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IMPACT OF FLOODING ON WOOD ASSORTMENT PRODUCTION

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ABSTRACT: This paper presents the results of a study of the impact of flooding on the total revenues generated by the production of wood assortments in poplar plantations. The research was carried out in two sample plots in the PE "Vojvodinašume". The impact of flooding on the qualitative structure of assortments is estimated on the basis of the curvature of the lower part of the stem. The method applied in this paper is the method of quality factor isolation [1]. The results of this research show that flooding has an impact on the curvature of the most valuable, lower, part of the stem, i.e. on the total value of produced assortments. The analysis of the loss of wood mass cut after a flooding was performed in the area of the Special Nature Reserve "Gornje Podunavlje" in the FA "Apatin" and the "Apatinski rit" FMU. The analysis was conducted in the period from 2009 to 2013. The data for the analysis were obtained from the commission reports. After the flooding, the annual loss of wood accounted for 0.03 to 1.90% of the total amount of felled wood in the area of FA "Apatin". In value terms, this percentage is even lower, considering the large share of firewood. The share of classical and multi-purpose wood for heating and cellulose accounts for 85.59% of the total losses. In order to minimize losses in unprotected areas, works in compartments and sections at the lowest elevations need to be carried out during the dry season of the year, i.e. during the period with the lowest probability of flooding.
Key words: flooding, poplar, structure of assortments, wood losses, dynamics of works

1 INTRODUCTION

Considering the existing knowledge on the hydrological role of forests and forest land and their extremely important water management role, the following question arises: How to use the forest and forest land during and after a flooding event, while maintaining and implementing all planned works in forestry? Flood waters of large rivers have an impact on all planned works in forestry primarily through:

- the dynamics of flooding (flood height),
- the duration of the flooding and
- the time of year when the flooding occurred.

Forests exposed to the impact of flooding can be found in the forelands of rivers. This area is characterized by a pronounced micro relief. It is intersected with ponds, micro-depressions and canals. Throughout the year, it is flooded, sometimes on several occasions, which considerably hampers the operating conditions in forestry.

Works in forestry take place throughout the year, including a certain volume and dynamics. The impact of flooding on forestry operations cannot be completely avoided. However, by taking appropriate measures, the consequences of flooding can be significantly mitigated. Forest professionals working in these conditions constantly monitor the water level of the nearby rivers, in order to adapt their activities (felling and production of wood assortments, skidding, etc.) to the potential dangers of flooding in the areas where these works are implemented.

The flooding of a riverbed stops the works of felling and wood assortment production. It happens that a part of produced wood assortments remains in the felling site, mainly due non-compliance of felling and assortment production with skidding. The presence of water in the felling site makes skidding impossible until the road subgrade dries.

After the withdrawal of water into the riverbed, there are losses of timber that remains in the felling site after the flooding. These losses vary in different felling sites, depending on the site conditions and the structure of materials.

The losses are considerably higher if no appropriate technical measures are taken to prevent the removal of cut timber by the stream of flood water. The frequency of flooding during plant growth affects the external characteristics of the stem, and most of all, the curvature of the lower (most valuable) part of a standing tree.

In addition to negatively influencing the quality of produced wood assortments and the share of utilization in mechanical wood processing, this feature of a tree causes a change in certain properties of wood. Studies of this problem indicate that a curvature can affect the development of compression and tension wood, fibre deviation and knot size [3], [9].

During tensile shrinking of the wood, deformations occur on the products of mechanical wood processing, while it also causes cracking of the most valuable part of the stem during felling [2]. The problem of tension wood has been investigated by several authors [8], [4], [6], [5].

Deviation from the straight form affects the share of round wood utilization in the process of further wood processing, which is significantly decreased. It also reduces the total value of the stem and in particular of its lower most valuable part, where this characteristic is the most pronounced [3].

According to [7], the use of cut and peeled assortments is significantly reduced with an increase in the degree of curvature.

