

# Impact Assessment of Sand and Gravel Deposits Mining in Klaj on the Natural Environment of the Raba Rivervalley

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## Abstract

The purpose of the Natura 2000 network is to preserve biodiversity while allowing sustainable development of the regions. Mining activities can be carried out when they have no negative impact on protected areas. This paper describes the types of impact exerted by gravel and sand mining sites on the natural environment. There was also presented the influence of the mining of sand and gravel in Klaj (Małopolska) on the objects of protection in the Natura 2000 network. These considerations end with opinions of experts describing the environmental impact assessment of the Klaj gravel mine. The conclusion is that the impact of sand and gravel mining in Klaj – due to the large distance between the site and Natura 2000 area and due to the objects of protection – is small.

Keywords: Klaj commune, mining activity, gravel pit, Natura 2000 network

## Introduction

Natura 2000 areas are a relatively new form of protection of plant and animal species as well as of natural habitats. The range of Natura 2000 areas covers the most important and the most representative taxa types for all European regions. It is a European network of protected areas, which includes habitats along with plant and animal species that typically occur in them, places of reproduction (breeding), foraging and resting habitats, roosting sites, moulting sites, tooting sites and "stops" located along migrating routes, as well as wintering sites. The purpose of the entire inter-linked network is to facilitate Europe-wide preservation of species. The Member States of the European Union that have implemented this new type of nature protection in their legislations rely on the legislative instruments: Directive of the European Parliament and of the Council 2009/147/EC of 30 November 2009 [6, comp. 3], European Economic Community Directive 1992/43/EEC of 21 May 1992 [4], European Commission Directive 1997/62/EC of 27 October 1997 [5].

## Impact Of Mining Sites Of Sand-Gravel Deposits On Natura 2000 Areas

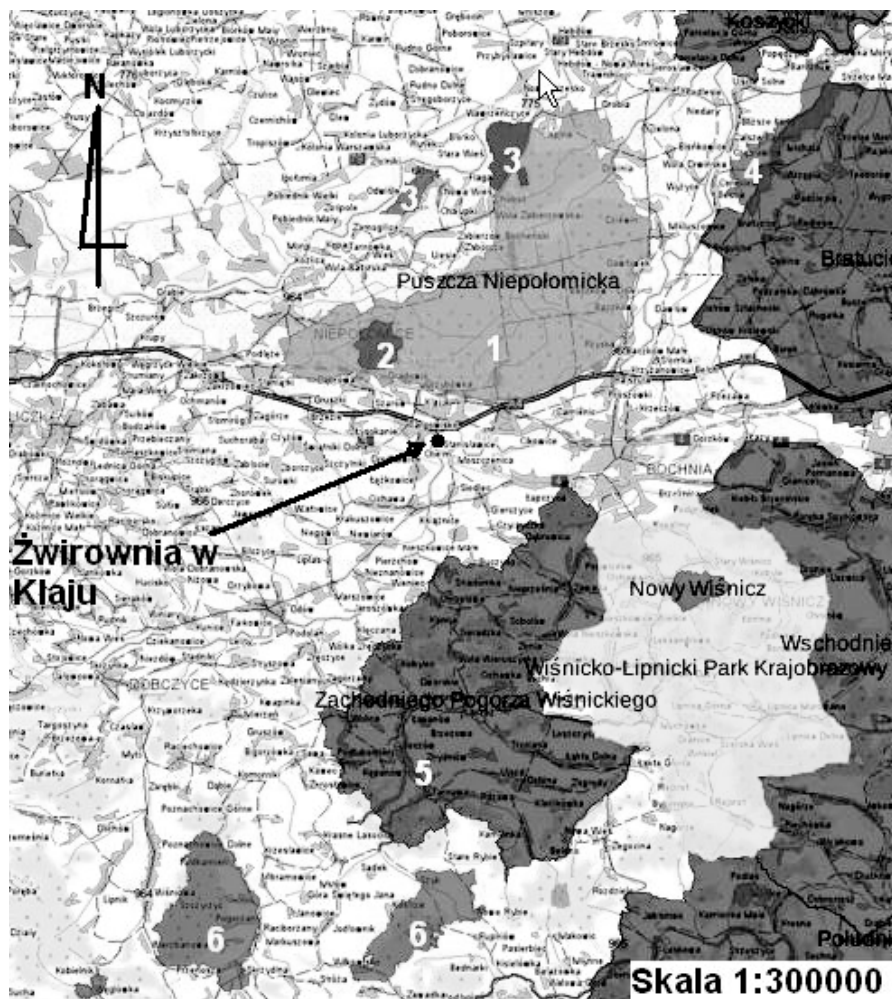
The deposits of minerals, including aggregates, are located in most cases in mountainous areas and river valleys, often in the areas of significant natural value [12]. Regardless of the scale and method of mining, technical means used to extract sand and gravel always have a negative impact on the natural environment. Extracting aggregates upsets the en-

vironmental balance of the place subject to mining and the areas linked to it in the ecological sense. In river valleys the following is extracted most often:

