Environmental repercussion of subsidence reservoirs reclamation

Edyta SIERKA¹⁾, Tadeusz MOLEND²⁾, Damian CHMURA³⁾

¹⁾ Department of Geobotany and Nature Protection, Silesian University, ul. Jagiellońska 28, 40-032 Katowice, Poland; e-mail: edyta.sierka@op.pl

²⁾ Department of Physical Geography, Silesian University, ul. Będzińska 60, 41-200 Sosnowiec, Poland; e-mail: tedimolenda@interia.pl

³⁾ Institute of Nature Conservation, Polish Academy of Sciences, al. Mickiewicza 33, 31-120 Kraków, Poland; e-mail: chmura@iop.krakow.pl

Abstract: Subsidence basins filled with water are being formed above exploitation fields also in woodland areas leading to changes in water relations simultaneously affecting creation of environmental islands characterized by higher biodiversity in comparison with adjacent areas.

Unfortunately, these types of water reservoirs from the legal point of view are considered mining damage and should thus be reclaimed. Reclamation usually consists in gravitational drainage and filling up with barren rock, appropriate relief forming and afforestation. So performed reclamation practices lead to negative effects both within the subsidence and in adjacent areas. The objective of this work was to determine the impact of reclamation based on filling subsidence with barren rock on changes in hydrology and biodiversity of nearby forest communities. For the purpose of the study two objects were selected: the existing water body and former water reservoir – at present filled with barren rock. Both are situated in Śląskie voivodship (the territory of Mysłowice and Katowice). Within the two objects, hydrological studies at two sampling points in each of the objects and vegetation sampling were performed. The DCA of 12 transects (6 in each object) and statistical analyses of vegetation showed differences between two objects in species composition, especially due to higher abundance and coverage of invasive and expansive species in reclaimed areas. Chemical analyses showed high contamination of surface waters (by e.g. SO_4^{2-} , Cl^- , Na^+) caused by waste deposition in barren rock and the negative effect of coal mine waters supplying the area of reclaimed reservoir.

Key words: *floristic plant species diversity, forests, land reclamation, surface water, water reservoirs*

INTRODUCTION

Industry is one of human activities which lead to profound modifications of natural environment (PEŁKA-GOŚCINIĄK and WAGA, 2003). Such cases are anthropogenic water reservoirs created due to the collapse of surface above underground excavations of coal mine (DULIAS, 2003; JANOWSKI and MOLEND²⁾, 2007).

The mining subsidences are very often formed in forest areas and the environmental islands with different site conditions (Wyspy..., 2002) compared with the former state (SIERKA and SIERKA, 2008). The newly formed water bodies are a permanent landscape element and they influence hydrological conditions and biocoenotic diversity within them and in their vicinity (NEWBOLD and EADIE, 2004). However, in spite of environmental value of such sites, water reservoirs in subsidences are treated as mining damages (according to Polish Geological and Mining Law Dz. U. No 27, position 96 from 1st March 1994) and subject to land reclamation. The reclamation consists in their gravitational drainage and then by filling up with barren rock from colliery wastes, shallowing the depression and afforestation.

Few studies (STALMACHOVÁ, 1997) indicate that reclamation of water reservoirs of such origin is followed by some negative consequences for natural environment because deposition of post-coal mine wastes results in significant changes of quality of water (TWARDOWSKA *et al.*, 1998; MOLENDĄ, 2006). It limits the development of rush vegetation (STALMACHOVÁ, 2004) – significant element of biodiversity.

The objective of this study was to determine the impact of reclamation on floristic diversity within adjacent forest communities and water conditions in reservoir created in the subsidence and filled with barren rock.

STUDY AREA

Study area – Katowice Upland – is delimited after KONDRACKI (1994) and is one of the 5 mesoregions of Silesian Upland (Fig. 1). Upper Carboniferous rocks are the main geological structures of this area which is the base of regional economy (GILEWSKA, 1972). The study objects are situated in the administrative borders of Mysłowice and Katowice city.