The greatest impact of flooding on this characteristic of the stem occurs in the first years of development. The effect of curvature in the plantation exposed to flooding is 2.4 times higher than the impact of curvature in a flood-protected plantation [2].

In addition to the losses in the assortment structure and losses incurred by the removal of wood assortments during flood water withdrawal, there is a disruption in the dynamics of the execution of planned works.

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The aim of this paper is to study the impact of flooding on the production effects, with a special emphasis on the qualitative structure of assortments and the loss of wood assortments after the flooding of a felling site. One more aim is to analyse the impact of flooding on the dynamics of execution of works in forestry.

On the basis of recent knowledge and with the aim of ranking the quality factor, the initial assumption was that the curvature of the lower part of the stem is more pronounced in terrains exposed to flooding, which affects the qualitative structure of wood assortments.

2 MATERIALS AND METHODS

2.1 Research area

The research was carried out in the area of the PE Vojvodinašume, in the FE " Sombor", the FMU "Apatinski rit", the FE "Pančevo", and the FMU "Gornje Potamišje".

The forest management unit "Apatinski rit" is located in the northwestern part of Bačka, on the left bank of the Danube River.

It extends from 1409 km in the north to 1367 km in the south. The villages of Bogojevo, Svilojevo and Sonta are in the east and southeast, while it is also located east of the town of Apatin.

The total area of state forests in the northern Bačka forest area is 23,438.00 ha. In this area 73% are surfaces under forests and 27% non-wooded forest land. Within this forest area there are ten management units, four of which are located along the Danube River, where conditions for the growing of poplar and willow are highly favorable. The total wood volume is 2 495 012.0 m^3 and 147 $m^3 \cdot ha^{-1}$. Poplar and willow account for 48% of the total wood volume.

The forest management unit "Apatinski Rit" is located in a flood-prone zone on an area of 3 652.67 ha.

The eastern boundary of this management unit goes along the embankment and separates the flood-prone area from the protected part. The terrain inside this management unit is intersected with canals, ponds, depressions, etc. The altitude ranges from 82 to 86 m. During the high water level, the Danube River pours out of its riverbed and floods this flood-prone area, which among other things had an impact on the formation of certain plant communities. The average annual rainfall is 583,3 mm, and during vegetation it amounts to 333,4 mm (Special forest management plan for the FMU "Apatinski rit").

The forest management unit (FMU) "Gornje Potamišje" represents a homogeneous whole, with a width ranging from several hundred meters to 2.5 km. It is located in the area between the floodgates in Opovo and Tomaševec. The natural border consists of loess terraces, and the Tamiš and Karašac Rivers in other parts.

The forests of this area are characterized by a highly developed micro relief, which has a decisive influence on the flooding regime and the groundwater regime. Inundations intersect extreme depressions and remains of abandoned parts of the riverbed, where water is retained throughout the year. The climate of this area is typical for the wider area of Vojvodina, as part of a large closed basin. The secondary maximum of precipitation occurs at the end of autumn and most often in December. The season with the highest precipitation is summer with an average 1/3 of annual precipitation. The lowest precipitation is recorded in autumn and winter. During the vegetation period, the amount of precipitation accounts for 56% of the total annual precipitation (Special forest management plan for the FMU "Gornje Potamišje").

A sample plot was established in the area of this FMU, in a poplar *Populus* × *euramericana* 'I-214' plantation which is exposed to the impact of flooding. The planned rotation is 25 years, and the planting spacing is 6 × 6 m, i.e. 278 seedlings per hectare. The control sample plot was established in the FMU "Donje Podunavlje" located in the south Banat area, in the territory of the municipalities of Pančevo and Kovin. It extends along the Danube River, in the form of a 55 km-long belt. Most of the areas are occupied by the largest Danube River islands, and a small part of the FMU is located in a protected area. The central part and the area close to terraces are located in a protected zone of the alluvial plane. A control sample plot, which was not exposed to the impact of flooding was established in that part of the management unit.