- sand and gravel excavated from the bottom of rivers and streams (from under the flowing water) as well as from exposed parts of the riverbed (backwaters and broad banks) during low water levels,
- crushed rocks, Carpathian shales, boulders extracted from the riverbed and river banks.

While the first two types of aggregates are extracted without applying measures that are highly destructive for the natural environment [10, 15, 16], mining of rocks and boulders destroys the geological structure of the river banks and bottom, as well as of the stream itself. The mining method does affect the natural environment. Casual mining (often called non-industrial) consists in excavating sand and gravel for one's own needs using hand tools. Cumulative mining is excavating sand and gravel by several or more perpetrators in the same place using hand tools, which results in the river or stream bottom devastation. Technical mining is excavating sand and gravel using mechanical tools: excavators, trucks, often in various places so that environmental protection services do not get suspicious. Industrial mining is a term used for sand and gravel mining with an extensive use of mechanical tools. In this case, river or stream banks are destroyed, oxbow lakes are covered, while riparian forests are logged or devastated.

The aggregate mining methods discussed above are used in currents and at the closest banks of riv-



Legend:

1 – SPA PLB120002 Puszcza Niepołomska; 2 – SCI PLH120080 Torfowisko Wielkie Błoto; 3 – SCI PLH120008 Koło Grobli; 4 – SCI PLH120067 Dolina Rzeki Gróbkki; 5 – SCI PLH120089 Tarnawka; – SCI PLH120052 Ostoje Nietoperzy Beskidu Wyspewego

Fig. 1. Gravel mine in Klaj and Natura 2000 areas (by A. Kowalska)

Rys. 1. Źwirownia w Klaju i obszary Natura 2000 (opr. A. Kowalska)

ers and streams. It is the most frequent way of sand and gravel mining in the Carpathians.

Whether the location of the aggregate mining site will affect the neighbouring areas, including the protected ones (especially Natura 2000 areas), depends on:

- location of the aggregate mining site in a protected area (ecological site, nature reserve, protected landscape area, landscape park, national park, biosphere reserve, Natura 2000 area);
- occurrence of species of fungi, plants and animals protected by the European and national law in the area of aggregate mining;
- technical conditions of aggregate mining (casual, cumulative, technical, and industrial mining);
- size of the aggregate mining site (from several acres to several hundred acres);

- duration of mining activity, which depends on the size of the deposit (from a few to 10–20 years);

- range of the impact on the ecosystem (range limited only to the place of aggregate excavation; local range – on flora and fauna and hydrographic conditions; supra-local range – on fauna, flora, habitat types and objects of protection in protected areas, as well as on migration corridors for animals, especially fish, amphibians and reptiles) [12, 13, 14].

In the SDFs developed for Natura 2000 areas, an assumption was made that positive impact from gravel mining on Natura 2000 areas would not be mentioned [17].

### Description Of Mining Sites Of Exploitation Of Sand And Gravel Deposits

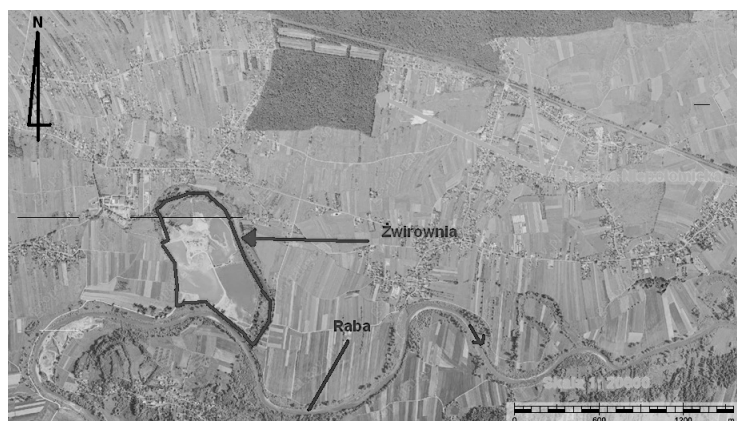


Fig. 2. Location of the gravel mine in Klaj in the Raba River Valley (by: A. Kowalska)

Fig. 2. Umieszczenie zwirowni w Klaju w dolinie Raby (opr. A. Kowalska)

Extraction of sand and gravel deposits in the Klaj locality, Wieliczka District, Małopolskie Province, is carried out in the Raba River Valley, which is a right-bank tributary of the Vistula River (Fig. 1, 2).

