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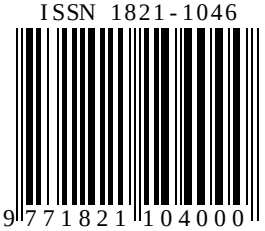

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BIOLOGICAL RECLAMATION OF LANDSCAPE DEGRADED BY SURFACE MINE EXPLOITATION -CASE STUDY OF COAL SURFACE MINE "TAMNAVA – ZAPADNO POLJE"

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Abstract: *Degraded landscapes, ecosystems out of the natural balance and areas with impaired aesthetic value are just some of the issues man is facing nowadays. Failure to resolve those issues is both luxury and a major threat leading to the degradation of the entire environment. Biological reclamation, phytomediation and other technologies for the recovery of the environment based on the use of plants represent appropriate ways for easy remedy of the consequences caused by surface coal mining. This paper presents a proposed solution for reclamation of a part the disposal site of the open pit coal mine Tamnava – Western field. Biological reclamation ought to enable restoration of the landscape degraded by the surface lignite mining close to its original condition from the pre-mining period. The works undertaken under obligation to incorporate the reclaimed landscape into the structure of the surrounding area in all ecosystem aspects to the maximum extent possible should result in revitalization and reclamation of the degraded landscape in such a manner that, following the lignite exploitation period, it can be reused. Selecting the appropriate dendroflora species, method of setting up the protection zone and technological procedure for soft landscaping of plateaus and slopes will result in restoration and strengthening of natural components, creation of more favorable microclimatic conditions, protection of land from erosion, protection of the open pit surrounding area from air pollution, and creation of visual barriers and habitats for the return of the old and arrival of the new plant and animal species.*

Key words: surface coal mining, degraded landscape, biological reclamation, revitalization

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BIOLOŠKA REKULTIVACIJA PREDELA DEGRADIRANIH POVRŠINSKOM EKSPLOATACIJOM UGLJA NA PRIMERU POVRŠINSKOG KOPA „TAMNAVA – ZAPADNO POLJE“

Izvod: *Dregradirani predeli, ekosistemi van prirodne ravnoteže i prostori narušenih estetskih vrednosti su samo jedni od problema sa kojima se čovek danas sreće. Nerešavanje ovih problema predstavlja luksuz i veliku pretnju, koja svakako dovodi do degradacije celokupne životne sredine. Biološka rekultivacija, fitoremedijacija i druge tehnologije za oporavak životne sredine koje se baziraju na korišćenju biljaka, predstavljaju dobar put, kojim bi lako mogle da se saniraju posledice koje za sobom ostavlja površinska eksploatacija uglja. Ovaj rad prikazuje predlog rešanja za rekultivaciju dela odlagališta površinskog kopa „Tamnava – zapadno polje“. Biološkom rekultivacijom treba da se obezbedi privođenje prostora narušenog površinskom eksploatacijom uglja lignita na kopu „Tamnava – Zapadno polje“ do približno prvobitnog stanja pre rudarske aktivnosti. Radovi treba da omoguće revitalizaciju i rekultivaciju degradiranog prostora, tako da on po završetku eksploatacionog perioda može ponovo da se koristi, uz obavezu da rekultivisani prostor bude maksimalno ukomponovan u strukturu okolnog predela po svim delovima ekosistema. Izborom odgovarajućih vrsta dendroflore, metoda osnivanja zaštitnog pojasa i tehnološkog postupka za ozelenjavanje platoa i kosina omogućiće se obnavljanje i jačanje prirodnih elemenata, stvaranje pogodnijih mikroklimatskih uslova, zaštita zemljišta od erozije, zaštita okoline kopa od aerozagađenja, stvaranje vizualnih barijera, kao i staništa za povratak starih i dolazak novih biljnih i životinjskih vrsta.*

Ključne reči: površinska eksploatacija uglja, degradirani predeli, biološka rekultivacija, revitalizacija

1. INTRODUCTION

As a result of setup of open pit mines and surface mining, landscapes suffer substantial alteration, not only to their structure, but also to their purpose, flow of matter and energy, landscape outline, etc. Local population inevitably migrates to other locations, flora and fauna change, new infrastructure facilities are introduced into the landscape, huge quantities of matter and energy are extracted from the landscape, different pollutants are generated and the landscape gradually becomes imbalanced (Dražić *et al.*, 2010).