2.2 Method

Felling was conducted in the sample plots in order to measure the elements needed for theoretical cutting. The choice of stems for the analysis was carried out using the principle of random sampling. The data of measurements performed were entered into the recording list created for the purpose of this research. All the elements necessary for the qualitative division of the stem, as well as other details that can be significant in the analysis of the results (noted as a phenomenon) were recorded.

The order of recording corresponded with the basic principles of qualitative division of a tree. The health state of a tree was determined at the forefront of the stem (canker, etc.), and, after that, two cross-sections (*mm*) were measured. These are the elements that need to be recorded at the forefront of the thicker trunk end and at cross sections, after the trunk has been cut through, and can be expressed either numerically or descriptively.

The diameters were cross-measured at every two meters starting from the thicker end of the stem, primarily for the purpose of ovality calculation.

The curvatures of the stem were measured before it was cut through and that included all curvature elements, regardless of the curvature being left, right, concave or convex (in relation to the axis of felled trees). The elements of the measurement were the lengths of the curvature arch arrow and arch tendon. The shorter knot axis was measured with a ruler with an accuracy of one millimeter, as required by the SRPS standards.

Data processing was performed according to the methodology that enables dealing with similar research problems in previous investigations [1].

The value of assortment classes is expressed by the value ratio of classes. The value ratio was derived from the price lists of the Public Enterprise "Srbijašume" for assortments produced according to the national (SRPS) standards. The price of 1m^3 of class II logs was taken for the coefficient 1 value.

In addition to the data directly measured in the field, data on the level of water in the area where the sample plots were established were also used. The analysis of losses of harvested timber was conducted in the area of the special nature reserve "Gornje Podunavlje" in the FA "Apatin" and the FMU "Apatinski rit". The analysis covered the annual periods from 2009 to 2013. The data on the quantities lost during flooding events were obtained on the basis of commission reports. The analysis included

both quantitative and qualitative losses of timber in the felling site.

In addition, the data necessary for the assessment of the impact of flooding on the dynamics of the execution of works were taken over from the records of the FA "Apatin".

3 RESEARCH RESULTS

3.1 Impact of flooding on the quality structure of asssortments

In these studies, the initial assumption was that flooding will influence the qualitative structure of assortments in poplar plantations. The impact of flooding is reflected in the higher curvature of the lower, most valuable, part of the stem and it depends on the frequency of flooding and the height of the flood water mirror in the first years of plantation development (fifth to tenth year). During the withdrawal of water into the riverbed, seedlings bend down in relation to the vertical position.

During cold winter months, deposits of ice are formed on the water mirror, which leads to the bending of seedlings.

In the following period of the year, the plant reaches out for light, returning to a vertical position. As a consequence, curvature appears at the lower, most valuable, part of the tree.

During the planning period (25 years), there was no flooding for only one year in the observed sample plot. The terrain was on average flooded three times annually, i.e. at least once a year, and at most six times during one year (Table I). The water mirror level measured from the level of the ground reached a maximum of 2.37 in the first years of plantation development, or an average of about 1 m in height. It should be noted that in the first yeas after plantation establishment, flooding was common in winter, when temperatures are low and snow cover appears, which additionally burdens the plants causing curvature.