On an area of approx. 50 ha aggregates are extracted by means of the industrial method. Several pits were formed once sand and gravel were exploited – they were filled with surface waters and underground waters. The Raba River Valley between Chełm and Wypychów features picturesque curves and meanders, while the river banks are overgrown with riparian woodlots (Fig. 3).

From the north and east, the place of aggregate mining is surrounded with lines of trees. From the west, the post-gravel pits border on a mosaic of fields. The aggregate mining site is situated approx. 1.5 km to the south of the Niepołomicka Primeval Forest. The gravel-pit in Klaj in the Raba River Valley covers both the active part (where mining activity continues) and the pit filled with water in the south-eastern part of the plant. Sites prepared for mining are levelled; also, their surface layers of soil and vegetation have been removed – along with the overlayer.

In the vicinity of the Klaj aggregate mining site in the Raba River Valley, the following objects of protection from by the Natura 2000 network are located Sites of Community Importance (SCI) PLH120067 Dolina Rzeki Gróbki, (SCI) PLH120080 Torfowisko Wielkie Błoto, (SCI) PLH120008 Koło Grobli, (SCI) PLH120052 Ostoje Nietoperzy Beskidu Wyspowego, (SCI) PLH120089 Tarnawka, Special Protection Area (SPA) PLB120002 Puszcza Niepołomicka.

The Gróbka River Valley near Strzelce Wielkie is located on the border of Krakow and Tarnów regions and it features a population of two species

of butterflies, listed in Annex II of Habitats Directive: the Scarce Large Blue (*Phengaris teleius*) and the Dusky Large Blue (*Phengaris nausithous*). There is no risk of significant impact being exerted by mining within the Klaj gravel mine on the objects of protection in SCI PLH120067 Dolina Rzeki Gróbki.

The Wielkie Błoto, the largest complex of swamps in the Małopolskie Province and one of the largest complexes of this type in southern Poland, located in the western part of the Niepołomicka Primeval Forest, was formed in the depression of the Vistula River's older terrace – the Raba River, due to a poor outflow of water. It is a fen established on the marshy valley bottom. There are precious grey willow thickets *Salicetum pentandro-cinereae* there, which constitute a refuge for numerous species of animals and water birds. One can encounter there swamp vegetation and wet meadows. The presence of the Dwarf Beech (*Betula humilis*) is noteworthy. As a result of devastation, several precious species have become extinct in that area, amongst others, the Yellow Marsh Saxifrage (*Saxifraga hirculus*), the Bog Clubmoss (*Lycopodiella inundata*), and the Round-leaved Sundew (*Drosera rotundifolia*). Mining of the gravel deposits in the nearby Klaj has no significant impact on the fauna and flora [8].

In addition to the aforementioned Natura 2000 areas, within a 20 km radius from the place where aggregate mining is performed in Klaj in the Raba River Valley, there are two refuges that belong to the Natura 2000 network. They are: SCI Tarnawka PLH120089 and SCI Ostoje Nietoperzy Beskidu Wyspowego PLH120052.

The Natura 2000 area – SCI Ostoje Nietoperzy Beskidu Wyspowego PLH120052 was established to protect the breeding colonies of the Lesser Horseshoe Bat, Geoffroy's Bat and the Greater Mouse-



Fig. 3. The Raba River in Klaj covered by the Natura 2000 programme (photo by: A. Kowalska)

Fig. 3. Raba w Kłaju na terenie sieci Natura 2000 (fot. A. Kowalska)

eared Bat. The bats nest in the attics of churches and other structures of worship. Mining of aggregates in the gravel mine in Klaj in the Raba River Valley located 20 km to the north has no significant adverse impact on the objects of protection at SCI Ostoje Nietoperzy Beskidu Wyspowego.

The Natura 2000 area – SCI Tarnawka was established for the purpose of protecting the natural habitats listed in Annex I of the Habitats Directive and six animal species listed in Annex II of the Habitats Directive [4, 5 respectively]. The main threats to SCI Tarnawka are: exploitation of river gravel as a result of which stony spawning grounds of lithophilic fish species disappear, work performed in the riverbed, linked with hydrotechnical facilities, i.e., maintenance and engineering of water (intensive river engineering began after 1997), development of flooding areas together with securing and additional filling over of the banks which has led to a gradual reduction of the riverbed width, polluting the riverbed with foreign rock material (rubble used to secure the river banks), littering, waste burning [8].

