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DAMAGE TO THE LANDSCAPE CAUSED BY CEMENT INDUSTRY IN SOUTHERN TRANSDANUBIA, HUNGARY

ABSTRACT: LÓCZY D., GYENIZSE P., RONCZYK, L. & DEZSŐ J., *Damage to the landscape caused by cement industry in Southern Transdanubia, Hungary*. (IT ISSN 1724-4757, 2007).

Limestone quarrying and cement manufacturing are industries capable of causing immense environmental damage. Deterioration in the visual quality of the landscape and changes in runoff are considered among the most significant geomorphological impacts. This paper explores the case of cement production in the Villány Hills. Landscape ecological analyses and visibility studies are made to survey environmental impacts. Besides human inconvenience such as water contamination, noise, traffic and visual obtrusion, the major conflict concerns nature conservation, where the industry threatens crystal caves, nature reserves with botanical and ornithological values, ecological corridors etc. Proponents of the new development insist that technological solutions exist for many of these problems and the plans are sufficient to persuade some local communities to support the project. However, there is a concern that some of the measures described in the project plan may not be enacted effectively once project approval is granted. Further ahead, there is a well-founded expectation that technological improvements in cement industry may soon result in the greater recycling of other industrial by products such as slag and building rubble, so leading to a reduction in the demand for new quarried raw material and less landscape damage.

KEY WORDS: Limestone quarrying, Pollution, Landscape ecology, Visibility assessment, Villány Hills (Hungary).

INTRODUCTION

The Southern Transdanubian region of Hungary is not particularly rich in rocks suitable for the cement manufacturing but an industry has developed using the high grade Mesozoic limestone of the Mecsek Mountains and Villány Hills (fig. 1). Although the reserves here are huge, concerns linked to environmental protection and nature conservation place limits on the industry. In particular, the cement industry has earned a bad reputation among environmentalists, who rank it among the least environment-friendly economic activities (Erdősi & Lehmann, 1984). While recent technological developments help reduce its impacts, the extraction, preparation and burning of limestone raw materials as well as the grinding and transport of the final product still involve considerable environmental disruption and pollution.

LIMESTONE QUARRIES IN VILLÁNY HILLS

The main economic strata of the Villány Hills include Jurassic crinoidal and foraminiferal shallow sea sediments, the deep-sea ammonite-bearing Villány Limestone and the most valuable greyish Szársomlyó Limestone, locally of 300 m thickness (Haas, 1994). There is also the Nagyharsány coral Limestone accumulated on a Cretaceous carbonate platform to depths of 400-500 m. All these imbricate limestones include 69 to 99.5% $CaCO_3$.

Kilns have existed in the Villány Hills since the early 1790's but large-scale cement production began in 1910 when the Counts Schaumburg-Lippe opened large quarries and built their cement works (Lehmann, 1999). In 1972, this Beremend Cement Works (BCM), after 1988 called the Beremend Cement and Lime Industry Company, commenced production. Partly from 1993, fully from 2002, its ownership passed to HeidelbergCement AG, a leading player in Europe's cement industry. This company has greater interests elsewhere in Eastern Europe but

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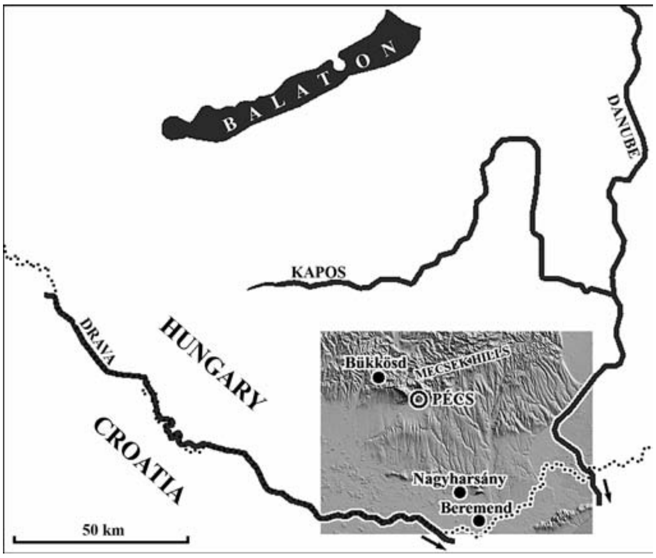

FIG. 1 - Location of limestone quarries and cement works in Southern Transdanubia (drawn by P. Gyenizse).

its Hungarian enterprise produces 1 million tonnes of clinker and cement each year of which the Beremend works contributes about 60% (HeidelbergCement, 2006). Today, the Beremend limestone quarries and cement works cover ca 1.9 km^2 and the Beremend limestone block is almost totally destroyed. Consequently, the focus of limestone extraction is shifting to the coral limestone of Szársomlyó Hill near Nagyharsány (fig. 2, and Lovász, 1977).

Here, from just 3000 tonnes in 1903, production increased to 100,000 tonnes in 1920, then declined after Hungary's territorial area was reduced (Tengler, 1997). In this period, bauxite was also mined and the demand for aluminium ore was higher. However, with the construction of the Danube Iron and Steel Works (1955), the demand for the Nagyharsány limestone revived and rose to a new peak of 800,000 tonnes per year. After 1988, production became oriented to the Beremend cement works, which also owned the quarry. During this period, local environmental problems including dust pollution both from the quarry and along access roads, noise from the quarry machinery and blasting, and vibrations causing damage in buildings received increasing attention from the local community.