Table I: Flooding and its duration

Year	Period		Height
77.	F M A-M	15-28. II. 1-26. III. 18 IV.-6. VI.	1,07 1,03 1,07
78.	M M-J J	3.III.-17.III. 7.V.-8.VI. 5.VII.-14. VIII.	0,67 0,73 0,61
79.	J J-M	6.I.-12.I. 29.I.-2.III.	0,64 0,97
80.	F M-J J-A	8.II.-18.II. 10.V.-24.VI. 29.VII.-13.VII	0,43 0,81 1,24
81.	F-A M-J J-A N-J	26.II.-18.IV. 10.V.-4.VII. 27.VII.-10.VIII. 17.XI.-26.I.	2,37 0,63 0,19 1,19
82.	F M-J	4.II.-8.II. 1.III.-4.IV.	0,51 1,19
83.	M-A	30.III.-11.IV.	1,21
84.	F A-M	3.IV.-25.V.	0,41 1,17
	S-O		0,46
85.	M A M J-J	11.III.-17.III. 1.IV.-29.IV. 10.V.-30V. 27.VI.-7.VII.	0,35 0,43 0,37
86.	M-M	30.IV.-10.V.	0,70
87.	F-M A-J	19.II.-28.II. 3.IV.-28.VI.	0,43 1,61
88.	M-M	20.III.-10.V.	1,63
89.	M-A M J S	29.III.-6.IV. 11.V.-29.V. 10.VI.-16.VII. 2.IX.-8.IX.	0,71 0,61 0,36 1,01
90.	-	-	-
91.	M-J A	17.V.-4.VI. 6.VIII.-18.VIII	0,43 0,51
92.	M-A	28.III.-15.IV.	0,69
93.	M-M	30.III.-5.V.	0,83
94.	J A-M	1.I.-14.I 16.IV.-10.V.	0,21 0,79
95.	A-M M-J	30.IV.-10.V. 19.V.-11.VII.	0,41 0,61
96.	J F-M A M-J S-O N-J	1.I.-20.I. 25.II.-3.III. 4.IV.-27.IV. 27.V.-4.VI. 22.IX.-7.X. 30.XI.-19.I.	1,11 0,33 0,47 0,71 0,35 1,15
97.	F A-M J-A O	20.II.-27.II. 22.IV.-30.V. 28.VII.-18.VIII. 20.X.-24.X.	0,29 1,25 0,87 0,21
98.	J A-M J N	1.I.-22.I. 25.IV.-16.V. 23.VI.-27.VI. 8.XI.-30.XI.	0,49 0,65 0,13 0,73
99.	J F-J J-A D-J	18.I.-21.I. 25.II.-13.IV. 26.VI.-6.VIII. 20.XI.-15.I.	0,11 1,63 0,46 1,27
00.	F-M	5.II.-22.V.	1,25
01.	M-A A-M J-J S-O	22.III.-7.III. 26.IV.-15.X. 24.VI.-11.VII. 22.IX.-8.X.	0,87 0,99 0,65 0,47
02.	A	16.-19.VIII.	0,57
03.	J M	8.I.-16.I. 6.V.-30.V.	0,49 0,89
04.	F F-M N-D D	12.-15. II. 28.II.-8.V. 30.IX.-1.XII. 8.XII.-12.XII.	0,25 1,19 0,17 0,35

The number of stems for analysis in the sample plot and the control plot is adequate (Table II).

The total value of assortments produced from trees of certain dimensions is in direct correlation with the diameter at breast height of a tree. With an increase in the diameter at breast height of a tree, the total value of produced assortments is significantly increased (Table III).

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Table II: The number of required and implemented measurements

Diameter classes		Areas	
		Sample plot	Control plot
27,5 *cm*	R	18	22
	I	21	23
32,5 *cm*	R	33	38
	I	41	38
37,5 *cm*	R	26	38
	I	40	42
42,5 *cm*	R	24	29
	I	45	40
47,5*cm*	R	32	27
	I	42	27
52,5 *cm*	R	29	10
	I	36	12
TOTAL	R	162	168
	I	225	182

R-required, I-implemented

The Reomer-Orphal's distribution was used to determine the strength of the correlation.

The correlation between the value of assortment structure and stem diamater in this plantation is represented by a power function.

$$\ln Y = b \ln X - \ln(a) \qquad (1)$$

The variables are fully correlated. The statistical elements of regression equations are shown in Table III.