Mining of aggregates in the gravel mine in Klaj in the Raba River Valley located approx. 13 km to the north has no significant adverse impact on the objects of protection at SCI Tarnawka.

### The Results of Observation

No mining impact was recorded on lowland and highland extensively managed meadows, fens with *Caricetum davallianae*, oxbow lakes and natural eutrophic water bodies, *Galio-Carpinetum* oak-hornbeam forests, or alluvial forests: willow, poplar, alder and ash. Similarly, all the species of protected birds (black stork, honey buzzard, black kite, lesser spotted eagle, osprey, spotted crane, corncrake) are

in no way endangered [8]. The aggregate mining in the gravel mine in Klaj, located nearby, has no significant negative impact on the objects of protection in the NATURA 2000 area.

A negative impact from the mining site of gravel and other aggregates in the gravel mine in Klaj has the form of potential lowering of the ground water level. This requires, however, long-term and adequate geological and hydrological research. The pit near the Raba River in Klaj does not interfere directly with the cohesion of protected areas and is not related to them. No changes have been found, such as reduction of areas of the habitats or their fragmentation. As a result of functioning of the Klaj gravel mine, local hydrographic conditions may have changed but without major consequences for the functioning of the ecosystems of protected areas. Due to the direct proximity of the Raba River flowing nearby, there is a risk that it will get polluted with oil-derivative products from the machinery operated there, as well as from the vehicles operated in the mining area. Once the mining activity is over and the site is subject to water recultivation, measures should be taken so that the newly-formed water bodies are not stocked with foreign fish species as there is a high risk that they will reach the Raba River. The Klaj gravel mine is located approx. 600 m from the southern border of the Niepołomicka Primeval Forest, which is part of the Natura 2000 network. Thirty plant species under protection have their sites near the Klaj gravel mine. Particular attention should be paid to the presence of plants listed in the Polish Red Data Book of Plants: the Water Chestnut (*Trapa natans*), *Nymphaea candida*, the Dwarf Beech (*Betula humilis*). The Niepołomicka Primeval Forest is a dwelling site for large mammals, e.g.: the Wild Boar (*Sus scrofa*), the Roe Deer



Fig. 4. Gravel mine in Klaj. In the foreground: construction works on new motorway in progress (photo by: A. Kowalska)

Fig. 4. Żwirownia w Kłaju. Na pierwszym planie budowa autostrady (fot. A. Kowalska)



Fig. 5. Sand and gravel mining in the Raba River Valley. Targowisko-Zakole locality near Klaj (photo by: A. Kowalska)

Fig. 5. Wydobywanie piasków i żwirów w dolinie Raby. Miejscowość Targowisko-Zakole koło Kłaja (fot. A. Kowalska)

(*Capreolus capreolus*), the Deer (*Cervus elaphus*), the Elk (*Alces alces*) and the Wolf (*Canis lupus*). Vast forest areas and open valleys are conducive to animals' migration. The Niepołomicka Primeval Forest is a place of occurrence of the Fire-bellied Toad (*Bombina orientalis*), listed in Annex II of Council Directive 92/43/EEC [4].

### Assessment of the Environmental Impact of the Klaj Gravel Mine in the Opinion of Experts

Assessment of the environmental impact exerted by mining of natural aggregates depends on the proper selection of features (factors) that affect the problem. In this article much weight is put on the content-related selection of features that has been performed by the experts. The criteria have been chosen in such a way as to facilitate describing the issue in question comprehensively.

On the basis of the selected features, a hierarchical model has been established to assess the en-

vironmental impact of natural aggregates mining. The environmental impact assessment of natural aggregates mining was performed with the participation of experts whose competences covered all the elements of assessment of the problem under analysis.

The assessment of impact of the mining facility on the local environment was performed using a simplified form of the Leopold's matrix (the so-called matrix of impacts). The applied method is one of the techniques used in assessing environmental impact. With this method, the types of impact that affect the elements of the environment can be identified and quantified. As a result of multiplying the magnitude of impacts and importance of particular environmental elements and by summing of all impacts subsequently, a total value of the assessment of environmental impact exerted by the facility has been established [comp.: 1, 2, 9, 11].

