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Item Type	article;article
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DOI	https://doi.org/10.7275/fabos.696
Download date	2026-05-19 04:45:26
Link to Item	https://hdl.handle.net/20.500.14394/23966

Impact of green industrial zones on city development

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Introduction

Arranged green spaces of industrial areas are a form of greenery planted in an organized way, accompanying industrial facilities. During the designing of large industrial facilities, green spaces constituted an integral element of industrial facilities and adjacent areas. They played numerous essential roles, such as protective, decorative, recreational, representative, psychological or masking functions. Depending on the intended purpose, a green space assumed also suitable forms: buffer strips, clumps, solitary plants, cross-shaped, strip-shaped or round-shaped layouts. An equally crucial aspect, as the form of greenery, was the selection of an adequate species adapted both to the terrain conditions and the specificity of production.

During the construction of an industrial facility, the terrain configuration is transformed, water relations and climate are changed and plant communities destroyed, leading to the destruction of their landscape values. To alleviate the negative effects of industrial areas, both technical and vegetation means were used to form: protection zones, plant communities grown on the premises of the facility, in addition to such measures as remediation of heaps and spoil tips reclamation or the formation of recreational areas. Green spaces regulate water relations, prevent erosion and reduce the negative impact on the adjacent areas, land relief and last, but not least, improve the climate.

It is not a random action, however. For green spaces to function well, they had to be introduced in the right places. As a result, a few types of greenery were formed: internal and external protective greenery, central reservations, decorative, green spaces on company housing estates, reserved areas, vegetation with psychological effects, successive, reservoir greenery as well as masking green spaces - all together creating large areas - green industrial zones.

Background/Literature Review

The primary literature sources, referred to in this thesis, present different facilities and their development on general terms, outlining the principles of establishing green spaces in industrial zones.

(Nowak, 1985; Urbanowicz-Oppenheim, 1965; Załęska-Złomanoff, Dziegielewski, Obarska, 1978,). In all books the same principles are repeated,

adapted to a facility, its type, specific nature of production, terrain on which it is located as well as buildings situated nearby, which should be protected. References also provide us with instructions on how green spaces were formed during World War II in order to protect factories from identification and destruction (1939, Camouflage ...; Magg, 1943; Wittmann, 1942). Unfortunately, no traces of green spaces with masking functions survived to this day. Nowadays, appropriate measures that aim at incorporating the retained industrial green areas into urban green spaces are taken (Zachariasz, 2006). They are also used for recreational and educational purposes or re-naturalization of selected city areas, creating, e.g. city forests.

Goals and objectives

The aim of this thesis is to demonstrate the correlation between green industrial areas and city development, as well as to indicate their impact on the urban tissue. They very often constitute the basis of urban greenery system, which was developing along with an industrial plant. Green spaces introduced to a city constituted an air filter for pollution generated during industrial production processes, as well as a buffer zone between a factory and a residential area.

Green industrial zones cover a large land, joining natural vegetation, forest communities or wildlife corridors. Nowadays, many of those zones are located within cities and may well be used for creation of green zones in urbanized areas. Such areas have a high educational potential, which proves that without human intervention, many plant and animal species, which for a long time have not been seen around, return to them. It also shows what procedures should be implemented in industrial areas to make the planted vegetation better fulfil their functions as a natural area, e.g. a wildlife corridor, recreational or urban green spaces.

Method(s)

Tasks involved in preparation of this thesis included small-scale actions, such as collection of source literature and analyzing it. The next step was to conduct a site inspection in three industrial centers - Machów and Piaseczno Mines, as well as at the Kraków's seat of the combined heat and power station EDF Poland. While visiting the facilities, such places as office, technical and production areas, a mining pit and a landfill site were inspected. What is more, an inventory of greenery was compiled in order to define what species function well in such difficult conditions. The collected data allowed to conduct an analysis of selected facilities as well as their comparison, providing solutions that are the most optimal in designing and maintaining green industrial spaces.

