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SPECIES COMPOSITION OF VEGETATION COVER IN THE FALLOW LANDS IN THE AREA OF THE TRZEBINIA MUNICIPALITY

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Abstract

The aim of the study was to evaluate the species composition in the fallow lands in areas heavily degraded by the mining and processing industries. The research was conducted in the western part of the Małopolska province in the municipality of Trzebinia. The layer C of phytocenosis that is the green layer was analyzed by specifying its all plant species and by approximately estimating vegetation cover according to the modified Braun-Blanquet scale. 212 species of vascular plants were found in the research areas. Species typical of fallow lands and ruderal areas i.e. giant goldenrod, couch grass and bush grass are the dominant species in the study areas. Among the species found in the study areas the species typical of fresh meadows such as false oat-grass, goosegrass and sorrel as well as thermophilic species such as crown-vetch, greater knapweed or cypress spurge appear with great frequency.

Keywords: species composition, fallow soil, heavy metals, contaminated land, the municipality of Trzebinia

INTRODUCTION

The term fallow lands stands for fields uncultivated for a long time and covered with natural vegetation succession, overgrown with weeds and subjected to far-reaching processes of sodding or shrubbing (Golonka and Świętochowski 1950, Świętochowski et al., 1996). Fallow lands, in the social awareness, are most often associated with negative economic and structural changes in the agricultural sector. This belief is confirmed by the facts. The decline in profitability of agricultural production and the weakening of purchasing and investment powers of individual farms and cooperatives are the common reasons for having fallow lands (Marks et al., 2000b). Fallow lands are said to be prone to the process of soil degradation and agrocenosis. It is difficult to identify a permanent scheme of its course. It is characterized by varied dynamics and the nature and extent depend on the adopted aim of fallowing, the type of maintenance system, the level of previously used agricultural technology, the origin and type of soil, the initial state of its characteristics and agronomic category as well as species diversity covering the vegetation (Marks et al., 2000a, Marks et al. 2002a, Podstawska-Chmielewska and Kurus, 2007). Chemical properties of the soil also change in the process of fallowing. The acidity of soil environment increases. A consistent fall in assimilation by plants of various forms of micro – and macronutrients due to the cessation of supply of nutrient components to the soil is observed. Initially, the content of nutrient elements, especially nitrogen ammonia in the lower layers of the soil, increases as a result of the transition of nitrate form to ammonia. This reduces the total porosity of the soil. Nitrates due to their ability to migrate easily and to intensify the processes of leaching pollute deep-seated waters. The pH is not subject to significant fluctuations (Koc et al., 1996, Dzienia et al., 1997, Sienkiewicz et al., 1998, Marks et al., 2000a, Marks et al. 2002a, Podstawska-Chmielewska and Kurus, 2007). The process of fallowing results in significant changes in phytocoenosis. These changes are in nature mostly negative for agriculture, but not necessarily harmful for the meadow ecosystems. Their pace and direction depend on habitat conditions of communities and the quality and range of agricultural technology used before excluding the fields from agricultural use. These changes apply mainly to the succession of flora in a manner appropriate for the type of habitat. Scrub community is formed on heavy defective soil whereas thicket community appears on sandy soil (Domańska 1997, Malicki et al., 2002, Kryszak et al., 2007). In addition, these changes may lead to the emergence of new syntaxons, forest and scrub communities or secondary plant communities or they may bring about the return of communities to the formerly existing ones which disappeared as a result of agricultural activity. (Łabza et al. 2003, Zawieja 2007).

METHODOLOGY OF RESEARCH

The research was conducted in the municipality of Trzebinia. Field work was carried out in each case in June and July in the years of 2010-2012. Field studies were conducted on the sample plots. Each surface had a shape of square with a side length of 5m (25 m^2). Geographical coordinates using a GPS (Garmin

GPSMAP 62s) and basic parameters of the habitat such as altitude, slope and orientation towards the cardinal directions were identified for each area. The locations of research areas were chosen so as they reflected the diversity of soils and vegetation in the municipality of Trzebinia. The designated areas used to be agricultural lands in the 80s whereas now they are fallow lands. This was done analysing topographic maps at a scale of 1: 10000. In total, 83 areas were selected. The differentiation in number of research areas selected in each of the rural administrative units results from the uneven distribution of both fallow lands and historical as well as current mining sites of mineral deposits and emitters of pollutants. Most areas were designated in Trzebinia (23), the fewest in the rural administrative unit of Dulowa (1). The assessment of species composition (phytosociological photograph) was performed according to the method of Braun-Blanquet (Dzwonko 2007, Wysocki and Sikorski 2002). A phytosociological photograph is a concise description of phytocenosis containing a list and share of plant species and the general characteristics of environmental conditions of vegetation lobe. The layer C of phytocenosis that is the green layer was analyzed by specifying its all plant species and by approximately estimating vegetation cover according to the modified Braun-Blanquet scale. This scale takes into account what percentage of the area of the tested lobe is covered with aboveground parts of the species as well as the number of individuals of each species (Table 1).