In addition to the environmental pollution, a particular issue is that of occupation and degradation of vast areas of land. Upon disposal, geological series are usually randomly distributed over the disposal site, which leads to the creation of areas with mixed overburden materials with different physical, mechanical and chemical properties (Dražić*,* 2002). Because of the manner in which overburden is removed and disposed of, series of soil with substantially reduced biological value commonly end up on the surface of the disposal site, whereas the humus layer is found at the bottom. In addition to reducing the quantity of nutrients, which would otherwise be available to the vegetation spontaneously inhabiting the site, such a manner of overburden disposal affects the bearing capacity and stability of the disposal site/landfill itself. Disposal of stripped overburden as a mixture of different layers onto the external disposal sites can easily destroy any form of vegetation in the surrounding area (Dražić *et al.*, 2012).

Today, an environmentally aware society defines clear requirements in order to prevent and remedy various forms of pollution originating from the industry and other sources of environment contamination. In this respect, techniques using plants in order to alleviate adverse effects of and prevent further soil, water and air pollution are becoming more and more significant. In addition to the protective function, plants can assist in full recovery of the degraded areas through the biological processes of phytoremediation.

It is this understanding of the significance of environmental protection and increasing focus on the reclamation of the degraded land at open pit mines of the Kolubara-Tamnava basin that has led to investing great efforts into restoring the land for agriculture and forestry, reducing the environmental pollution with harmful substances, preventing erosion of slopes and providing water supply near open pit mines. Moreover, the efforts have been made not to disrupt the relief by landscaping but to create opportunities for establishing recreational centers and leisure zones instead.

Previous experience in area reclamation and landscaping (Schlattzer, 1973; Knabe, 1973; Jonaš, 1973; Lindley and Mansfild, 1979; Hage *et al.*, 1996; Hildmann and Wonsche, 1996; Bismarck, 2000; Dražić *et al.*, 2002) suggested the possibilities for arranging lignite basin areas and provide multifunctional facilities with modifications imposed by the newly created environmental conditions, manner of deployment, equipment and other factors. There is no need to insist on the restoration to the authentic shapes, facilities and functions that existed prior to the commencement of the mining activities; instead, taking into account the altered ecological, social and other conditions other ambience values of these landscapes can be created (Čule *et al.*, 2012). Such areas, with their relief, vegetation, actually existing and potential water bodies and by appropriate planning of further reclamation and restoration works can provide all natural and other prerequisites for various activities (Dražić, 2002). The aforedescribed transformations ought to make the post-mining landscapes attractive, rich in offer of amenities and multi useful for the inhabitants of the surrounding settlements despite drastic alterations to the landscape and ecosystems (Dražić, 2006).

The area under the open pit mine "Tamnava – Western Field" is situated in the south of the Posavina-Tamnava Lowland within the territory of the Municipality of Lazarevac. It constitutes a part of the disrupted and almost completely destroyed autochthonous anthropogenic spatial units and their original contents, both living and non-living. This open pit mine, as other surface mines, represents an area with more or less sterile substrate. Unless reclamation is performed, such areas are subject to intense eolian erosion, which causes air pollution jeopardizing the environment of a larger area.

At such man-made biologically empty and degraded areas, self-renewal – spontaneous revitalization – is ether impossible or inadmissibly slow. In order to enable formation of initial vegetation as soon as possible, which will in the long run lead to the final stages of formation of biocenoses and ecosystems, technical and technological process of reclamation is to be applied.

The area selected for reclamation is a part of the inner disposal site. The disposal site consists of a cassette for gypsum, cassette for ash, two plateaus and two slopes. The slopes and plateaus are intended for reclamation.

2. LANDSCAPE ANALYSIS

The open pit mine "Tamnava – Western Field" is located about 50 kilometers to the south-west of Belgrade and covers an area of 1,569 hectares within the region of Šumadija, with topography typical for valleys and mildly rolling terrain at the altitude between 100 and 160 meters. It is situated along the lower course of the Kladnica River, i.e. in the floodable area between this river and the Kolubara River. This is why in pre-mining period there were forests of *Querceto Fraxinetum Serbicum* in higher and poplar and willow forest communities in lower wastelands (Vučković, 1986.).

The area (a part of the inner disposal site) intended for reclamation is located at the north-east section of the Western Field. Plateau A is located at level 109, and Plateau B at level 94. Between the two plateaus there is Slope a and at the foot of Plateau B there is Slope b. The total area of land intended for reclamation covers 86.9 hectares.

