

## Elaboration and Analysis of Wood Processing Industry Residuals in Zlatibor region



**MRS. BRANKA MITROVIĆ**

## TABLE OF CONTENTS

1. Regional Overview and Data Analysis.....	8
2. Northern Part of Zlatiborski Region . Bajina Bazta, Čajetina, Ušice and Arilje .....	14
3. Southern Part of Zlatiborski Region. Prijepolje, Nova Varoš and Priboj .....	17

## LIST OF TABLES

Table 1: Annual average available wood residuals in studied 7 municipalities in Zlatiborski region .....	5
Table 2: SWOT Analysis.....	7
Table 3: Forested areas . per municipality.....	9
Table 4: Number of wood processing firms by size and municipality.....	10
Table 5: Processed volume of wood by Wood Processing Industry . per Municipality in m <sup>3</sup> on average in 2013-2015.....	11
Table 6: Average Raw Material Input per municipality by major species 2013-2015	12
Table 7: Average Production of Wood Residuals 2013-2015 . by type .....	13
Table 8: Distances in the Ušice region (km) .....	14
Table 9: Transportation fleet . wood processors in Northern part of Zlatiborski region.....	15
Table 10: Distances in Southern Part of the Zlatiborski region (km).....	17
Table 11: Transportation fleet . wood processors in Southern part of Zlatiborski region.....	17

## LIST OF FIGURES

Figure 1: Produced average quantity of wood residuals (rm /a) per municipality 2013-2015 .....	4
Figure 2: Wood processor plants yard .....	6
Figure 3: Map of the Zlatibor Region, with underlined researched municipalities .....	8
Figure 4: Processed wood volume per specie.....	11
Figure 5 Wood Residuals Availability in the Region .....	12
Figure 6: Transportation fleet operated by local wood processors.....	18

## LIST OF ABBREVIATIONS AND MEASURES

DHC = District Heating Center  
m<sup>3</sup> = cubic meters  
rm<sup>3</sup> = raum (spatial) cubic meters  
m<sup>3</sup> /a = cubic meters per annum  
RSD = Serbian dinars  
ha = hectares  
km = kilometers  
t = tons  
t/a = tons per annum

## Summary of main research findings

Zlatibor region occupies South-Western mountainous part of Serbia. City of UOice and 6 other municipalities (Bajina Bazta, ajetina, Arilje, Priboj, Prijepolje and Nova Varoz) have been at the focus of this research. The objective of the assignment was to identify wood processing facilities in those 7 designated municipalities and respective availability of wood residuals for fueling planned local biomass District Heating Centers (DHCs).

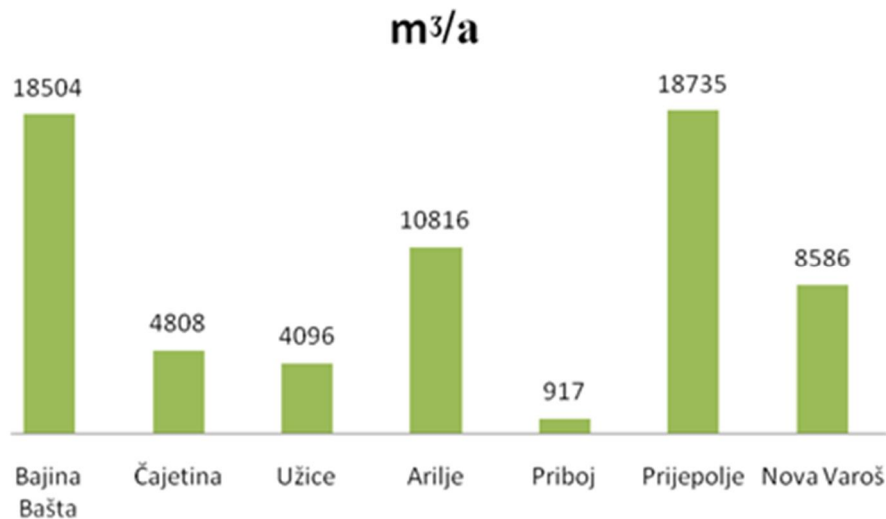
In total 94 wood processors have been identified and included in the research, with number of unregistered small sawmills taken into account. Those who have closed their plants were also considered as indication of the consolidation process in wood processing industry that is going on in the region and in Serbia as the whole. In addition, Serbian law allows small entrepreneurs to temporarily close their businesses, up to one year. A number of small seasonal family-owned sawmills are not easy to track. From the point of view of number of wood processors as well as the collected data showing total volume of processed wood and produced wood residuals . Bajina Bazta and Prijepolje are clearly two main concentration points for the wood processing industry. Bajina Bazta is the one single municipality with the highest biomass potential, included forested areas and their annual increment (wood mass growth on annual basis). Arilje and Nova Varoz are also distinguished, with other 3 municipalities behind. This distribution of the biomass potential and wood industry is also translated in the produced quantities of wood residuals. Figure shows the quantities of produced wood residuals per municipality.