The water body “Fala” (1), (Fig. 2), (before reclamation treatments 10.55, now 7.52 ha) was created as a result of building earth bank fastened with concrete screen in the Przyrwa River valley. It was an example of dam reservoir. Despite its anthropogenic character it started to undergo the same spontaneous processes comparable with natural water bodies. However, coal mine activity changed the course of succession. The exploitation of coal caused the subsidence of study object. The depth and the surface area increased. The subsidence resulted in the flooding of some forest areas. The new polygenetic water body was formed. Therefore, land reclamation of this reservoir started in 1955 which mainly included reservoir emptying and building dams of barren rock. Partially barren rock was used to level parts of the reservoir. After termination of these reclamation practices, the water-table declined by 1.3 m. However, unstable formation (further ground settlement)

Fig. 1. Location of the study area on Silesian Upland background; 1 – localization of study objects

Fig. 2. Objects of study; 1 – forests, 2 – basin reservoir “Fala”; 3 – reclaimed reservoir “Świniarnia”
4 – streams, 5 – roads and tracks, 6 – coal main “Wesoła”

and also inflow of episodic waters to girdling ditch resulted in flooding and ground water-logging of forest areas.

The water body „Świniarnia” (2) (Fig. 2) was originally formed in the 19th century as a typical dam reservoir with water wheel. The coal exploitation deformed the substratum and changed the surface area and bathymetry of the water body. As in the reservoir “Fala” polygenetic-dammed-subsidence water body developed. Now it is a water body with permanent inflow, because it is supplied by waters of two streams (Fig. 1). In 1996 flooded land covered an area of 7.6 ha and

together with nearby areas was classified as a mining damage, which according to the law should be reclaimed by the coal mine industry. For this purpose wastes from the “Wesoła” coal mine were used. Surface streams were restored and 7.0 ha out of 14.5 ha were subjected to land reclamation with the afforestation aim. The last phase of management was accomplished by the decision of President of Mysłowice City in January 2006.

MATERIAL AND METHODS

The studies were carried out in the adjoining areas: water body (1) and former water body now filled with barren rock during land reclamation (2). Vegetation data were collected in nearest forest communities along 12 transects (6 in each object) covering 150 m² of an area. The basic subplots, as in other forest studies (DZWONKO and GAWROŃSKI, 2002) were 5 m x 5 m. In total floristic inventory and estimation of percent plants cover (in the scale 1%, 5%, 10%, 20%, ..., 100%) were done in 72 subplots. Detrended Correspondence Analysis (DCA) made with Canoco for Windows 4.5 software (TER BRAAK and SMILAUER, 2002) was used to characterise the difference of species composition between the two objects. The species data included the coverage. Shannon diversity index H' , evenness (N_2/N_1) and species richness N_0 (HILL, 1973) characterised the biodiversity of each subplot. Nomenclature of syntaxonomic units was adopted after MATUSZKIEWICZ (2008), that of vascular plants – after MIREK *et al.* (2002).

Water samples were taken from two sites in each reservoir: close to the inflow and close to the outflow of water courses supplying the objects. Physical and chemical analyses of surface waters included the determination of cations and anions (KRAWCZYK, 1999) according to respective norms: Ca²⁺ (PN-91/C-04551/01), Mg²⁺ (PN-75/C-04554/10), Na⁺ (PN-86/C-04576/10, PN-ISO 9964-3), K⁺ (PN-74/C-04591/01, PN-ISO 9964-3), Cl⁻ (PN-75/C-04617/02), SO₄²⁻ (PN-74/C-04566/09), HCO₃⁻ (PN-74/C-04540/03), NO₃⁻ (PN-86/C-04576/10), PO₄²⁻ (PN-89/C-04537/02), water hardness (PN-72/C-04554/03), conductivity (PN-77/C-04542) and water pH (PN-80/C-04540/07).

Differences in species composition, species richness and diversity as well as the share of ecological groups of species between the two objects were examined using *U* Mann-Whitney test (SOKAL and ROHR, 1995). Wilcoxon pair-matched test was performed to analyse differences in chemical and physical water properties.