Table III: Statistical elements of adopted functions$V_{SS} = f(D_{1,3})$

Areas	Sample plot	Control plot
a	-8,25	-10,47
b	2,39	2,94
t_a	-46,66	-44,42
t_b	50,44	44,91
R	0,959	0,959
R^2	91,94	92,06
S_x	0,138	0,204

V_{SS}-Total value of produced assortments
$D_{1,3}$-Diameter at breast height

An increase in the value of a tree with the growth of the stem diameter is created due to the production of more valuable assortments: logs for peeled veneer, logs for cut veneer and class I logs for processing.

There are no significant statistical differences between the total value of the assortments produced in the sample plot and the control plot (F-1.27, p-0.265). The average value in the sample plot is 1.63, and in the control plot 1.92. However, even though this difference is not significant, it has also been recorded in this case, and it amounts to 0.29.

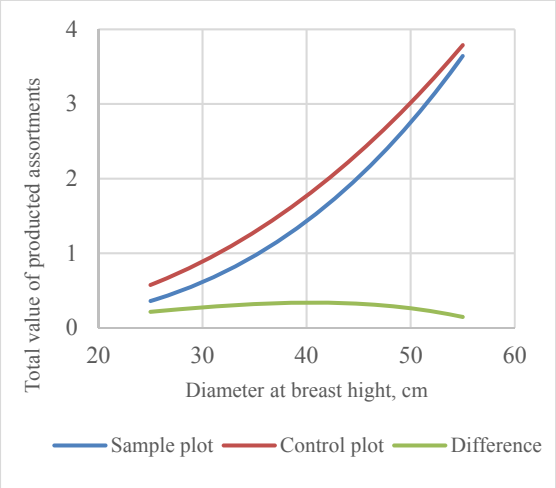

Figure 2: Total value of produced assortments

3.2 Impact of flooding on the losses of timber

Logging and wood assortment production in poplar plantations are implemented throughout the year. The intensity of works in forest utilization is the highest in the summer period (July-November), when the conditions for work in flood-prone terrains are optimal. In the spring period, the dynamics of works execution is affected by the sensitivity of poplar to cracking at the lower, most valuable, part of the stem during felling. The reason is high moisture content in the sapwood and heartwood of the poplar species. In comparison to other broadleaved species, moisture content in the central part is higher than in the peripheral part. Therefore, the intensity of works on felling and wood assortment production is lower in the spring period.

This period of the year is characterized by frequent rainfalls that can cause flooding. There is a particularly pronounced rise of water levels in rivers due to the melting of snow in Central Europe. The appearance of underground surface waters causes an increase in water levels, in some cases exceeding the levels of regular flood defence, as well as the emergency flood protection levels. The limit of regular defence is declared when the water level at the hydrological station Apatin reaches 600 cm, and the limit of the emergency defence when the water level is 750 cm at the same hydrological station.

The zero elevation is 78.84 m altitude, and the level of water levels is added to it. When the water level is 430 cm in the Apatin hydrological station, it is necessary to stop works in the FMU "Apatinski rit", as the roads become impassable.

Water flows out of the riverbed, pours over the canals and ponds flooding the terrain. In the lowest depressions, the flood water remains for a long time, even after the withdrawal into the riverbed. In unfavorable climate conditions (rapid snow melting in the Alps with freezing in the middle and lower Danube streams) winter floods can occur in January and February.

During these floods, it is possible to access the forest only by boats, and it is not an uncommon way to perform skidding. (Figure 3)

Figure 3: Transport of wood by water

Figure 4: Combined transport

In protected areas of forest management units, the water level in ponds and depressions, i.e. the groundwater regime, depends on the water level in the unprotected part.

The characteristics of the water level and flow-average water level for the long-term period are the following:

- Two high-water waves, i.e. two maximums and two minimums occur during one year.
- The main maximum in this part occurs in mid-June, and the secondary maximum in mid-April.
- The main minimum occurs in autumn, as a result of summer droughts in the basins of the main tributaries.
- From September to the end of February, as a rule, there are no maximum water levels. However, high water levels occur in October, November and December.
- The high variation of the water level in the Danube River Basin is the consequence of the diversity of climate conditions in the precipitation region of the Danube and its tributaries.
- The construction and operation of the HPP "Djerdap" significantly changed the regime of the Danube River compared to the natural conditions.