Results

Green industrial zones are green spaces surrounding industrial facilities with a high vegetation coverage ratio (forests, bushes) often joining wildlife areas such as wildlife corridors. They often contain green areas which are part of the urban tissue and adjacent areas: company housing estates, reserved areas, (internal, external) facility shielding areas, green spaces with psychological effects - humanization of the area, successive, masking greenery, greenery of reservoirs and central reservations.

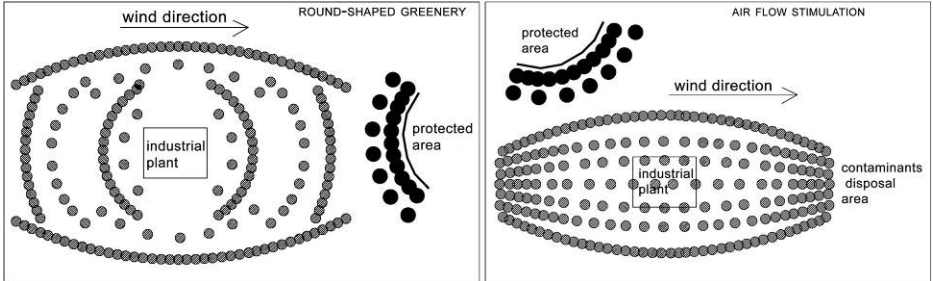


Figure 1. Location of an industrial facility among green spaces

Industrial greenery separates an industrial facility from protected areas or housing estates, constituting a buffer for harmful substances generated by a factory. Vegetation is also planted in places degraded by industry: dumping grounds, landfill sites, pits or reservoirs. In this way green spaces are formed, often left out due to the possible negative impact on human health. However, lack of human intervention makes the areas perfect dwelling places for animals, which can peacefully live in such spaces, not bothered by anybody. Such created green spaces also allow free migration of plants and animals.

Machów and Piaseczno Mine Complex was the largest sulfur mine in Poland with the biggest deposits of this mineral resource in the world. Mining began in 1958 at the Piaseczno pit and lasted until 1970, whereas Machów mine operated in the years 1971-1992. As a result of performed works, two excavations were created a 160 ha - Piaseczno and 500 ha Machów, which were currently reclaimed in water-forest direction. The overburden removed from the pits was used to form 2 heaps with the area of 880 ha - Machów and 245 ha - Piaseczno. Both facilities are located in the immediate vicinity of Vistula riverbed, consisting the biggest wildlife corridor in Poland. The adjacent areas are mostly croplands, urbanized and rural spaces and small forest complexes.