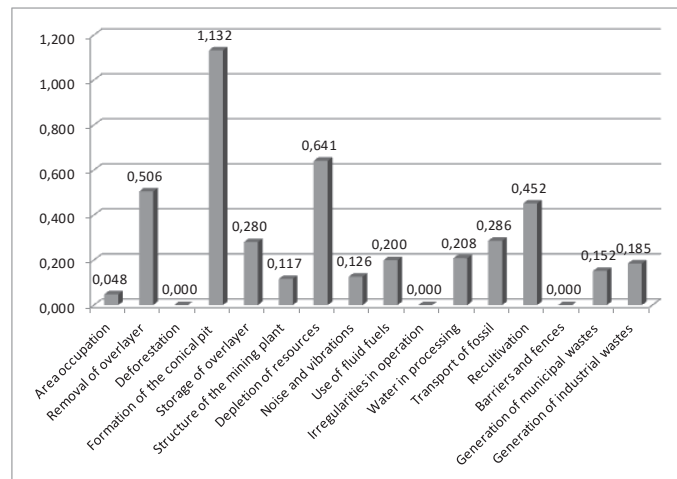


Fig. 6. Magnitude of impact of the diagnosed impact types on the environmental items in the Klaj deposit (prepared by authors)

Fig. 6. Intensywność oddziaływania zdiagnozowanych rodzajów wpływów na elementy środowiska w złożu Klaj (opr. autorów)

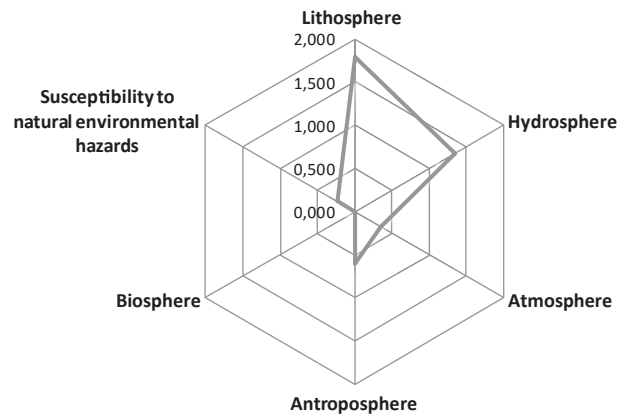


Fig. 7. Assessment of the impact of sand and gravel deposit in Klaj on particular environmental items (prepared by authors)

Fig. 7. Ocena oddziaływania złoża piasków i żwirów Klaj na poszczególne elementy środowiska (opr. autorów)

The effect of the types of impact on particular environmental items in the Klaj deposit is very limited, except for the formation of the conical pit (1,132) as a result of resources bailing (0,641) and removal of additional fill (0,506). Other analysed impacts on environment elements are of little significance (Fig. 6).

In the Klaj deposit, an impact of mining activity on the lithosphere (1,798) and hydrosphere (1,338) was recorded. The items that are particularly susceptible to impact are ground waters (1,249), landforms and landscape (0,618).

An interesting point is the lack of any impact on fauna (0,000) and flora (0,000). Other items under analysis are subject to small impact of mining activity (Fig. 7).

## Conclusions

The impact assessment of mining activities carried out in the deposit in question shows that the lithosphere is the most vulnerable to mining activities from among all of the environmental items. Fairly strong pressure is observed in the hydrosphere, mainly in surface waters. Changes in the atmosphere, anthroposphere and in the susceptibility of the environment to natural hazards are very small or insignificant. In the Klaj deposit, no negative changes in the biosphere were observed. The overall conclusion is that the impact of sand and gravel mining in Klaj – due to the large distance between the site and Natura 2000 area and due to the objects of protection – is small.

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## *Ocena wpływu eksploatacji złóż piasków i żwirów w Kłaju na środowisko przyrodnicze doliny Raby*

*Zadaniem sieci Natura 2000 jest zachowanie bioróżnorodności przy zrównoważonym rozwoju regionów. Działalność górnicza może być prowadzona, gdy nie oddziałuje negatywnie na obszary ochronione. W artykule scharakteryzowano rodzaje oddziaływania miejsc eksploatacji złóż żwirowo-piaskowych na środowisko przyrodnicze. Przedstawiono wpływ eksploatacji złóż piasków i żwirów w Kłaju (Małopolska) na przedmioty ochrony sieci Natura 2000. Rozważania kończy ocena oddziaływania żwirowni w Kłaju na środowisko w opinii ekspertów. Stwierdzono, że wpływ eksploatacji piasków i żwirów w Kłaju ze względu na oddalenie obszarów Natura 2000 oraz ze względu na przedmioty ochrony jest niewielki.*

*Słowa kluczowe: sieć Natura 2000, gmina Kłaj, działalność górnicza, żwirownie*