Figure 1. *Position of Plateaus A and B (left) and Slopes a and b (right) within the disposal site*

Based on the analysis of climatic parameters for development of flora (temperature, precipitation and winds), it may be concluded that the climate of the Kolubara basin is rather dry, with continental and steppe climate properties (Dražić *et al.*, 2012). In winter months there is little precipitation and the soil does not provide sufficient moisture in the initial vegetation phase. In late spring precipitation is plentiful but not sufficient to prevent injury form summer heat. Moreover, even if larger quantities of rainfall occur in June, July and August, those are still insufficient due to the high air temperatures. In fall there is substantial precipitation, yet rains are untimely as they occur toward the end of the vegetation period. The analysis of the climate elements confirms that the climate of this area is under strong steppe climate influence from the Pannonia Plane.

The analysis of the soil leads to the conclusion that substrates (deposols) formed from the tailings on the surfaces intended for biological reclamation exhibit poor physical properties, which, in addition to the low contents of humus and lack of easily available nutrients, causes low effective and potential fertility of those surfaces. Therefore it is necessary to perform melioration which will lead to formation of structure aggregates, which will, in turn, improve the physical

properties of the substrates and trigger pedological processes. It is vital that the substrates be enhanced with organic matter, which will improve the structure of the substrates and give rise to the biological processes within soil as energy materials for the work of a large number of heterotrophic microorganisms in the soil. This will further induce the processes of organic matter degradation and humus synthesis, and further humification processes will lead to the inflow of plant assimilants. Pedological processes will commence and gradually, over time, convert the tailings into fertile soil.

Natural vegetation of this region comprised forests of white willow (as. *Salicetum albe* Issl., 1926), forests of English oak with broom (as. *Genisto elatea-Quercetum roboris* Horv., 1938), forests of English oak and hornbeam (as. *Carpino betuli-Quercetum roboris* Rauš., 1969), forests of English oak with and hornbeam with silver linden (as. *Carpino-quercetum roboris* subas. *Tilietosum tomentosae* Rauš., 1969), forests of sessile oak and hornbeam with butcher's broom (as. *Querco-Carpinetum* subas. *aculeatetosum* Jov., 1951), forests of sessile oak and hornbeam with Hungarian oak (as. *Querco-Carpinetum quercetosum farnetto* Gaj.), forests of Hungarian oak and Turkey oak (as. *Quercetum farnetto-cerris* Rud., 1949), stands of silver linden (*Tilia tomentosa*) and Turkey oak (*Quercus cerris*), etc. (Vučković, 1986.). Setup of surface mines and surface mining have degraded the natural vegetation to a great extent.

In previous works on land reclamation in the Kolubara-Tamnava lignite basin, a number of forest plantations of deciduous and conifer species have been grown. Depending on the micro-environmental conditions and the types of deposol, a large number of deciduous and conifer species were used for forestation (Dražić *et al.*, 2011). In numerous reclamation projects, the selected species used were the following: *Pseudotsuga menziesii* Mirbel. Franco, *Picea pungens* Engelm., *Picea abies* L. Karst., *Larix europaea* Lam. et DC, *Pinus wallichiana* A. B. Jacks., *Pinus strobus* L., *Pinus ponderosa* Dougl. et Laws., *Pinus nigra* Arn., *Pinus silvestris* L., *Chamaecyparis lawsoniana* Murr. Parl., *Liriodendron tulipifera* L., *Ulmus pumila* L., *Quercus borealis* Michx., *Quercus robur* L., *Betula pendula* Roth., *Alnus glutinosa* L. Gaertn., *Populus x euramericana* Dode. Guinier., *Tilia* sp., *Robinia pseudoacacia* L., *Acer negundo* L., *Acer platanoides* L., *Acer saccharinum* L., *Acer pseudoplatanus* L., *Fraxinus excelsior* L., *Fraxinus americana* L., etc. (Dražić., 2006). Using the above listed species, stable forest ecosystems were formed, with allochtone and autochtone species and rich in flora diversity.

3. BIOLOGICAL RECLAMATION OF THE PLATEAUS AND SLOPES OF THE DISPOSAL SITE

Biological reclamation of the open pit mine Tamnava – Western Field is to enable restoration of the area disrupted by the surface lignite mining in the open pit mine Tamnava – Western Field close to its original condition from pre-mining period. The works undertaken under obligation to incorporate the reclaimed landscape into the structure of the surrounding area in all ecosystem parts to the maximum extent possible should result in revitalization and reclamation of the

degraded landscape in such a manner that, following the lignite exploitation period, it can be reused.