Bajina Bazta and Prijepolje are situated in the northern and southern tips of the region. The wood processing industry has been, in recent years, advancing the most in the Prijepolje, Priboj and Nova Varoz municipalities. Prijepolje has the most advanced transportation fleet in the region.

Over the researched period, the prices of wood residuals have been growing nominally, expressed in RSD. However, the prices converted in " have remained rather stable. It is to be expected that prices will follow the increasing trend over the next years because of the development of mini pellet and briquette production facilities, as well as the expected

finalization of wood biomass based district heating centers, with projects on-going in Bajina Bašta, Nova Varoš and Priboj.

**Figure 1: Produced average quantity of wood residuals (rm<sup>3</sup>/a) per municipality 2013-2015**



Note: raum meters

Research showed that the transportation fleet exists within wood processing companies and that transportation of wood residuals from wood processing plants to the consumers (wood pellet, briquettes, panel and other producers) can be conducted from the supply side, delivering residuals to the final customers` yards.

Total Raw material input in the studied area has been 233.392 m , and total quantity of produced wood residuals 66.462 rm . According to our estimate based on the consistent information we got from conversations, there are approximately 20% more wood residuals produced, which are not registered in the books. Residuals remaining in the forest have not been taken into account. Taking into account legal requirements for substantial part of the residuals to remain in the forest, current forest exploitation practices, configuration of terrain and the level of development of the forest infrastructure in the area; we estimate that between 25.000 and 30.000 rm /a of residuals could be collected in the forests. Adding up all the sources . wood processing industry, including unregistered and seasonal processing as well as accessible and surplus forest residuals, we estimate that there is on total 107.254 rm of wood residuals available in the region . see Table 1.

**Table 1: Annual average available wood residuals in studied 7 municipalities in Zlatiborski region**

<b>Wood Residual Availability</b>	<b>rm<sup>3</sup></b>
<b>Wood processors Production</b>	66.462
<b>Unregistered production estimate (20%)</b>	13.292
<b>Accessible forest residuals estimate app.</b>	27.500
<b>TOTAL</b>	107.254

It is important to note that the supply side . production of wood residuals was researched. Therefore, wood processing companies that only consume wood residuals (demand side) such as wood pellet plants were not taken into account, as their processing of wood residuals . consumption cannot be added to the production part. Similarly, with companies that bought produce wood residuals themselves, but who also buy up residuals from other companies throughout the region (such as %Star Jela+ from Prijepolje), only the part they produce (supply) themselves was taken into account in order to avoid duplication.

Much of the wood from the region is being sold to other regions or abroad (e.g. to %Kronospan Serbia+ in Lapovo). However, researched companies are also engaged in importing wood from Bosnia and Herzegovina, Montenegro and Kosovo (e.g. %Star Jela+ from Prijepolje).

Based on the geographic characteristics of the region, as well as on the existing wood processing industry and the way forestry administration is set-up in Serbia; for the purpose of this research we can identified two different areas:

- Northern part, with wood processing plants concentrated around National Park %Tara+ and this area is north of Zlatibor Municipalities of Bajina Bazta, ajetina, Arilje and City of U0ice belong here.
- Southern Part, along the border with Montenegro and south of Zlatibor, including municipalities of Prijepolje, Nova Varoz and Priboj.