RESULTS

In total 151 vascular plant species were found within study objects including 143 in “Fala” and 129 in “Świniarnia”. There were no statistically significant dif-

ferences between vegetation in terms of quantitative measures (Fig. 3). Mean number of species in subplots was 15 in both surrounding areas. Similar results were obtained for H' Shannon index (ca. 2.1) and evenness (ca. 0.05). However, there were qualitative differences i.e. in species composition. The ordination of 72 samples from two sites in the DCA is shown in Fig. 4. The eigenvalues of the 1 and 2 axis were 0.651 and 0.393, respectively. They explained only 10.5% of cumulative variance. High value of the length of gradient (4.738) along 1 axis revealed high heterogeneity of the vegetation. There was statistically significant difference in mean eigenvalues of the 1 axis for two objects which indicates high β -diversity in surrounding objects studied (Tab. 1). There were no significant differences in the share of forest species (representatives of the classes *Quercio-Fagetea*, *Vaccinio-Piceetea*, and *Alnetea glutinosae*), and forest-scrub plants i.e. species of the classes *Rhamno-Prunetea*, *Salicetea purpureae*, and *Betulo-Adenostyletea* (Fig. 5). Non-forest species mainly rush, meadow, and mire species or representatives of the classes *Phragmitetea*, *Molinio-Arrhenatheretea* and *Scheuchzerio-Caricetea* contributed much to the vegetation of both studied sites. However, in the vicinity of reclaimed water body significantly higher mean cover of other accompanying species was observed (Fig. 4). They were chiefly alien species like *Quercus rubra*, *Padus serotina*, *Reynoutria japonica*, *Robinia pseudoacacia*.

Fig. 3. The comparison of mean values of biodiversity indices and mean values of eigenvalues for two transects of objects studied – mean and SD are shown; 1 – basin reservoir, 2 – reclaimed reservoir

Fig. 4. The ordination of the subplots of two transects situated in areas adjoining water body (1) and subsidence reservoir filled with barren rock (2) along the two first DCA axes

Table 1. Chemical and physical properties of two water sampling points in water body (1), all differences in means are insignificant statistically

	Sites of water sampling			
	1		2	
	<i>X</i>	<i>SD</i>	<i>X</i>	<i>SD</i>
Conductivity, $\mu\text{S}\cdot\text{cm}^{-1}$	492.4	58.1	525.5	27.7
pH	6.50		6.88	
Ca, $\text{mg}\cdot\text{dm}^{-3}$	42.88	7.06	37.00	4.31
Mg, $\text{mg}\cdot\text{dm}^{-3}$	15.9	6.0	16.9	4.6
Na, $\text{mg}\cdot\text{dm}^{-3}$	32.0	6.8	35.0	4.9
K, $\text{mg}\cdot\text{dm}^{-3}$	4.3	1.6	4.9	0.5
Cl, $\text{mg}\cdot\text{dm}^{-3}$	66.1	21.6	79.4	20.8
SO ₄ , $\text{mg}\cdot\text{dm}^{-3}$	103.3	32.5	97.4	29.3
NO ₃ , $\text{mg}\cdot\text{dm}^{-3}$	3.9	3.3	0.9	1.0
PO ₄ , $\text{mg}\cdot\text{dm}^{-3}$	0.01	0.01	0.01	0.01
Total hardness, $\text{mg}\cdot\text{dm}^{-3}$	170.5	22.4	163.6	25.8

The comparison of chemical and physical properties of water between sampling points within the same object showed that in water body (1) there were similar water conditions. Both water course (the Przyrwa Stream) and other waters flowing to girdling ditches did not differ significantly in all measured water parameters (Tab. 1). However, analyses of waters in two sampling sites of the reclaimed water body showed very significant differences in conductivity which was more than twofold higher in the second sampling site. Also concentration of sodium, potassium, chlorides and sulphates were much higher in the second sampling point (Tab. 2).