Taking into account the environmental conditions (climate, substrate, types of habitats), condition of the vegetation in the industry plant impact zone and objectives set at provision of multiple positive functions by taking biological measures, dendroflora species were selected.

Woody species are used for forestation of plateaus A and B. One conifer and four deciduous tree species were proposed for reclamation: *Pinus nigra* Arnold – Austrian pine, *Tilia parvifolia* Ehrh. – small-leaved linden, *Tilia argentea* Desf. ex DC. – silver linden, *Ulmus pumila* L. – Siberian elm and *Betula verrucosa Ehrh.* – silver birch.

Herbaceous species are used for landscaping Slopes a and b. The following species: *Spiraea x vanhouttei* (Briot.) Zbl. and *Pyracantha coccinea* M. Roem. were selected as the most suitable.

The proposed woody and herbaceous species fully meet the requirements necessary for the plants in such an area. In addition, the combination of these species will achieve an even better effectiveness of the zone given the fact that weaknesses of one species are compensated by the advantages of another one. For example, the zone features a combination of trees and shrubs minimizing the boundary layer conductance. Beside the protective function, i.e. prevention of particle dissemination from the disposal site, upon selection of vegetation, other functions mandatory for such a category of green area were taken into account. The selected species are therefore very decorative, the compact form of greenery will result in the reduction of noise level in the vicinity of the disposal site and, in time, a green area will be formed which will completely blend into the surroundings.

Seedlings to be used for reclamation of the plateaus and slopes must originate from the registered nurseries, must be of even quality, with well-developed root systems and stems, without mechanical damage or injury caused by insects and diseases (Veselinović *et al.*, 2010). Only well nurtured transplanted seedlings (trees of 3+0 and shrubs of 0.3 to 0.5 m in height), balled and burlapped are planted. In this manner, unhindered starting growth will be enabled within the first year following plantation and solid growth and yield and functional development in the near term. This is particularly significant given the green area category being established at the disposal site.

3.1. Method of Protection Zone Establishment

Given the aforesaid task, formation of two large masses of trees on Plateaus A and B was proposed. For the slope separating the two plateaus (Slope a) as well as for Slope b, herbaceous species were planned as the slopes are rather steep. The entire area intended for reclamation will also be grassed.

3.1.1. Reclamation through forestation on Plateaus A and B

The total area of Plateaus A and B covers 76.8 hectares. Here triangular plantation of trees is carried out at distances of 6 x 6 m. The ratio of conifer to deciduous seedlings equals 40:60.

Plateau A is divided into two parts given the varying width of the stretch to be forested.

The first part is 180 meters long and 1,167 meters wide. Woody species will be planted there in 34 rows. Looking from the western side of Plateau A toward Plateau B, the green belt of trees will appear as follows: the Siberian elm will be planted in 8 rows in full length; small-leaved linden will be then planted in 8 rows in full length; in the next 7 rows at each 50 meters the Austrian pine seedlings will be followed by silver linden; there will be 3 rows of the Austrian pine seedlings in full length; eventually, there will be 8 rows with intermittent silver birch and Austrian pine seedlings at each 50 meters.

The second part of this Plateau is 935 meters long and 101 meters wide. The green stretch will comprise the total of 19 rows of trees. Looking onto the stretch from the same point as in the case above, the plantation scheme will be as follows: 2 rows of the Siberian elm in full length; 1 row of small-leaved linden in full length; 6 rows with intermittent Austrian pine and silver linden at each 50 meters; 3 rows with Austrian pine seedlings in full length; and finally, 7 rows with intermittent silver birch and Austrian pine seedlings at each 50 meters.