Table 1. Cover abundance scale according to Braun-Blanquet (Dzwonko, 2007)

r	hardly any, one or a few individuals
+	rarely, with inconsiderable cover
1	Plentiful but with small cover value or not so abundant but with higher cover but lower than 5 % of the
2	cover 5-25% of the research area or abundant with cover less than 5 %
2 m	abundant
2 a	cover 5-12.5%
2 b	cover 12.5-25%
3	cover 25-50%
4	cover 50-75%
5	cover 75-100%

CHARACTERISTICS OF THE RESEARCH AREA

Trzebinia is the urban-rural municipality located in the western part of the Malopolska province, in the northern part of the Chrzanów county. A strategic railway line from Krakow to Katowice connecting Chrzanów and numerous local factories and mines runs through the municipality (Environment Programme 2013). The municipality of Trzebinia includes the town of Trzebinia and 10 rural administrative units i.e. Bolęcin, Czyżówka, Dulowa, Karniowice, Lgota, Młoszowa, Myślachowice, Piła Kościelecka, Płoki and Pisary (Figure 1).

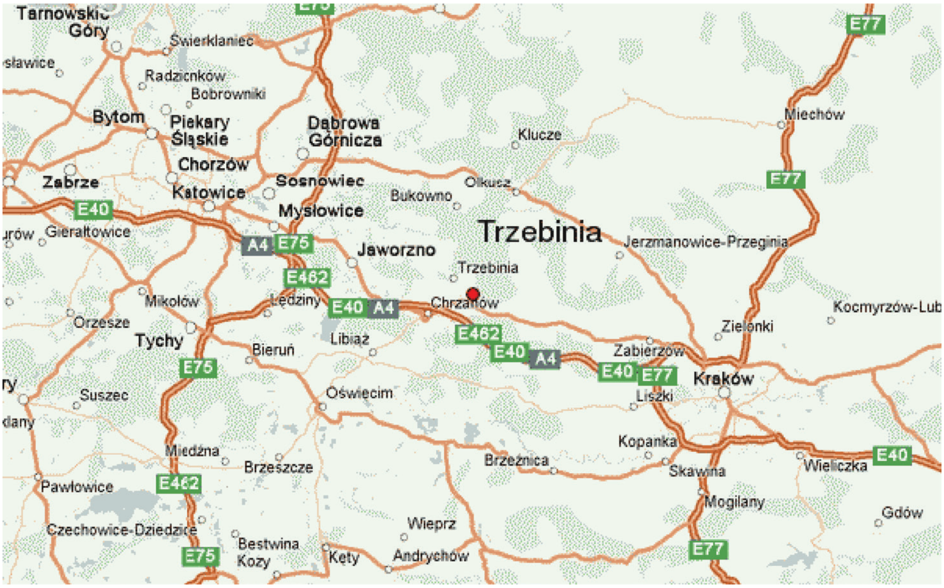

Figure 1. Location of Trzebinia (http://www.weather-forecast.com/locations/Trzebinia)

The total area of land in the municipality of Trzebinia adds up 10 540 ha out of which 9.7% are fallow lands and green areas. 24.1% comprise the remaining agricultural lands (Figure 2).

In total, the cultivated area constitutes 536 ha and the crop structure is as follows: cereals in total of approximately 70%, potatoes approximately 21%, fodder approximately 3%, other plants approximately 6% including field vegetables around 4%. The economic development of the Trzebinia municipality is determined by the natural resources which the type and range made the region of Trzebinia become a thriving mining and processing centre. The economy of Trzebinia is notorious for water absorption, sources absorption, disorganized, organized and cross-border emission of pollutants into the atmosphere, a significant impact on the structure of soil as well as considerable production of municipal and industrial waste (Kot-Niewiadomska 2013). Among the most noteworthy energy and industrial emitters of pollutants into the atmosphere within the municipality of Trzebinia the following should be named: the Trzebinia Refinery Capital Group", PCC Rail "Szczakowa" SA, the "Siersza" Power Plant in Trzebinia, the metallurgical slag heap of the "Trzebinia" Metallurgical Plant and the stockpile of flotation tailings of the "Trzebionka" Mining plant. The presence of three groups that is area (urban areas, industrial areas, mines, etc.), line (transportation lines and railways) and point (waste dumping and wastewater discharges, municipal waste landfill, etc.) of pollution sources of surface and groundwater was identified. The degradation of soil structure of the municipality is associated with the intense activity of entities in the mining, metallurgy, refining and energy sectors. The metallurgical slag, zinc, copper, lead heaps, the former margle excavations, the stockpiles of coal wastes, flotation tailings, slags, dross and slag casting among the others have a considerable impact (Motyka and Szuwarzyński 1998, Environment Programme 2013, Kot – Niewiadomska 2013).