**Figure 2: Wood processor plant's yard**



In recent years, there has been consolidation of the wood processing sector in the region. Many smaller sawmills, higher up in the mountains have been closed. For instance, now all sawmills in Bajina Bazta towards Tara Mountain are within 10km distance from the city. Since the winters are sharp, and major mountains are situated across the region, many smaller sawmills cease their operations during the winter months, depending on the weather.

%Zelena Drina+ pellet producing company situated in Bajina Bazta, owned by the Italian Crabo SpA used to be the biggest wood processor in the region. However, it was shut down. This closure implicates both added room for the new/existing wood processors and growing trade misbalance between wood trade of Bajina Bazta area and other municipalities / regions. Namely, %Zelena Drina+used to import bulk of its raw material from Eastern Serbia, and now far more wood is exported from e.g. National Park %Tara+and surrounding area to far-away regions, while not much wood is imported.

SWOT analysis, in table below outlines Strengths, Weaknesses, Opportunities and Threats for the wood residuals production and availability on the market in Zlatiborski region.

**Table 2: SWOT Analysis**

<b>STRENGTHS</b>	<b>WEAKNESSES</b>
<ul style="list-style-type: none"> <li>▪ Abundance of forests and increasing biomass stock</li> <li>▪ Sizable amounts of produced wood residuals.</li> <li>▪ Wood processors also have transportation potential . trucks and other vehicles are available</li> <li>▪ Openness for expanding business ties on the side of wood processors</li> <li>▪ Increasing cross- border wood trade with Bosnia &amp; Herzegovina, Montenegro and Kosovo</li> </ul>	<ul style="list-style-type: none"> <li>▪ Hilly terrain and lack of infrastructure (access roads) in forests.</li> <li>▪ Lack of access to finance</li> <li>▪ Dependence on major raw material suppliers</li> <li>▪ Seasonality of production, especially in higher mountain` s areas.</li> </ul>
<b>OPPORTUNITIES</b>	<b>THREATS</b>
<ul style="list-style-type: none"> <li>▪ Huge untapped potential especially in private forests.</li> <li>▪ Local municipalities are conducting projects of fuel switch of district heating from fossil fuels to wood chips (Bajina Bazta, Nova Varoz and Priboj)</li> <li>▪ Joint approach to larger biomass customers, such as %ronospan Serbia+or District heating centers.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Family-sized companies are often dependent on the personal fortunes of the single owner</li> <li>▪ Disloyal competition from illegal loggers</li> </ul>



## 1. Regional Overview and Data Analysis

Research of wood processing industry, focused on the supply side (production) of wood residuals in Zlatiborski Region has been conducted in the following municipalities: Bajina Bašta, Čajetina, City of Užice, Arilje, Nova Varoš, Prijepolje, and Priboj. This is highly forested region, as Table below shows.

**Figure 3: Map of the Zlatibor Region, with underlined researched municipalities**



Source: Wikimedia



**Table 3: Forested areas – per municipality**

Municipality	Forested area (ha)
Arilje	15.306
Bajina Bazta	30.073
Nova Varoz	20.866
Priboj	33.581
Prijepolje	39.861
U0ice	28.239
ajetina	23.866
<b>TOTAL</b>	<b>191.792</b>

Source: Statistic Bureau of Republic of Serbia

According to the official data of Statistic Bureau of Republic of Serbia, based on agricultural census, annual cuttings in Zlatibor region of hardwood are 148.217 m and 136.874 m of softwood. This provides both firewood for households, which is a priority, and raw material for wood processing industry.

National forests in Serbia are managed by state-owned companies %Srbijazume+, %vojvodinazume+ and by National Parks. Around 50% of all forests in Serbia are private forests. This percentage is increasing due to the on-going restitution process. Forests in Zlatibor region are managed by two branches of %Srbijazume+, based in U0ice and Prijepolje and by National Park %Tara+, with headquarters in Bajina Bazta. U0ice branch of Srbijazume covers municipalities of Arilje, U0ice, and ajetina (as well as Kosjeri and Po0ega), while the branch in Prijepolje covers municipalities of Nova Varoz, Priboj, and Prijepolje.