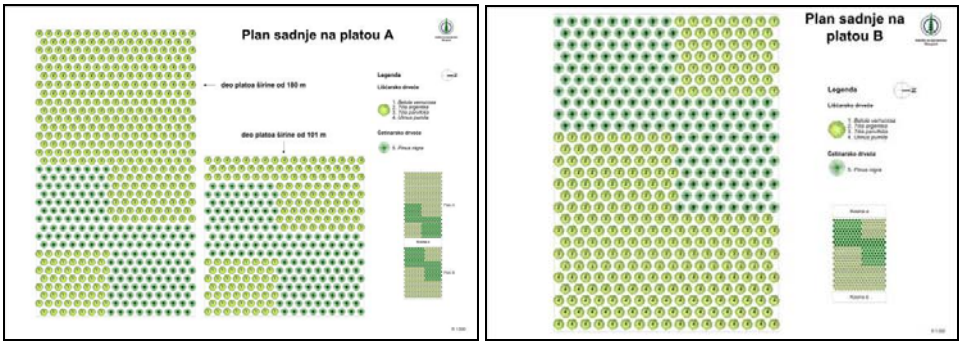

Figure2. *Plantation plan for Plateau A (left) and Plateau B (right) in a 100-meter length*

Plateau B is 3,291 meters long and 141 meters wide, allowing for the plantation in the total of 26 rows. Looking from Plateau A toward Plateau B, the rows follow each other as follows: 7 rows with intermittent silver birch and Austrian pine seedlings at each 50 meters; 3 rows of the Austrian pine in full length; 7 rows with intermittent silver linden and Austrian pine seedlings at each 50 meters; 4 rows of small-leaved linden in full length; and finally, 5 rows of elms in full length.

3.1.2. Reclamation through forestation on Slopes a and b

The total area intended for reclamation in Slopes a and b covers 10.1 hectares. The plantation on Slope a will be identical to that on Slope b. Triangular plantation of shrubs at distances of 2 x 2 m will be carried out.

Slope a is 3,284 meters long and 22 meters wide. Slope b is 3,366 m long and varying in width from 6 to 41 meters.

Plantation of shrubs in the first row of each slope will commence at 9/5 meters from the slope peak. At each 50 meters there will be intermittent seedlings of *Spiraea x vanhouttei* (Briot.) Zbl. and *Pyracantha coccinea* M. Roem. The following 3 rows will be identical. The final fourth row ends at 8.5 meters from the slope foot. In this manner, shrub grouping is positioned in the midst of both slopes so that the growth will not be affected even when the trees on the plateaus reach larger sizes.

3.1.3. Reclamation through grassing plateaus and slopes

Setup of a lawn on the entire area intended for reclamation (86.9 hectares) represents an efficient way of protection from eolian erosion. The problem that is to be resolved upon lawn setup on this substrate is bonding and stabilizing the substrate itself in order to prevent eolian erosion until the grassy cover is formed, as well as introduction of substantial quantities of organic and mineral fertilizers.

As the most suitable mix of species the following combination was selected: red clover - 20 kg per hectare, Italian ryegrass - 12 kg per hectare and orchard grass - 12 kg per hectare. The share of red clover is significant as red clover is a species best suited for the reparation of land in the short term.

3.2. Technological Procedure of the Green Zone Formation

The plan is to commence the procedure of biological reclamation with planting woody and herbaceous plants and grass the area thereafter. If the procedure were reversed, it would be possible to damage the newly-sawn lawn. However, if the investor is not in possession of sufficient funds to have these operations performed in succession, it is possible to have the grasses sawn first and, after the lawn has formed, to commence deciduous and conifer tree species. It is recommended that the works be initiated in spring, before vegetation starts.

Prior to plantation, agro-technical preparation of the terrain was completed and locations of planting holes were marked.

Plantation of trees and shrubs was performed using the standard technological procedure, with machinery digging circular planting holes (60 x 60 cm) for the trees, whereas the holes for planting shrubs were dug manually.

Given the fact that the soil is poor in respect of the available nutrients and inability to provide the seedlings with sufficient quantities of water in the initial nurturing period, upon plantation, a mix of hydro absorbing substances and nutrients, root growth activating and supporting substances will be added to the soil (*TerraCottem Univerzal* preparation), which would absorb water and gradually

release it together with the nutrients over the period most significant for the development of plants. The application of this treatment allows for reducing the need of irrigation by as much as 50%, given the extremely high water retention efficiency. All the seedlings will be abundantly watered upon completion of the plantation.

Following the agro technical preparation of the terrain for lawn formation, the preparation *TerraCottem Turf* will be introduced into the soil in order to provide the future lawn with sufficient quantities of nutrients and water. Sowing will be conducted manually in two cross-directions. The sawn area will then be rolled over using the spiked and smooth grass rollers and abundantly watered thereafter using sprinklers.