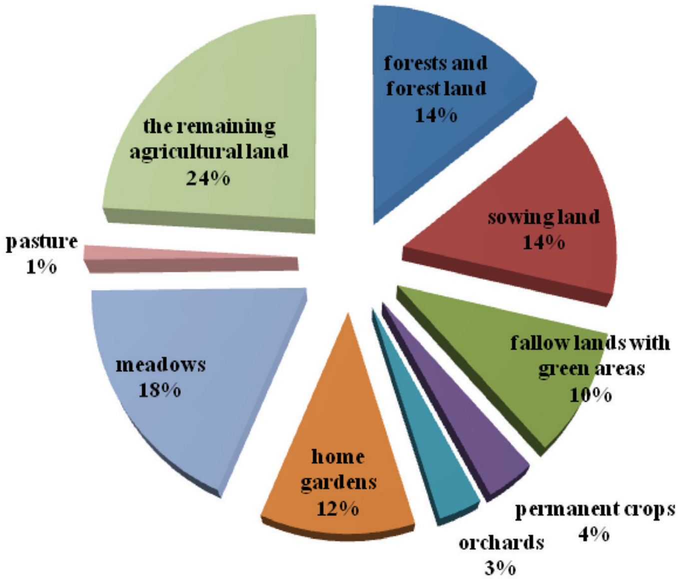

Figure 2. The structure of land use in the municipality of Trzebinia (according to CSO data. Local Data Bank 2004-2013)

RESEARCH RESULTS AND DISCUSSION

The process of fallowing brings about significant changes in phytocoenosis. Fallow fields are subject firstly to a process of gradual fouling with various weed species, especially wild and often closely related to the species and agronomic practices of the last planted crop and secondly to the appearance of shrubs and trees. Spontaneous and devoid of control weed vegetation, especially of anemochorous species such as common dandelion (Taraxacum officinale) dandelions (Sonchus), creeping thistle (Cirsium arvense) poses a real threat to nearby crop fields. Seeds of these plants spread by wind have high fertility which gives them an advantage over many crop species. Deprived of competition on their part, weeds manage to take the whole life cycle and spread easily their seeds to neighbouring lands. A large variety of species, dominated by annual weed species, is observed in the first three years of fallowing (Kuraszkiewicz 1994, Majda 1997, Hochół et al., 1998). Over the years, annual species give way to segetal, perennial and ruderal ones. The number of aphophytes and species of the grass family (Poaceae) increases. Therefore the relationship between the time period of fallowing and the increase in prevalence of perennial weed species is noticeable. The authors also point out the fact that together with the spread of weeds the number of agrophags of crops increases leading to potential weeding (Malicki and Podstawska-Chmielewska 1998, Marks et al., 2000a, Marks et al., 2002a). As a result, after the recommencement of agricultural activity in the fallow lands, aside from crops also weeds linked with agrophags of the given plant appear which hinder any agronomic practices. An example of such a pest is black bean aphid beet which is a pest of sugar beet and which feeds on the weed species of the goosefoot family (Chenopodiaceae) (Rola and Rola 1998, Niedźwiecki et al. 1998, Ziemińska-Smyk 2000, Kostuch et al. 2004). Vegetation of fallow lands appears spontaneously on abandoned arable lands. In most cases the species are expansive with a huge ability to multiply. 212 species of vascular plants were found in the research areas. The diversification of species composition between particular areas was relatively big. There were no species in the fifth grade of stability that is occurring on 80-100% of the area. The largest number of species are the sporadic species, recorded with the frequency of up to 20% of the area among which 63 appeared only once. The following species were prevalent (Table 2): ordinary yarrow (*Achillea millefolium*), couch grass (*Elymus repens*), false oat-grass (*Arrhenatherum elatius*), goosegrass (*Galium mollugo*). False oat-grass, couch grass and bush grass (*Calamagrostis epigejos*), Giant goldenrod (*Solidago gigantea*) and ground elder (*Aegopodium podagraria*) belonged to the species which dominated over the other species (5 in the Braun-Blanquet scale) in some research areas. *Cardaminopsis arenosa, carthusianorum Dianthus, Silene vulgaris, Viola tricolor, Biscutella laevigata* classified as facultative metallophytes were found among the species occurring in contaminated meadows of the nearby District Ore of Olkusz (Szarek-Łukaszewska and Grodzińska 2011). Among facultative metallophytes in the fallow lands of Trzebinia only *Silene vulgaris* and *Dianthus carthusianorum* were found. Their occurrence was less frequent though which disables them from being used as indicators of pollution. However, in the subjected fallow lands species which are not typical metallophytes but accompany them (pseudometallophytes) such as *Achillea millefolium, Plantago lanceolata, Polygala vulgaris, Ranunculus acris, Rumex acetosella, Thymus pulegioides, Agrostis capillaris, Holcus lanatus* often appear (Baker et al. 2010).