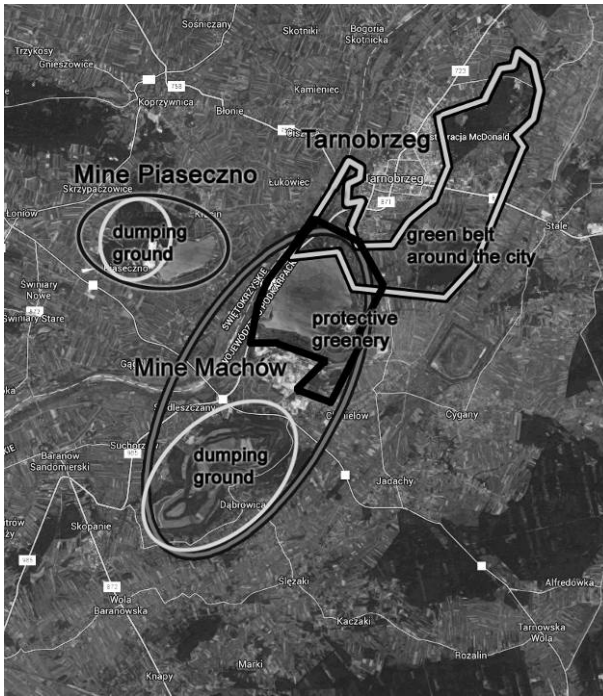


Figure 2. Location of the Machów and Piaseczno Mine Complex and green spaces

Establishment of the mines and a sulfur processing plant in Machów allowed for an increase of the importance of the place and development of nearby towns. Moreover, the city of Tarnobrzeg was founded in the immediate vicinity, in which population from the still increasing conglomerate settled. Together with the development of settlement communities, efforts were made to reduce the negative impact of the industrial facility by using filters capturing produced gases and dusts as well as purifying wastewater. However, during the operation of the plant, the best solution was to use protective greenery - in the form of buffer strips, groups or solitary plants. Vegetation was planted in strip sections, between the industrial facility and the city, directing the flow of wind and pollutants towards agricultural areas. The plants constituted a natural filter capturing pollutants from the air, water and soil. "In the area development plan of Tarnobrzeg district settlements from 1966", the Voivodship Sanitary and Epidemiological Station stated that it is "not recommended" to locate residential buildings within 10 km radius from the combine collective due to the periodically exceeded maximum concentration limit of sulfur compounds. Vegetation planted between the mine and the city was recommended in the "Detailed Regional Plan of the Tarnobrzeg Sulfur Basin for the years 1961-1980", in which it was emphasized that there should be a 4.5 km zone filled

with greenbelts between the city and the combine collective in order to maximize air filtration effect. The greenery planted according to the plan was also introduced in the city as an element of housing estates, public utility buildings, traffic area plants or garden allotments.

Both mines, however, were flooded and currently constitute a habitat for many species of birds, as well as a stopover on their migration route. The spoil tips and protective strip areas, on the other hand, constitute a habitat for many species of plants and animals, such as birds of prey, whose population began to grow again in the peaceful refuge with a sufficient amount of food.

The combined heat and power plant EDF Poland, branch in Kraków was established in the years 1966-68 in the district of Łęg. At that time the facility was located on an agricultural terrain beyond the city borders. The company complex is divided into 2 office and manufacturing buildings as well as a landfill site located in the immediate vicinity of the Vistula riverbed.

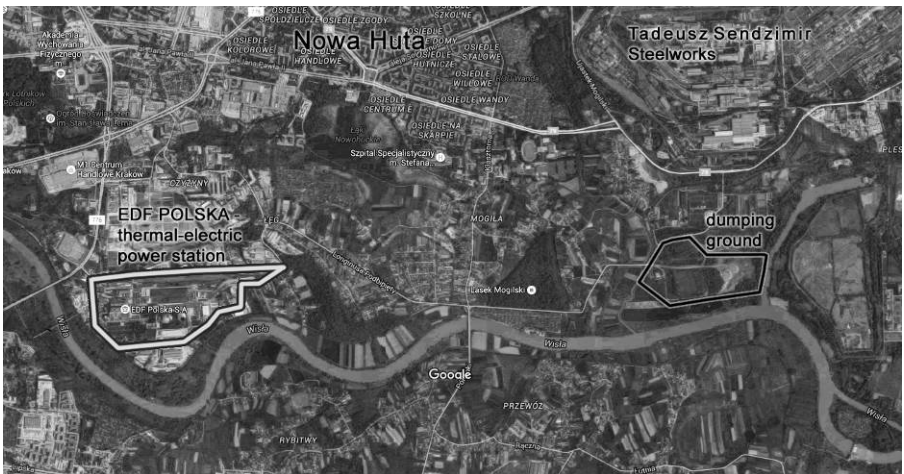


Figure 2. Location of the combined heat and power station EDF Kraków, green areas and the landfill site

The office and manufacturing complex was surrounded by arable lands as well as bush and tree communities. On its territory plants were introduced, mainly as decorative and humanizing elements. At the moment this land is in a residential area, however, it is a very hostile environment. Large, artificially formed areas increase the temperature, causing reduced humidity and windblasts, which carry high amounts of dust in the air. Lack of buffer strips and a small amount of high and medium-sized vegetation allows for uncontrolled flow of pollutants to housing estate areas.

The landfill site is around 9 km from the main facility and it is located among arable lands and riparian communities. In this area slag from coal burning in the electric power generation process is disposed. In order to protect the overburden from being blown out, heaps were covered by natural tree and bush vegetation, whereas the surrounding areas were planted with buffer strips. The strips were mainly formed with *Salix caprea* and *Ulmus minor* with the sapling of *Salix aurita*, *Cornus alba*, *Cornus sanguinea* and *Prunus spinosa*. For the purposes of embankment stabilization, *Caragana frutex* and *Cornus alba*, *Cornus sanguinea* was used, as well as *Crataegus* sp. in the form of strips or groups. The presented species proved to be the most effective solution in the analyzed area due to their resistance to difficult conditions and their speed of growth. However, for plants to fully meet their function, they must be properly taken care of and cut to prevent dying, disease or pest attacks.