The %Srbijazume+forestry branch in U0ice manages state forests on territory of City of U0ice and municipalities of ajetina, Arilje, Po0ega and Kosjeri with covers 32.342,87 ha of forests, with total volume of 5.046.174,7 m , on average 156 m /h . Annual increase of biomass volume is 121.920,50 m , on average 3,8 m /h . This is excluding private forests. There are 60.665 ha of private forests on this territory, which makes around two thirds of all forests.

The Public Company National Park "Tara" manages 12.300 ha of state forests on the territory of Bajina Bašta. Total volume of wood is 3.374.792 m<sup>3</sup>, average 260 m<sup>3</sup>/ha, with annual increase of 68.872 m<sup>3</sup>, or on average increase of 5,3 m<sup>3</sup>/ha. Reservation, where any exploitation is forbidden covers one third of the National Park. The National Park sells 45.000 m<sup>3</sup> of all assortments of wood per year, out of which 90% stays in Bajina Bašta municipality. This wood volume consists 70% of softwood and 30% of hardwood. Softwood part consists of the following species: fir 60%, spruce 30% and pine 10%, while hardwood part is made of beech 80%, maple 10% and 10% other hardwood species. According to the cadaster there are 17.773 ha of private forests (including church forests). However, census of private forests, conducted by National Park "Tara" on the territory of Bajina Bašta municipality has registered around 25.000 ha of private forests. The census was conducted in 2013. Because of the decreasing rural population, former fields and meadows have effectively turned into forests, while this was not accounted by updating cadaster register.

**Table 4: Number of wood processing firms by size and municipality**

MUNICIPALITY	NUMBER OF WOOD PROCESSORS (per annual log input m <sup>3</sup> )	
	Over 1,000	Below 1,000
Bajina Bašta	15	20
Čajetina	3	7
Užice	4	0
Arilje	8	6
Priboj	1	2
Prijepolje	13	1
Nova Varoš	9	5
<b>TOTAL</b>	<b>53</b>	<b>41</b>

The "Srbijazume" forestry branch in Prijepolje manages state forests on the territory of municipalities Prijepolje, Priboj and Nova Varoš, with total space of 54.434,87 ha, with wood volume of 8.020.945 m<sup>3</sup>, which is on average volume of 147,3 m<sup>3</sup>/ha with annual growth of

205.587 m<sup>3</sup> or on average 3,8 m<sup>3</sup>/h . There are 43,390 ha of private forests on this territory. Therefore, state owned forests are dominant on this territory.

In this research in Zlatiborski region, we interviewed 94 saw mills . see Table 4.

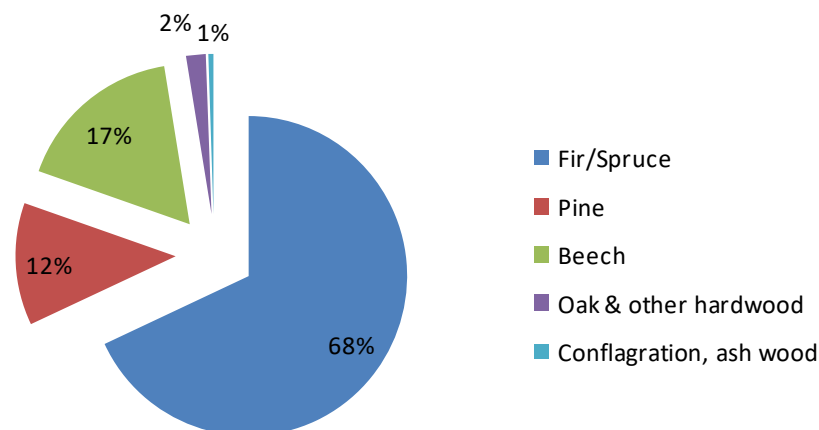
According to our research 233.392 m<sup>3</sup> of raw material is being processed on average annually in the period 2013-2015 .