Fig. 5. The comparison of mean cover of species representing various syntaxonomical groups; 1 – basin reservoir, 2 – reclaimed reservoir

Table 2. Chemical and physical properties of the two water sampling points in reclaimed water body (2); the means $\bar{X}$ underlined and in bold in first column differ significantly from means of the second column at the level $p < 0.05$

	Sites of water sampling			
	1		2	
	$\bar{X}$	SD	$\bar{X}$	SD
Conductivity, $\mu S \cdot cm^{-1}$	544.0	210.2	1988.8	1323.5
pH	6.70		6.98	
Ca, $mg \cdot dm^{-3}$	40.7	10.7	69.8	66.7
Mg, $mg \cdot dm^{-3}$	11.0	5.1	26.0	26.1
Na, $mg \cdot dm^{-3}$	23.7	2.1	267.8	205.3
K, $mg \cdot dm^{-3}$	9.0	2.0	26.3	17.9
Cl, $mg \cdot dm^{-3}$	46.0	20.6	380.0	444.5
SO ₄ , $mg \cdot dm^{-3}$	90.17	17.4	138.5	44.4
NO ₃ , $mg \cdot dm^{-3}$	27.83	22.7	1.0	0.9
PO ₄ , $mg \cdot dm^{-3}$	0.31	0.1	0.1	0.0
Total hardness, $mg \cdot dm^{-3}$	156.3	8.9	283.2	274.0

DISCUSSION

Biological characteristics of subsidence reservoirs are limited to few and usually general floristic and faunistic works (e.g. BUSZMAN *et al.*, 1993; TOKARSKA-GUZIŁ and ROSTAŃSKI, 1996; KOSTECKI and KRODKIEWSKA, 2005; SIERKA and SIERKA, 2008) thus, there is a limited possibility of comparison of obtained data

with the literature. This limited comparison results both from the use of different methods of vegetation sampling and from studies within adjacent forests instead of interior of subsidence reservoirs.

A lack of differences in the species number and in Shannon's H indices between the objects studied was probably caused by considerable degeneration of forest phytocoenoses. One of the most important transformations of the studied communities was a domination of *Carex brizoides* in herb layer, what led to unification of the structure, and displacement of other species (SIERKA, 2003; CHMURA and SIERKA, 2007). Also high contribution of Scots pine *Pinus sylvestris* (SIERKA and CHMURA, 2004) to tree stands probably influence homogenization of the studied objects. Perhaps a short period after reclamation was not sufficient to allow development of phytocenotic relationships within surrounding forest vegetation.

The main difference in physiognomy and species composition between water reservoirs and reclamation areas filled with barren rock is the occurrence of the rush species in coastal zone. They enhance self-cleaning of waters within the reservoir and those supplying the reclamation area (STALMACHOVÁ, 1997; 2000). The ecotone vegetation between reservoir and forest communities stabilise soils. Nevertheless, the most important role of these plants is the maintenance of biodiversity. Such type of habitat is a place, where numerous rare and endangered animal and plant species have favourable conditions. The former include e.g. predatory insects (SIERKA and SIERKA, 2008) and birds. Rushes are excellent refuges for birds, breeding sites of amphibians and hiding places of fish (STALMACHOVÁ, 1999). The most advantageous for organisms inhabiting plant communities of the *Phragmitetea* class are reed beds with mean width of 3–5 m (WOLEJKO *et al.*, 2004), which occurred only in the object not subjected to land reclamation with barren rock. They increased the diversity of organisms in this area which was demonstrated by higher number of rush plant species found there as compared with the reclaimed reservoir.

Land reclamation based on filling up the water reservoir eliminates rush communities and enhances penetration of alien species into forest communities. Some of alien species such as *Quercus rubra*, *Padus serotina*, *Reynoutria japonica*, *Robinia pseudoacacia* present in the studied object are considered invasive species (TOKARSKA-GUZIŁ, 2005). The impact of invasive alien species – IAS – is believed to be the most serious, apart from habitat fragmentation, threat to biodiversity in the global scale (MCNELLY *et al.*, 2001). These species are further the factor of disturbance and degeneration and are completely harmful from the nature conservation.

Numerous studies (TWARDOWSKA *et al.*, 1998; MOLENDĄ, 2006) demonstrated that post-coal mine wastes are very important source of water pollution. This study does not permit to directly show the main cause of water pollution in the water body "Świniarnia". Undoubtedly, increased contents of chlorides and sodium are associated with the discharge of heavily salted water. An increase in the con-

centration of sulphates is caused by coal mine wastes deposition. These wastes contain pyrites (iron sulphides) (FeS_2) which, during chemical weathering, become significant sources of sulphates (SO_4^{2-}).