Table 2. The most common plant species of fallow lands in the municipality of Trzebinia. Species with stability of occurrence above 30%.

Species in Latin	Species in English	Stability of occurrence [%]	The scope of abundance
Achillea millefolium L	Yarrow	77.1	+, 3
Elymus repens (L) Gould	Couch grass	71.1	+, 5
Arrhenatherum elatius (L) Beauv ex J & C Presl	False oat-grass	63.9	+, 4
Galium mollugo L	Goosegrass	60.2	+, 3
Rumex acetosa L	Sorrel	56.6	+, 2m
Dactylis glomerata L	Cock's-foot	54.2	+, 3
Festuca rubra L	Red fescue	53.0	+, 3
Solidago gigantea Aiton	Giant goldenrod	53.0	+, 5
Vicia tetrasperma (L) Schreber	Smooth tare	51.8	+, 2a
Convolvulus arvensis L	Field bindweed	50.6	+, 2m
Melandrium album (Miller) Garcke	White campion	47.0	+, 2a
Crepis biennis L	Rough hawksbeard	44.6	+, 2m
Equisetum arvense L	Field horsetail	43.4	+, 2a
Cirsium arvense (L) Scop	Creeping thistle	43.4	+, 2a
Vicia cracca L	Tufted vetch	39.8	+, 2m
Plantago lanceolata L	English plantain	38.6	+, 1
Calamagrostis epigeios (L) Roth	Bush grass	38.6	+, 5
Poa pratensis L	Kentucky bluegrass	38.6	+, 2a
Knautia arvensis (L) Coulter	Field scabious	36.1	+, 2m
Phleum pratense L	Timothy-grass	34.9	+, 2m
Daucus carota L	Wild carrot	32.5	+, 3
Agrostis gigantea Roth	Black bent	32.5	+, 3
Veronica chamaedrys L	Germander speedwell	30.1	+, 2a
Coronilla varia L	False oat-grass	30.1	+, 2a

The occurrence of particular species is affected by habitat conditions. In most cases, the habitats associated with high metal content are remnants of mining and processing of ores and have extreme soil conditions (low fertility, high or low pH, poor moisture) (Krzaklewski and Pietrzykowski 2002, Szarek-Łukaszewska and Niklińska 2002, Wong 2003, Ye et al. 2002). The result is that metallophytes are usually species which are resistant primarily to these factors. These species are often associated with poor dry grasslands (Becker and Brandel

2007, Baker et al. 2010, Szarek-Łukaszewska and Grodzińska 2011). The soils of fallow lands of Trzebinia are of higher quality which enables the growth of many species and reduces the harmful effects of heavy metals. The main factor influencing the species composition of the vegetation of fallow lands was the granulometric composition of the soil. The selective influence of harmful effects of heavy metals on plants is therefore insignificant. This is confirmed in other authors' studies, which found that properties of habitat are usually a much more important factor influencing the occurrence of species than the content of metals in the soil, especially when the contamination level is not very high. The research of Parraga-Aguado, et al. (2014) proved that the main effect on plant growth on the enriched with heavy metal waste had edaphic conditions, and the metal content was secondary. The comparison of species composition of vegetation on the post-mining areas in the Hartz mountains also indicated a greater significance of edaphic factors and the altitude than the metal content (Becker and Dierschke 2008).

CONCLUSIONS

The research results obtained allowed to put forward the following conclusions:

1. Species typical of ruderal areas, fresh meadows and thermophilic species were found in the fallow lands in the municipality of Trzebinia.
2. 212 species of vascular plants were found in the research areas (Annex). The diversity of species composition between particular surfaces was immense. There were no species in the fifth grade that is occurring in the 80-100% of the area. The largest number of species are the sporadic species noted with the frequency of appearance up to 20% of the area.
3. The species typical of the fallow lands and ruderal areas i.e. giant goldenrod, couch grass and bush grass are the dominant species in the study areas.
4. Among the species found in the study areas the species typical of fresh meadows such as false oat-grass, goosegrass and sorrel as well as thermophilic species such as crownvetch, greater knapweed or cypress spurge appear with great frequency.
5. The main factor influencing the species composition in the fallow lands was granulometric composition of the soil.

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