. Currently, the PFE "Sume Republike Srpske" has the potential to realize the construction of a network of forest roads through the investment cycle, thus contributing to the increase in the competitiveness and liquidity of the company's operations.

- Rehabilitation of forest roads in the future development period will continue with continuous and programmed maintenance, followed by rehabilitation and modernization of forest roads and reconstruction of facilities (gaps, bridges) according to defined priorities.

- Unsatisfactory is the communal infrastructure with forest areas in numerous populated areas that are in the forest zone, which leads to pollution of water and air. A special problem is the removal and disposal of solid waste, especially in the part of non-selective collection and treatment, with a more precise definition of "dumping wild depots along forest roads".

- A positive step was made by building two regional landfills. The problem is insufficient control over the implementation of regulations in the field of environmental protection, as well as the lack of a sufficiently efficient system of financing environmental protection. The problem is an insufficient or inadequate use of natural resources, which would ensure their sustainability and economic development, as well as a higher level of well-being for PFE "Sume Republike Srpske" and even for local self-government units. In this regard, with increased attention to the multifunctional of resources, as well as the preservation of nature, the quality of the environment and the landscape.

- Transport and economic indicators within all modes of transport represent a significant basis, support and logistics for customers-customers of wood assortments. Namely, with road potential as a transport system, justifies the assessment of flexibility and accessibility in the widest scope of all forest areas. Also, transport operators have a vehicle fleet that fully meets "external services" within logistic strategies. On the other hand, rail transport through transport corridors represents the integrative base of the Republic with a closer and further environment.

- The power represents the preserved environment in non-industrialized areas, provided protection and regulation of certain areas and sections of watercourses (Sava, Una, Vrbas, Bosna and Drina) from natural disasters. Of particular importance is the commitment of the PFE "Sume Republike Srpske" and the institutions for environmental protection, as well as institutional support for the development of environmental and nature protection systems.

- Disadvantage is the existence of ecological "black spots" on certain segments of the road network as a result of unplanned exploitation of stone, gravel in the interaction of certain points of contact with the forest area, where it is not uncommon for the overlapping or continuation of forest roads to local or even regional directions.

- The effects of the cooperation based on the participation of the partner of the PFE "Sume Republike Srpske" - buyers of wood sorters - transport operators, using the network of forest roads, are reflected in: reduction of unnecessarily duplicated logistics systems, reduction of the stock of woody varieties in logistics processes, concentration in flows modern technologies, accelerates the flow of materials through logistics processes, better use of the capacity of logistics systems, reduces associated capital in logistics systems, increases the quality of service and is a prerequisite for the modern strategy of the transport process oriented towards the so-called. "Traction flows" increases the flexibility of the logistics system, which is increasingly important and more present in the market of products and services, the reduction of logistics costs.

- Forest roads that are mainly used for forest management - logistical process in the transport of wood assortments can be damaged by the overloaded truck or the too high speed of the vehicle. Damage caused by an inadequate organization of the transport process, for example, the transport of an overloaded truck is closely related to the load capacity, which can be reduced for various reasons, including:
  - **heavy rain;**
  - **dissolving snow and ice;**
  - **insufficient carriageway thickness;**
  - **improper road construction (insufficient bottom layer thickness);**
  - **lack of maintenance;**
  - **overloaded trucks (especially high-load individual axles on the tires themselves).**
- The solution is to regulate traffic through a restricted approach that helps to limit traffic in an acceptable and feasible way from the aspect of the transport process to the FMA. Sometimes the option is to close the road, especially when the road is too wet for driving or at the end of winter. The second solution is to strengthen the lower (bearing layer), and the upper layer of the road by reconstructing the damaged part of the road.

The Strategy Implementation Program will serve:

To the Ministry, in cooperation with PFE “Sume Republike Srpske” that, in charge of forest roads management, as well as international financial institutions, starts the investment cycle for the construction of at least 170 roads and the construction of facilities (bridges and tracks) in the amount of BAM 78,098,548.34, which would represent the current minimum of meeting the needs and expectations for the cycle of exploitation of forest wood assortments of the Public Enterprise “Sume Republike Srpske”.

- The PFE "Sume Republike Srpske", as a measure to improve the network of forest roads, with emphasis on traffic safety, sustainable financing and environmental protection, will initiate the development of its own application software for monitoring, data collection on lenses, traffic and economic indicators, exploitation parameters of the network of forest roads of RS.
- Considering that the Strategy is foreseen for a thirty-year planning period, means that during that period programs will be introduced in which the real situation needs to be defined, and that the Program must be aligned with the Strategy, the Spatial Plan, the previous Program and the situation on the ground with possibility of connecting with local communities especially in terms of where some of the routes go from the area of forest roads into categorized and even regional roads.

The benefits that can be expected from the realization of the Strategic Plan for forests and roads are:

- Savings in exploitation costs - use of vehicles, attracting a larger number of users - customers.
- Reduction of the cost of economy of the company of the road network users, less retention on points within the FMA, shortening of the transport time.
- Minimizing the risk of accidental events such as traffic accidents.
- Reduction of vehicle maintenance costs, increase technical and economic indicators of the vehicle, loading and reloading of transport machinery up to 17.5%.
- Indirect benefits can include the effects of connecting the local population through the tourism sector, increasing employment, hunting, developing additional activities from collecting forest fruits for reasons of accessibility.
- Other benefits from the construction of the road network of roads are the strengthening of the socio-economic structure of the population, with the increase in goods traffic - vehicles, people and goods, in all places that have been peripheral to date and poorly connected to the paths of individual FMAs as gravity model.
- Development of service-type activities. The concluding results of the "feasibility study of road reconstruction for the needs of the strategic plan of the forest roads in the Republic of Srpska" include cumulative and shows the basis for the reconstruction of forest roads that are being reconstructed and improved in order to improve these roads in the modern network of forest roads for the needs of the unauthorized and efficient operation of the PFE "Sume Republike Srpske" through a strategic plan, in line with the preparation of the project.

15. PROPOSAL FOR THE DEVELOPMENT OF FUTURE PROJECTS

1. **Development of the cadastral register of forest roads of the Republic of Srpska (GIS model)**
2. **Preparation of plans (studies) for the opening of forest truck roads according to the FMA,**
3. **Elaboration of feasibility studies for the opening of forest truck roads for each FMA,**
4. **Program for the use of forest biomass from private forests,**
5. **Development of a study on the monitoring and use of non-wood forest products,**
6. **Analysis of transport of FWA to processing capacities,**
7. **Analysis of the burden on the network of forest roads in the second phase of transport of FWA,**
8. **Digitization and establishment of a cadastre of a secondary network of forest roads,**
9. **Study of the capacity and timing of response to forest fire prevention,**
10. **Supply Chain Management and Integrated Logistics in Forestry,**
11. **Implementation of logistics principles in the modern operation of the PFE "Sume Republike Srpske",**
12. **Developing a financial model of forest road managers in order to check the possibility of financing this project without a loan, and determine the share that the state could eventually replace, because it would inevitably be profitable,**
13. **Development of more studies on the optimal utilization of forest roads and different types of forest assortments, with the proposal to implement a public private partnership for the processing of certain forest assortments and benchmark analysis of potential private partners from the country, region and the world,**
14. **Development of a system for monitoring relevant transport parameters (traffic flows, speeds, levels of environmental indicators, meteorological data, etc.),**
15. **Making a decision on incentive measures for the transport of forest timber by intermodal transport, and**
16. **Make a benchmark for the analysis of the maintenance of forest roads in the world and the proposal of the model of contract, in which these roads will be maintained in the future.**

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