Obtained results do not indicate unequivocally the negative impact of the reclamation of subsidence reservoirs on adjacent forest phytocoenoses. Nevertheless, it seems necessary to postulate avoiding reclamation of subsidence water bodies by their fulfilment. It is possible to transform them into aquatic ecosystems of standard value, which can pose a lesser threat to species diversity of forests (KALIN, 2004) which was shown in the present study.

Unfortunately, a scarcity of complex studies on water bodies created in subsidences both these not reclaimed by filling up (MACIAK, 2006) and those which underwent natural succession and regeneration compared with multitude of analogous works devoted to terrestrial post-coal mine areas is the reason of a lack of ecological bases for their reclamation and management (e.g. WANG *et al.*, 2001, WOŹNIAK *et al.*, 2005). This is probably the main reason of their negative influence on adjacent woodlands which was demonstrates in this study.

CONCLUSIONS

1. Land reclamation of subsidence reservoir by filling up hampers or even makes impossible the development of rush communities (the *Phragmitetea* class) which have great biocenoctic importance.

2. Based on analysis of forest vegetation situated in the neighbourhood of the studied objects one cannot point out direct consequences of filling up the water body with barren rock.

3. Encroachment of alien species into forest communities from reclaimed areas is an important problem.

4. The reclamation practices, apart from changes in the natural environment, profoundly transform inanimate nature e.g. cause changes in chemical composition of waters which are contaminated by leachates from material used for reclamation.

Acknowledgements

The work is financed by the Ministry of Science and Higher Education for 2007–2009 as a Research Project (N305114/32/4126).

REFERENCES

1. BUSZMAN B., PARUSEL J.B., ŚWIERAD J., 1993. Przyrodnicza wartość leśnych stawów w Tychach Czulowie przeznaczonych na zwałowisko odpadów kopalni węgla kamiennego. Kształt. Środ. Geogr. Ochr. Przyr. Obsz. Uprzemysł. Zurbaniz., 8: 10–15.