**Table 5: Processed volume of wood by Wood Processing Industry – per Municipality in m<sup>3</sup> on average in 2013-2015**

Municipality	Average Raw Material Input (m <sup>3</sup> ) 2013-2015
<b>Bajina Bašta</b>	69.692
<b>Čajetina</b>	15.992
<b>Užice</b>	12.990
<b>Arilje</b>	31.182
<b>Priboj</b>	3.043
<b>Prijepolje</b>	61.150
<b>Nova Varoš</b>	39.343
<b>TOTAL</b>	233.392

Out of the processed input, more than two thirds goes for fir and spruce, and four fifths is the pine is added. Hardwood makes close to 20% of the processed wood, with beech being predominant with its 17%. Around 1% of input has been wood from conflagration which affected the area in 2012 and ash wood. This is demonstrated in the Figure below and is presented in detail in the Table nr. 6.

**Figure 4: Processed wood volume per specie**

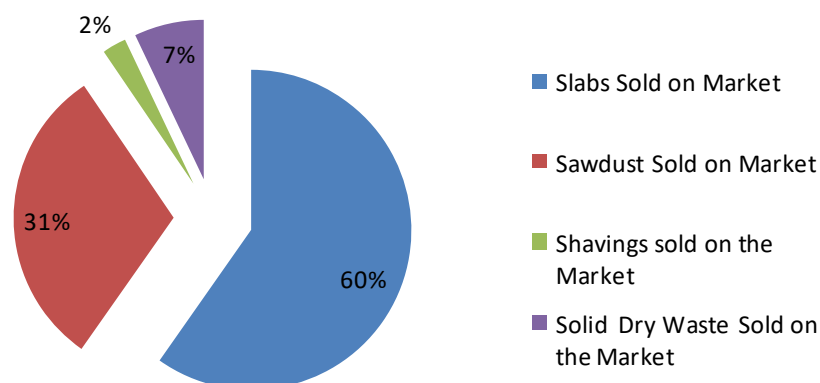


**Table 6: Average Raw Material Input per municipality by major species 2013-2015**

Municipality	Average Raw Material Input by major species 2013-2015					
	Fir/Spruce	Pine	Beech	Oak & other hardwood	Conflagration, ash wood	Total
<b>Bajina Bašta</b>	32.334	2.358	30.882	4.020	98	69.692
<b>Cajetina</b>	11.186	3.698	640	30	438	15.992
<b>Užice</b>	3.540	9.450	0	0	0	12.990
<b>Arilje</b>	21.565	3.990	4.962	665	0	31.182
<b>Priboj</b>	2.837	206	0	0	0	3.043
<b>Prijepolje</b>	54.934	5.491	0	0	724	61.149
<b>Nova Varoš</b>	32.247	3.677	3.418	0	0	39.342
<b>Total</b>	158.643	28.870	39.902	4.715	1.260	~233.390

With total raw material input of 233.392 m and with most companies having their yield around 70%; there have been in the period 2013-2015 on average produced 66.462 rm of wood residuals. We have identified wood residuals sold on the market by type, and we have also identified the quantity of internally used wood residuals. The sold and internally used quantities add up to make total quantity of residuals. The most available wood residuals on the market are slabs and sawdust as it can be seen in the Figure 5 and is shown in detail in Table 7.

**Figure 5 Wood Residuals Availability in the Region**



**Table 7: Average Production of Wood Residuals 2013-2015 – by type**

Municipality	Average Production of Wood Residuals 2013-2015					Total by municipality
	Slabs Sold on Market	Sawdust Sold on Market	Shavings sold on the Market	Solid Dry Waste Sold on the Market	Internal Use	
<b>Bajina Bašta</b>	7.897	3.667	476	362	6.102	18.504
<b>Čajetina</b>	1.369	628	0	0	2.811	4.808
<b>Užice</b>	1.605	1.348	0	1.143	0	4.096
<b>Arilje</b>	4.932	2.118	773	2.043	950	10.816
<b>Priboj</b>	735	182	0	0	0	917
<b>Prijepolje</b>	10.132	5.010	0	0	3.593	18.735
<b>Nova Varoš</b>	3.529	2.599	0	0	2.458	8.586
	30.199	15.552	1.249	3.548	15.914	Grand Total 66.462 rm /a