In the case that wood assortments remain in a felling site located in the FMU "Apatinski rit" the connecting of logs with steel reinforcement is performed, and after the withdrawal of water, the works are continued. The data on the incurred damage can be obtained after the completion of skidding.

The timber assortments that remain in the felling sites after the flooding float on the surface of the water (Figure 5). At the moment of withdrawal of water into the riverbed, the water stream carries a part of the timber towards the riverbed. Without previously taken measures to prevent the free movement of logs and stack wood, losses are incurred, since one part of the timber is carried away to the riverbed, which is the Danube riverbed in this case.

Figure 5: Timber in water after felling

Figure 6: Technical roundwood at the Danube riverbank

The quantity of timber assortments lost in this way is analyzed in the area of the FA"Apatin, the FMU"Apatinski rit". The data are systematized and shown in Table IV. The systematization of data was performed for the 2009-2013 period by the type of assortment.

The total quantity of wood harvested in the five-year period in the FA "Apatin" is 165498.73 m^3, or 33099.75 m^3 per year. The total losses of wood created during the flooding amount to 1249.6 m^3, or an average of 245 m^3 per year.

The losses of wood incurred during the investigated period of timber amount to 2294942.4 dinars. The share of wood losses in the total amount of felled wood in the area of the FA "Apatin" is from 0.03 to 1.90%. In value terms, this percentage is lower, since the share of firewood is considerable. The share of classical and meter wood for heating and cellulose accounts for 85.59% of the total losses.

In the case of a deficiency, a commission for the assessment of damages is formed. Another possibility is to suspend all works and form a commission for an extraordinary inventory, which would determine the factual situation in that case.

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Table IV: Type and quantity of wood assortments which appears as loss after the floods from 2009 to 2013.

Type of assortment	F	L	I class	II class	VTO	Firewood I class	Total
Tree species	m^3						
Euromerican poplar	11,74	33,3	49,22	60,92	41,75	905,36	1102,29
Willow	0	0	4,65	6,5	0	34,16	45,31
White poplar	0	0	3,2	5,35	0	0,69	9,24
American ash	0	0	0,97	0	0	5,52	6,49
Elm	0	0	0	0	0	13,12	13,12
Other soft leaves	0	0	0	0	0	45,85	45,85
Other hard leaves	0	0	0	0	0	27,27	27,27

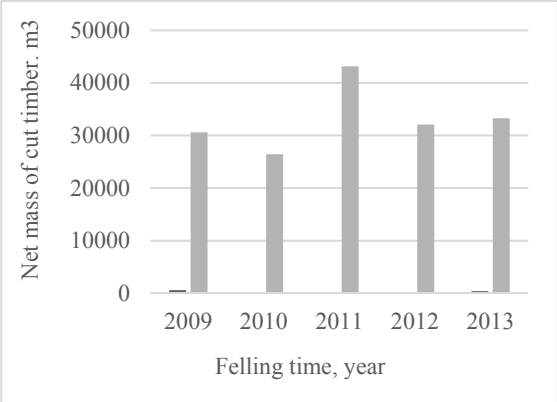

Figure 7: Total amount of felled timber and losses created after flooding in the 2009-2013 period

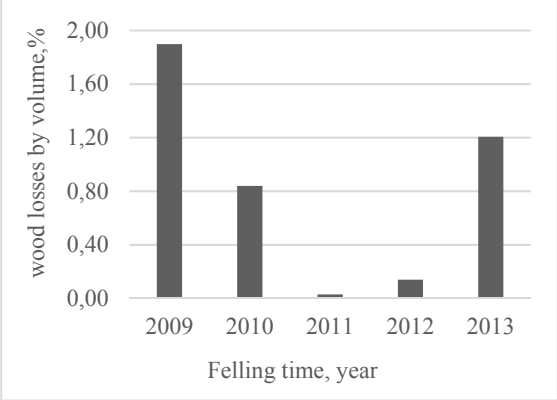

Figure 8: Share of losses in the total amount of produced assortments

After a detailed review, the commission makes a report, which requires several days of work and engagement of a number of persons, as well as the use of machinery, which is deficient and expensive. In addition, there are costs of re-stacking of scattered pulp wood and determination of its amount. The current Forest law does not clearly regulate matters related to the collection of wood material from the river or from the coast after a flood event.