2. CHMURA D., SIERKA E., 2007. The invasibility of deciduous forest communities after disturbance: A case study of *Carex brizoides* and *Impatiens parviflora* invasion. *Forest Ecol. Manag.*, 242: 487–495.
3. DULIAS R., 2003. Bezodpływowe baseny sedymentacyjne na obszarze osiadań górniczych na Płaskowyżu Bytomskim. W: Problemy geologiczne Górnośląsko-Ostrawskiego Regionu Przemysłowego. Mater. symp. pol.-czes. Red. A.T. Jankowski, M. Rzętała. Sosnowiec, Wyd. Nauk o Ziemi UŚI: 23–27.
4. DZWONKO Z., GAWROŃSKI S., 2002. Effect of litter removal on species richness and acidification of a mixed oak-pine woodland. *Biol. Conserv.*, 106: 389–398.
5. GILEWSKA S., 1972. Wyżyny Śląsko-Małopolskie. W: Geomorfologia Polski. Red. M. Klimaszewski. Warszawa, PWN: 232–250.
6. HILL M.O., 1973. Diversity and evenness: a unifying concept and its consequences. *Ecol.*, 54: 427–432.
7. JANKOWSKI A.T., MOLENDĄ T., 2007. Antropogeniczne środowiska wodne na Górnym Śląsku. Cz. 4. Środowiska powierzchniowe – zbiorniki zapadliskowe i w nieckach osiadań. *Przyr. Gór. Śl.*, 48: 10–11.
8. KALIN M., 2004. Passive mine water treatment: The correct approach? *Ecol. Engrg.*, 22(4–5): 299–304.
9. KOSTECKI M., KRODKIEWSKA M., 2005. Zbiornik Paprocany – immologia, hydrobiologia. *Pr. St. IPIŚ PAN*, 62: 85.
10. MACIAK F., 2006. Ochrona i rekultywacja środowiska. Warszawa, Wydaw. SGGW: 466.
11. MATUSZKIEWICZ W., 2008. Przewodnik do oznaczania zbiorowisk roślinnych Polski. *Vademecum geoboticum*. Wyd. 3. Warszawa, Wydaw. Nauk. PWN: 538.
12. MCNEELY J.A., MOONEY H.A., NEVILLE L.E., SCHEI P., WAAGE J.K., 2001. A global strategy on invasive alien species. Wallingford, Oxon, CAB Intern.
13. MIREK Z., PIĘKOŚ-MIRKOWA H., ZAJĄC A., ZAJĄC M., 2002. Krytyczna lista roślin naczyniowych Polski. *Kraków, Inst. Bot. Pol. Acad. Sci.*: 442.
14. MOLENDĄ T., 2006. Charakterystyka hydrograficzno-hydrochemiczna wpływów wód odciekowych wybranych składowisk odpadów przemysłowych. *Zesz. Nauk. PŚI.*, 272, Górn.: 95–103.
15. NEWBOLD S., EADIE J.M., 2004. Using species-habitat models to target conservation: a case study with breeding mallards. *Ecol. Appl.*, 14: 1384–1393.
16. PEŁKA-GOŚCINIĄK J., WAGA J.M., 2003. Wpływ eksploatacji węgla kamiennego na przyrodę w Górnośląskim Zagłębiu Węglowym – analiza skutków ubytku masy z górotworu. W: Problemy geologiczne Górnośląsko-Ostrawskiego Regionu Przemysłowego. mater. symp. pol.-czes. Red. A.T. Jankowski, M. Rzętała. Sosnowiec, Wyd. Nauk o Ziemi UŚI: 117–124.
17. SIERKA E., 2003. The role of grass species in forest communities with *Carex brizoides* of the Silesian Upland. In: Problems of grass biology. *Kraków, Inst. Bot. Pol. Acad. Sci.*: 503–512.
18. SIERKA E., CHMURA D., 2004. Changes in mixed pine forest (*Quercus robur*-*Pinetum*) as a result of forest economy in the Silesian Upland. *Zesz. Nauk. UZ Inż. Środ.*, 131: 327–334.
19. SIERKA E., SIERKA W., 2008. The effect of flooded mine subsidence on thrips and forest biodiversity in the Silesian Upland of Southern Poland – a case study. *Acta Phytopathol. Entomol. Hung.*, 43 (1): 345–353.
20. SOKAL R.R., ROHLF F.J., 1995. Biometry: the principles and practice of statistics in biological research. 3rd ed. New York, W.H. Freeman and Co.: 887.
21. STALMACHOVÁ B., 1997. Watered depressions as ecological phenomena in regions affected by mining activities. *Proc. Mine Planning and Equipment Selection*. Rotterdam, Balkema: 979–984.
22. STALMACHOVÁ B., 1999. Přírozená vegetace a její význam pro regeneraci hornické krajiny Karvin-ska. *Habilitační práce*. Ostrava VŠB – TU: 220.
23. STALMACHOVÁ B., 2004. The importance of vegetation to the planning of mining landscape regeneration. In: 13th Intern. Symp. Mine Planning and Equipment Selection. Eds. M. Hardygora, G. Paszkowska, M. Sikora. London, Taylor & Francis Group, 242.