As already mentioned, taking into consideration geographic and therefore transportation consideration, number of wood processors and where they source their raw material, we have identified two different areas:

- Northern part, with wood processing plants concentrated around National Park Tara and north of Zlatibor Municipalities of Bajina Bašta, Čajetina, Arilje and City of Užice belong here.
- Southern Part stretches along the border with Montenegro and south of Zlatibor including municipalities of Prijepolje, Nova Varoš and Priboj.

Transportation considerations and other more details we will details taking this spatial fact into account.

## 2. Northern Part of Zlatiborski Region – Bajina Bašta, Čajetina, Užice and Arilje

The relief in Zlatiborski region is hilly and mountainous. However, regional roads are in good condition. Less so are the forest access roads, where the maintenance is often inadequate and where large portion of forests on difficult terrains is inaccessible.

The greatest distance in the region is between Bajina Bazta and Prijepolje, which is 117 km<sup>1</sup>.

City of Užice is administrative center of Zlatiborski region and it is situated on the crossroads between other towns. Distances are not great, with distances in the Northern part not greater than 80 km between the towns, often less than 50 km. This satisfies the most economic sourcing expectations, which rely on 50 km fiber shred.

**Table 8: Distances in the Užice region (km)**

Municipalities	km
Užice - Čajetina	20
Užice - Bajina Bazta	38
Užice - Arilje	42
Bajina Bazta - Čajetina	48

Source: Google Maps

The distance from Arilje to Bajina Bazta is 80 km and to Čajetina is 62 km. However, Arilje together with Užice has the best road network and is easily accessible. Bajina Bazta and Čajetina lie in the immediate proximity of the resource (forests).

As it can be seen in Table 9, wood processors largely have their own trucks, with Bajina Bazta leading in transportation capabilities.

<sup>1</sup> According to Google Maps

**Table 9: Transportation fleet – wood processors in Northern part of Zlatiborski region**

Municipality	Nr. of trucks	Total tonnage
Bajina Bazta	26	421
ajetina	12	186
U0ice	6	144
Arilje	13	294
Total	57	1.045

While some wood processors in U0ice have closed their operation in the researched period, most of firms increased their production. Therefore, we can talk about some consolidation of the sector in this area. Most of processors are located in the western part of the municipality, closer to ajetina and Bajina Bazta then to U0ice. Closed 5 processors were processing around 3,500 m /a, with around 65% of their raw material input coming from Bosnia.

Company %Gorztak+from ajetina has been identified as the leading processor in the area. The company is located in Branezko polje. This site has been identified as potential Biomass Logistic Wood Trade Center, since it already sells and produces most of the wood based fuel types, and it has good infrastructure. This plant is situated in intended industrial zone, with regional road access on the front side and railway access from the back side. Other infrastructure elements, such as strong capacity of supply of electrical power are in place as well.

Bajina Bazta is located between Drina riverbed and National Park Tara. This municipality is leading with quantity and quality of available forests, managed by both Srbijazume and NP Tara. In the period covered by the research a few wood processing facilities have been close, most notably %Zelena Drina+lumber and wood pellets producer, which was the biggest local producer with around 33-35.000 m /a. This quantity was mostly brought from Eastern Serbia.

The %Mikro tri+company used to have sawmill on the Bajina Bazta territory, however in the last years in Bajina Bazta there is left only panel and briquette production plant. This company sources wood elements from its own sawmill in Kraljevo, or buys them from other producers. Around 27.500 m /a of beech . timber is being processed. In addition, between 180 and 200 t/a of briquettes are produced.