The production and landfill site area is located in the wildlife corridor zone of the Vistula River, in the city's zone of nature development system and air free flow area. Therefore, it is very crucial to use vegetation in order to support the system that filtrates industrial contaminants. Such an isolated area as a landfill site has become a refuge for many species of animals migrating through the wildlife corridor, coming from suburban areas, such as deer, boars, foxes, hares, birds, including many species of birds of prey which can nest in high treetops.

Discussion

Nowadays, despite being practically unnoticeable, greenery of industrial zones occupies large areas. Many of those areas were destroyed, built-up or agriculturally changed. Until the middle of the 19th century, the design of an industrial facility and its surroundings was determined by human factors and environmental protection. Facilities had an esthetic appearance and efforts were made to make them as friendly to human mental health as possible. Vegetation was planted both for esthetic and health reasons in order to improve the condition of the natural environment, intensively degraded by an industrial facility. Green spaces constituted an integral, inherent as well as necessary element of an industrial facility.

Today, however, what matters when designing an industrial plant is the product and optimization of production, hence, large concrete lands with no vegetation emerge. If greenery is, in fact, included in such an area, it is marginalized, pushed aside, often planted along a fence, only to cover the building of a factory. Elimination of green areas leads to creation of the so-called "concrete deserts" with detrimental working and living conditions. There is an increased

temperature in those areas, in addition to reduced humidity, which results in formation of winds that carry dusts and gases from the industrial facility area.

High and medium-sized vegetation constitutes a natural, self-purifying filter for air, water or soil contaminants. It also constitutes a habitat for animals and other green plants or bushes, creating appropriate conditions for their growth. Development of slag heaps with a forest, results in their slow re-naturalization and to some extent, a return to the pre-manufacture state. However, in the areas, in which buffer strip vegetation was planted to direct the flow of wind and as an air filter, such greenery should be subject to special care procedures. The conducted studies have shown that it is exposed to a number of factors that cause slow dying out of vegetation and as a consequence, it no longer serves its function properly. Plants die out due to health reasons, damaged by weather conditions or pests, destroying lower vegetation and often preventing their access to light below treetops. If properly taken care of, trees grow healthier and their tops are not excessively thinned out, they have a more natural habit that corresponds to the statics of the tree.

Conclusion

Green industrial zones constituted a buffer between an industrial facility and residential or environmentally valuable areas. The zones prevented the negative impact of a facility, such as noise, water and pollution as well as protected residential areas. They often constituted green spaces with a high vegetation coverage ratio. These were usually regular forests or bush patches, joining other areas in the form of wildlife corridors, running along watercourses, forests or Nature 2000 network.

The designed greenery of industrial plants also included allotment gardens, holiday centers, plants growing along roadsides, housing estates, schools or palace parks. In cities where industry developed, whole districts were created for the purposes of an industrial plant. Sometimes they were bigger than the city itself, like in the case of Tarnów - Mościce. Those districts included green paces as well as buffer zones. Today they are often the basis for greenery systems of those towns – a well designed and properly introduced urban tissue. Vegetation did not constitute an addition to the place, but it was its integral element designed according to city standards (Dąbrowska-Milewska, 2010), to make sure it fulfills its functions in the best way possible. It was not just a one-off undertaking, but a planned and long-term action developed along with the growth of an industrial facility and expanding its impact.

Unfortunately, industrial areas are disappearing from the landscape, and with them also green spaces, which are replaced by roads, housing estates or

shopping centers. Due to this process also large areas of greenery disappear, which are so needed in the ever increasing population centers, where the condition of the environment deteriorates and with it also human health. More and more of “concrete desserts” are created, in which such factors as the influence of plants on shaping healthy residential and work environment, as well as places of animals and plants migration are not present.

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