24. STALMACHOVÁ B., PERTILE E., VALČÍKOVÁ K., 2000. Ekologické podmínky zvodněných poklesových kotlin hornické krajiny Karvinska. In: Hornická Příbram ve vědě a technice. Sci. Rerum Montan. Příbram: 1–16.
25. TER BRAAK C.J.F., ŠMILAUER P., 2002. Canoco reference and CanoDraw for Windows User's guide: Software for Canonical Community Ordination (version 4.5) – Microcomputer Power (Ithaca, NY, USA): 500.
26. TOKARSKA-GUZIŁ B., 2005. The establishment and spread of alien plant species (kenophytes) in the flora of Poland. Katowice, UŚl.: 192.
27. TOKARSKA-GUZIŁ B., ROSTAŃSKI A., 1996. Rola zatopisk (zalewisk) pogórnických w renaturalizacji przemysłowego krajobrazu Górnego Ślaska. Prz. Przyr., 7, 3–4: 267–272.
28. TWARDOWSKA I., SZCZEPAŃSKA J., WITCZAK S., 1988. Wpływ odpadów górnictwa węgla kamiennego na środowisko wodne. Ocena zagrożenia, prognozowanie, zapobieganie. Pr. Stud. IPIŚ. PAN Wroc., 35: 25.
29. WANG Y, DAWSON R., HAN D., PENG., LIU Z., DING Y., 2001. Landscape ecological planning and design of degraded mining land. Land Degrad. Dev. 12(5): 449–459.
30. WOŹNIAK G., ROSTAŃSKI A., SIERKA E., ASCHAN G., PFANZ H., 2005. Diversity of spontaneous vegetation on post-industrial sites importance in reclamation process. In: Sustainable development indicators in the minerals industry. Essen, Univ. Aachen, Glůckauf GmbH: 315–323.
31. Wyspy środowiskowe. Bioróżnorodność i próby typologii, 2002. Pr. zbior. Red. J. Banaszak. Bydgoszcz, Wydaw. ABydg.: 302.

STRESZCZENIE

Środowiskowe skutki rekultywacji zbiorników powstałych w nieckach osiadań

Słowa kluczowe: *lasy, rekultywacja, różnorodność florystyczna, wody powierzchniowe, zbiorniki wodne*

Niecki osiadania wypełnione wodą tworzą się nad polami eksploatacyjnymi również na terenach leśnych, zmieniając poważnie warunki hydrologiczne a równocześnie przyczyniając się do powstania wysp środowiskowych o znacznie większej różnorodności biologicznej niż tereny sąsiadujące.

Niestety tego typu zbiorniki wodne z punktu widzenia prawa są szkodami górnicznymi i podlegają procesom naprawczym, polegającym najczęściej na grawitacyjnym odwodnieniu niecki a następnie jej wypełnieniu skałami płonnymi, odpowiednim ukształtowaniu rzeźby terenu i najczęściej posadzeniu lasu. Tak prowadzone prace rekultywacyjne pociągają za sobą (paradoksalnie) szereg negatywnych skutków, zarówno w obrębie samej niecki jak i obszarach przyległych. Celem prezentowanej pracy jest określenie wpływu rekultywacji zbiornika, powstałego w niecce osiadań, przez zasypianie skałą płonną na zmiany warunków hydrologicznych oraz różnorodność biologiczną sąsiadujących zbiorowisk leśnych. W prezentowanej pracy dane florystyczne gromadzono na terenie zasypanego zbiornika, zlokalizowanego na terenie miasta Mysłowice (woj. śląskie) i zbiorowiska leśnego w jego sąsiedztwie. W obrębie zbiornika szczegółowo scharakteryzowano warunki

hydrologiczne. Wykonano spisy gatunków roślin naczyniowych z ich procentową wyceną w skali 0%, 10%, 20%, ..., 100% w obrębie wyznaczonych reprezentatywnych powierzchni badawczych, zarówno na terenie byłego zbiornika, jak i w sąsiadującym zbiorowisku leśnym. Różnice w różnorodności gatunkowej, udziale grup ekologicznych gatunków roślin przeanalizowano testem nieparametrycznym Kruskala-Walisa i post-hoc Conovera, natomiast związek z warunkami siedliskowymi sprawdzono analizą korelacji sumy rang Spearmana i metodami analizy gradientowej (DCA).

Wyniki badań wskazują na negatywny wpływ procesów rekultywacji technicznej zbiorników powstałych w nieckach osiadań na różnorodność biologiczną, mający wyraz w składzie gatunkowym – obecność gatunków obcego pochodzenia. Również z punktu widzenia hydrologii zasypanego skałą płoną zbiornika ten typ rekultywacji prowadzi do wysokiego stopnia zmineralizowania oraz podwyższonego stężenia siarczanów, chlorków oraz jonów sodu.

Received 08.12.2008

Reviewers:

Dr. Janusz Czerepko

Prof. Kazimierz Piekut