Significant quantities of softwood from Bajina Bazta are sold to other municipalities of Zlatibor region, most often to Prijepolje and ajetina. Recently, %Kronospan Serbia+ from Lapovo has expanded its sourcing area to Bajina Bazta too. However, since %Star Jela+ company from Prijepolje buys the biggest quantities of softwood celluloses, it was taken into account not to duplicate the amounts sourced within one municipality of the given region, and processed in the other municipality. %Star Jela+ sources between 3.000-3.500 m annually from the territory of Bajina Bazta municipality.

In Arilje and Bajina Bazta, due to many raspberry and blueberry producers, part of sawdust is sold for the purpose to fertilize the land . so the soil gets the optimal acidity for the culture.

Another characteristic of the Northern part is that on average annually 700 m<sup>3</sup> of wood is collected at the Peru ac lake dam, which was not taken into account by this study.

### 3. Southern Part of Zlatiborski Region– Prijepolje, Nova Varoš and Priboj

The relief in the southern part of the Zlatiborski region is also hilly and mountainous, and regional roads are in good condition. Forest infrastructure is similar to the northern part. Long borders from the west and south characterize this part of the region.

Three towns of Prijepolje, Priboj and Nova Varoz are dispersed in three corners of a triangle. Distances are less than 50 km, which means that the sourcing of raw material can be very economic, given that the demand from wood residuals would be developed locally (DHCs, pellet or panel producers).

**Table 10: Distances in Southern Part of the Zlatiborski region (km)**

Municipalities	km
Nova Varoz - Prijepolje	30
Nova Varoz - Priboj	37
Priboj - Prijepolje	30

Source: Google Maps

Concerning the transportation fleet, Prijepolje has by far the most capabilities in the whole of Zlatiborski region. As it can be seen in Table 9, wood processors largely have their own trucks, with Bajina Bazta leading in transportation capabilities. Around half of trucks in Prijepolje come from %Star Jela+company. Nova Varoz processors also have sizable fleet, while Priboj would have to both procure residuals and transport them in cooperation with processors in neighboring municipalities, in case that DHC or other consumer of wood residuals appear in Priboj.

**Table 11: Transportation fleet – wood processors in Southern part of Zlatiborski region**

Municipality	Nr. of trucks	Total tonnage
Priboj	1	24
Prijepolje	53	1.164
Nova Varoz	26	604
Total	80	1.792

Another characteristic is that on the territory of Priboj municipality there are 15 unregistered sawmills. These sawmills work seasonally mainly to satisfy personal needs of their owners. All together they process estimated 300 m<sup>3</sup> from private forests. During research period, 6 wood processors have ceased their operations.

**Figure 6: Transportation fleet operated by local wood processors**



Significant wood processor 'Jela Star doo' is located in Prijepolje. This company is major producer of lumber, wood pellets (45.000 t/a) and wood chips (4.500 t/a). There are a few unregistered sawmills in Prijepolje too, which also work seasonally mainly to satisfy personal needs of their owners and source wood from private forests. Significant briquette producer 'Briko' from Nova Varoz has ceased the operations.

**Annex 1: Survey Sheet**

COMPANY AND CONTACT	_____	LOCATION	_____
NUMBER OF TRUCKS	_____	TOTAL TONNAGE	_____ t
TYPE OF PROCESS	_____		
SOURCE	SRBIJA/UME	_____	%
	NACIONALNI PARK TARA	_____	%
	Privately owned forest	_____	%
	IMPORT	_____	%
		_____	%
YIELD	FINAL PRODUCT	_____	%
	SLABS	_____	%
	SAWDUST	_____	%
	SHAVINGS	_____	%
	SOLID DRY WASTE	_____	%
	INTERNAL USE	_____	%
THE PRICE	SLABS	_____	EUR/M3
	SAWDUST	_____	EUR/M3
	SHAVINGS	_____	EUR/M3
	SOLID DRY WASTE	_____	EUR/M3

ANNEX 1: Survey Sheet

INPUT	2013	M3	FIR/SPRUCE	%	Type of Raw Material
	2014	M3	PINE	%	
	2015	M3	BEECH	%	
			OAK	%	
			MAPLE	%	
			WALNUT	%	
			ASH WOOD	%	
			Wood-conflagration 2012	%	
			ACACIA	%	