This wood material ends up in the possession of organized groups dealing with its collection and sale. It is generally very difficult to prove the origin of that material, since there are no specific visible marks on it.

3.3 Impact of flooding on the dynamics of works execution

The value of a forest is estimated on the basis of several indicators, and one of them is the value of produced wood. It varies depending on the quality of produced assortments and their prices. The curvature of the logs is correlated with the diameter, length and diameter decrease, and it significantly influences the value of the logs and assortments produced in further mechanical processing (Tuner and Tombleson, 1999).

The planning of works on forest utilization is a demanding and complex activity. It is necessary to align the activity plan with activities that are limited regarding the available technical capacities, weather, market trends and organizational abilities at various levels of an enterprise. The consequences that appear after poor planning are multiple and primarily related to the non-execution of planned activities in the observed period, which in turn affects the financial results of a company's operations. That problem is not only the concern of a timber raw material producer, but a general problem of the supply chain in the raw materials market. This chain includes wood processing capacities, energy plants, pulp and paper production plants, plants for the production of final wood products, the needs of citizens for wood, etc. The need for raw materials is in a large number of cases related to the fulfillment of contracted obligations of employers in the national and international markets. A failure to fulfill contractual obligations may lead to the termination of contracts and other undesirable events.

Clear cutting in the area of the FA "Apatin" is carried out on an area of 120 ha with an average felling volume of about 350 m^3 per ha. The largest part of the total area planned for cutting is mostly exposed to the impact of flooding. The planning of works in unprotected areas is performed so that the logging and production of wood assortments in compartments and sections at the lowest elevations are planned for the dry season of the year, i.e. in the period with the lowest probability of flooding.

In the FA "Apatinski rit", the problems in the execution of works in forest utilization appear at the Danube water level of +260 m. At that water level, the water is 20 cm above the the road level at the crossings over the Srebrenica canal, which stops works in the largest part of the area of fish ponds of Kanlija pesak and Duboki jendek.

When it comes to the area of the Harčaš fish pond, at a water level of +300 m, the access of machinery (forwarders and tractor teams) is not possible. At a water level of +420 m, all four stone paths in the FMU "Apatinski rit" are exposed to the impact of flooding at their lowest parts.

This situation suggests that the works of logging and assortment production in the unprotected part of the FMU

"Apatinski rit" during flooding should be planned to be organized in the FMU "Protected forests", thereby reducing the impact of floods on the dynamics of planned works.

The number of effective days of work on the operations of forest utilization is on average 170 per year.

4 DISCUSSION OF RESEARCH RESULTS

Based on the results of these studies, it appears that floods occurring in the forelands of large rivers have a continuous impact throughout the entire process of wood assortment production. The impact of curvature on the assortment structure is significant, because it occurs on the lower, most valuable, part of the tree, and in co-occurrence with various other factors (wind, light), the impact of this characteristic is even higher and generally manifested as multiple curvature. This feature of a tree cannot be completely avoided, although it can be reduced by certain measures. The suggested measures are increasing the quality of planting, straightening of the seedlings after floods, etc.

The quantity of assortments occurring as a loss cannot be ignored even though these are not large quantities. They are mostly small-size assortments from the stack wood category. The amount of loss can be significantly reduced if adequate measures are taken. These could be either planned performance dynamics or technical measures. An example of such a measure is to connect the assortments in the felling site during the flooding.