Implementation of nurturing and protective measures is uniform for both trees and shrubs. The period of initial nurturing covers the first two years upon plantation. Operations performed during the period include: watering, fertilizing, pollination, weed removal, mulching and pruning. If necessary, harmful insects and diseases are fought as well.

The period of initial lawn nurturing covers the first year upon sawing the lawn. The primary nurturing of the newly formed lawn includes watering, fertilizing, first mowing and weed removal.

Upon the expiry of the initial nurturing period of the newly planted trees and shrubs and newly sawn lawn, implementation of the aforesaid measures ought to continue. The intensity of the measures may be reduced, yet they certainly need to continue to achieve the desired objective – that the green area fulfills its functions.

4. CONCLUSION

Degraded landscapes, ecosystems out of the natural balance and areas with impaired aesthetic value are just some of the issues man is facing nowadays. Failure to resolve those issues is both luxury and a major threat leading to the degradation of the entire environment. Biological reclamation, phytomediation and other technologies for the recovery of the environment based on the use of plants represent appropriate ways for easy remedy of the consequences caused by surface coal mining.

Formation of green zones on the degraded surface, which at some point will grow into stable forest ecosystems, can certainly lead to the revitalization of the surface mine areas. The newly formed protection zones will result in restoration and strengthening of natural components, creation of more favorable microclimatic conditions, protection of land from erosion, protection of the open pit surrounding area from air pollution, and creation of visual barriers and habitats for the return of the old and arrival of the new plant and animal species. In this manner, the biological value of the newly formed landscape will increase. By applying the selected methods and technologies for the setup of protection zone, the landscape degraded by the lignite surface mining in the open pit mine Tamnava – Western Field will in time be restored close to the original pre-mining condition and blended into the structure of the surrounding landscapes in all ecosystem aspects.

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BIOLOGICAL RECLAMATION OF LANDSCAPE DEGRADED BY THE OPEN PIT COAL MINING – EXAMPLE OF THE OPEN PIT COAL MINE "TAMNAVA – ZAPADNO POLJE"

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Summary

At locations where open pit mines are set up, the structure and purpose of landscapes suffer substantial alteration, as do the flow of matter and energy and landscape outline. In addition, local population inevitably migrates to other locations, new infrastructure facilities are introduced into the landscape, plant and animal communities change, flow of matter an energy within the landscape change and the environment becomes polluted. As a result, the landscape's natural balance gradually becomes impaired.

Owing to the development of environmental awareness in modern societies, the techniques using plants to alleviate adverse effects and prevent further soil, water and air pollution are becoming increasingly significant. In addition to the protective function, plants stimulate the recovery of the degraded areas through the biological processes of phytoremediation.

The area under the open pit mine "Tamnava – Western Field" is situated in the south of the Posavina-Tamnava Lowland within the territory of the Municipality of Lazarevac. This open pit mine, as other surface mines, represents an area with more or less sterile substrate. Such areas are subject to intense eolian erosion, which causes air pollution jeopardizing the environment of a larger area. This is why it is important to perform reclamation of this area. The area intended for reclamation is located at the north-east section of the Western Field and consists of two plateaus (Plateau A and Plateau B) and two slopes (Slopes a and b).

Following the landscape analysis, this paper presents the proposed solution for the biological reclamation of the two plateaus and lopes of the disposal site. Taking into account the environmental conditions, condition of the vegetation in the industry plant impact zone and objectives set at provision of multiple positive functions by taking

biological measures, dendroflora species were selected. For the forestation of Plateaus A and B woody species were proposed, i.e. one conifer and 4 deciduous tree species, while for the slope landscaping of the slopes two herbaceous species were proposed. The proposed woody and herbaceous species fully meet the requirements necessary for the plants in such an area. Moreover, the selected species are very decorative; the compact form of greenery will result in the reduction of noise level in the vicinity of the disposal site and, in time, a green area will be formed which will completely blend into the surroundings.

This paper presents a detailed description of the method of the setup of the green zone, i.e. the procedure to be performed upon reclamation through forestation of the plateaus and slopes, as well as upon reclamation through grassing of the plateaus and slopes. There is a description of the technological procedure for the setup of protection zone, whereby it is planned for the biological reclamation to commence with agro technical preparation of the terrain and designation of the planting hole positions, whereafter plantation of the woody and herbaceous species will be carried out, followed by grassing. In addition, implementation of the measures for nurturing and protection of the newly formed green areas is proposed.

Biological reclamation of the degraded area will in time result in the formation of the stable forest ecosystems, which will fully revitalize the open pit mine area. By applying the selected methods and technologies for the setup of protection zone, the landscape degraded by the lignite surface mining in the open pit mine Tamnava – Western Field will be restored close to the original pre-mining condition and blended into the structure of the surrounding landscape.

BIOLOŠKA REKULTIVACIJA PREDELA DEGRADIRANIH POVRŠINSKOM EKSPLOATACIJOM UGLJA NA PRIMERU POVRŠINSKOG KOPA „TAMNAVA – ZAPADNO POLJE“

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Rezime

Na mestima gde se otvaraju površinski kopovi, menja se struktura i namena predela, protok materije i energije, kao i slika predela. Pored toga, stvaranje površinskih kopova dovodi do raseljavanja stanovništva na druge lokacija, unošenja novih infrastrukturnih objekata u predeo, menjanja sastava biljnih i životinjskih zajednica, zagađenja životne sredine, kao i do promene toka energije u predelu. Kao posledica ovih promena, prirodna ravnoteža predela se narušava.

Razvojem ekološke sveti u modernom društvu, tehnike koje koriste biljke kako bi ublažile negativan uticaj i sprečile dalje zagađenje zemljišta, vode i vazduha imaju sve veći značaj. Pored funkcije zaštite, biljke pospešuju oporavak degradirane sredine kroz biološke procese fitoremedijacije.

Područje zahvaćeno površinskim kopom „Tamnava – Zapadno polje“ se nalazi u južnom delu posavsko – tamnavske nizije i teritorijalno pripada opštini Lazarevac. Ovaj kop, kako i ostali površinski kopovi, predstavlja površinu sa sterilnim supstratom u manjoj ili većoj meri. Na ovakvim površinama izražena je eolska erozija, koja dovodi do aerozagađenja i ugrožavanja životne sredine šireg područja. Zbog toga je važno izvršiti rekultivaciju ovog prostora. Površina koja je predviđena za rekultivaciju nalazi se na severoistočnom delu zapadnog polja i sastoji se od dva platoa („A“ i „B“) i dve kosine („a“ i „b“).

U radu je nakon analize predela dat predlog rešenja za sprovođenje biološke rekultivacije platoa i kosina odlagališta. Polazeći od ekoloških uslova sredine, stanja vegetacije u zoni uticaja industrijskih postrojenja i postavljenih ciljeva da se biološkim merama obezbede višestruke pozitivne funkcije, izvršen je izbor vrsta dendroflore. Predloženo je korišćenje drvenastih vrsta za pošumljavanje platoa „A“ i „B“. Za rekultivaciju je predložena jedna četinarska i 4 lišćarske vrste drveća, dok su za ozelenjavanje kosina predložene dve žbunaste vrste. Izabrane vrste drveća i žbunja u potpunosti ispunjavaju sve uslove koje biljke na jednom ovakvom prostoru moraju da imaju. Pored toga, odabrane vrste su vrlo dekorativne, a sama kompaktna forma zelenila će uticati i na smanjenje buke u okolini odlagališta. Nakon određenog vremena, projektovana zelena površina će se u potpunosti uklopiti u okolni predeo. U radu je detaljno opisan metod osnivanja zaštitnog pojasa, odnosno postupak koji treba sprovesti pri rekultivaciji pošumljavanjem na platoima, rekultivaciji pošumljavanjem na kosinama „a“ i „b“, kao i pri rekultivaciji zatravljivanjem platoa i kosina. Opisan je i tehnološki postupak osnivanja zaštitnog pojasa, kojim je predviđeno da biološka rekultivacija započne agrotehničkom pripremom terena i obeležavanjem položaja sadnih jama, nakon čega će se vršiti sadnja drvenastih i žbunastih vrsta, a potom zatravljivanje. Pored toga, predloženo je i sprovođenja mera nege i zaštite novih zelenih površina.

Biološka rekultivacija degradiranih površina vremenom će dovesti do formiranja stabilnih šumskih ekosistema, što će u potpunosti revitalizovati prostor površinskih kopova. Korišćenje odabranih metoda i tehnologija za podizanje zaštitnog pojasa, predeo narušen površinskom eksploatacijom uglja lignita na kopu „Tamnava – Zapadno polje“ će dovesti do približno prvobitnog stanja predela i njegovog uklapanja u strukturu okolnog predela.