The assortments which remain in the felling site must be connected with the steel reinforcement before the arrival of flood water along the periphery of the felling site in order to reduce the losses resulting from the withdrawal of the water into the riverbed. In this way, an obstacle is formed from the edge trees, which prevents timber assortments from being taken away by the water stream. These trees are cut at the end of the harvest.

This operation is performed by a team of two workers with a boat and a tool for installing the steel reinforcement. It is important to know the direction of the water withdrawal, in order to position the reinforcement on the right side.

These protection measures have proved to be effective in practice, although it is not possible to preserve all stack wood in this way.

After the withdrawal of the water, the assortments in the felling site are concentrated in the lower part along the direction of the water withdrawal.

5 CONCLUSIONS

The following conclusions were reached on the basis of the conducted research:

- The total value of assortments produced from trees of certain dimensions is in direct correlation with the diameter at breast height of a tree.
- There are no significant statistical differences between the total value of produced assortments in plantations that are exposed to the impact of flooding and the plantations located in the area protected from floods. The impact of curvature in the plantations exposed to floods is more than twice as high as the impact of curvature in the plantations protected from floods.
- Wood losses after the occurrence of a flood event can be significantly reduced if the logs are previously connected with steel reinforcement.
- The share of wood losses in the total quantity of felled wood in the area of FA "Apatin" is from 0.03 to 1.90%.
- The share of classical and multi-purpose wood for firewood and cellulose accounts for 85.59% of the total losses.
- The works in unprotected areas and departments and sections at the lowest elevations should be planned for the dry season of the year, i.e. at the time with the lowest flooding potential.

6 REFERENCES

[1] Danilović M. 2000: Značaj i uticaj faktora kvaliteta na sortimentnu strukturu u intenzivnim zasadima topole Populus×euramericana 'I-214', Magistarski rad, Šumarski fakultet, Beograd.

[2] Danilović M. (2006): Proučavanje faktora kvaliteta u zasadima topole *Populus×euramericana* 'I-214' i *Populus×euramericana* 'Ostia' sa aspekta primene nacionalnih i evropskih standarda, Doktorska disertacija, Šumarski fakultet, Beograd.

[3] Ehrenberg C (1976): Breding for stem quality, Unisylva No. 97-98,2., 1-16.

[4] Herpka I. (1979): Uticaj tenzionog drveta na proučavanje zapreminske težine juvenilnog drveta topole u sekciji, Topola, 123-124, Beograd.

[5] Holt D.H. and Murphy W.K, 1978: Properties of hybrid poplar juvenile wood affected by silvicultrual treatments Wood Science and technology 10(4): 198-203, 1978.

[6] Isebrands**,** J.G., and Parham**,** R.A. (1974**):** Tension wood anatomy of short-rotation Populus spp. before and after kraft pulping. Wood Sci. 6(3): 256-265.

[7] Knežević M. (1969): *Način istraživanja zakrivljenosti trupaca i njen uticaj na procenat iskorišćenja*, Šumarstvo 5-6, Beograd.

[8] Mutibarić J. (1969): Stanje i perspektiva mehaničke i hemiske prerade drveta topole i vrbe u Jugoslaviji, Topola 73-74, Beograd.

[9] Taylor F. W., Wagner F. G. (1996): Impact of log sweep on warp in douggaas-fir structural lumber, Forest Products Journal, 53-56.

[10] Turner J. A., Tombleson J. D. (1999): Prediction of final sweep in pruned Pinus Radiata logs from juvenile sweep measurements, New Zeland Journal of forestry science, 29, 1. 146-164.

[11] Knjiga o poplavama u Apatinskom ritu. Pozz....

[12] **(1989): Zbirka jugoslovenskih standarda za drvo, Beograd.

[13] **Posebna osnova gazdovanja šumama, G.J."APATINSKI RIT", Sombor.

[14] **Posebna osnova gazdovanja šumama, G.J."GORNJE POTAMIŠJE", Pančevo.

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