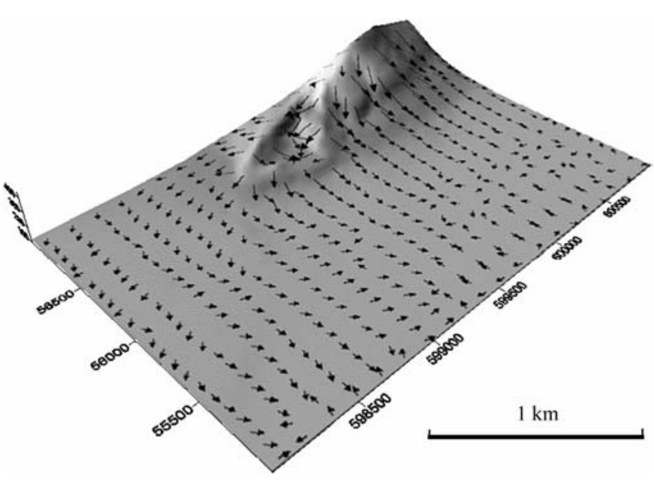

FIG. 2 - Digital Elevation Model of the Szársomlyó Hill with limestone quarry in operation (by K. Máté).

LAND USE CONFLICTS

As elsewhere in Europe, limestones quarrying and cement manufacturing leads to conflict with other land users. For example: in Nagyharsány village, quarrying has affected the expansion of the built-up area and the miners' settlement (locally called the Kolónia) built in the immediate vicinity of the quarry, had to be demolished. Another source of conflict is potable water. Water management is adversely influenced by the quarry because the waters that infiltrate through the quarry floor can be contaminated by oil, laden with silt, and so threaten the water quality of an extraordinarily vulnerable karstic aquifer. Local forestry is also affected due to losses of area and dust accumulation. However, the most serious conflict concerns nature conservation. In addition to biological values, the quarrying threatens major protected sites namely dripstone or «crystal» caves (fig. 4 and 5). Although, it was the quarrying that exposed one cave in each of the limestone quarries (table 1), all caves in Hungary are legally protected and it is not easy to exclude all harmful effects.

TABLE 1 - A comparison of the basic data of the Beremend and Nagyharsány caves (after Vigassy & Leél-Őssy, 2001 and other sources)

	Beremend crystal cave	**Nagyharsány crystal cave**
date of discovery	November 02, 1984	1984, 1989 or 1994 (?)
altitude above sea level	116 m	107 m
length	>700 m	>550 m
vertical extension	53 m	60 m
enclosing rock	Middle Cretaceous Nagyharsány Limestone	Middle Cretaceous Nagyharsány Limestone
origin	thermal water labyrinth	thermal, tectonically preformed
features	spheroids, shafts	spheroids
mineral precipitations	beautiful botryoids, dripstones, huntite, aragonite needles, gibbsite, goethite, magnesite	more dripstones, botryoids, dolomite, magnesite, illite, sericite, böhmite, chlorite, kandite
fossil finds	voles, shrews, bats, sabre-tooth tiger, wild sheep, antelope remains	Rodents

Of course, quarrying also transforms the land surface and landscape. Any degradation of the aesthetic quality

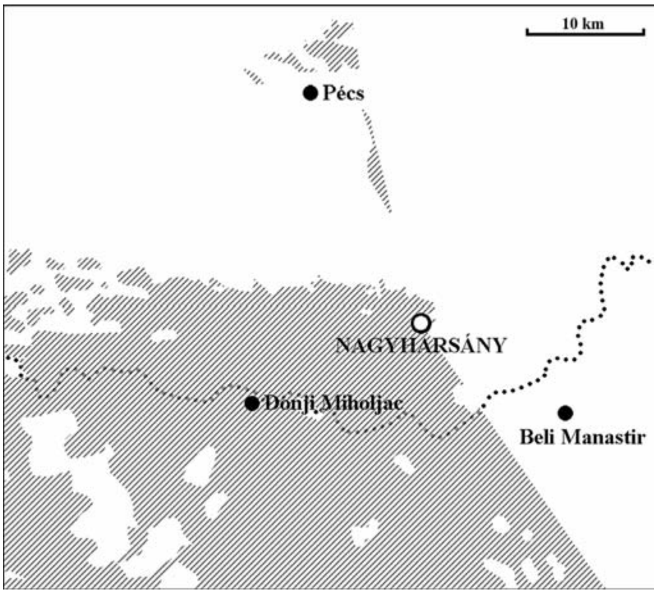

FIG. 3 - Visibility area (shaded) of the limestone quarry of Szársomlyó Hill (drawn by P. Gyenizse).

of the landscape endangers an emerging and potentially self-sustainable future in tourism and the recreation industries. The landscape scars of Szársomlyó Hill are visible from large distances, as revealed by analysis using a Digital Elevation Model (fig. 3), and affect scenic quality as far away as the economically important Siklós-Villány Wine Route, which runs across the southern slope of this hill region.

However, abandoned quarries may be turned to good use. When extraction ceased on the eastern side of the hill, the former quarry was quickly adapted as the site for an internationally renowned open-air sculpture exhibition, the Szabadtéri Szoborpark, and now acts as a tourist attraction. Additionally, the quarries may have some future in public education; after reclamation they may be ideal sites to show and explain local geological structures and rocks.

POSSIBLE SITES FOR NEW CEMENT WORKS

Today, motorway construction in Southern Transdanubia drives a growing demand for cement. Arguing that Hungary's capacity for cement manufacturing is not yet fully exploited, the investor STRABAG AG has applied to expand production at the Bükkösd I limestone quarry in the Western Mecsek Mountains from 150,000 to 1 million tonnes per year (Beliczay 2004). The limestone reserves of Western Mecsek (ca 56 million tonnes) do not limit this plan but the establishment of a new associated cement works does present many problems. Misra's international survey of such problems mentions the need for Public Hearings and to convince local communities of the benefits of a venture against strengthening opposition based on

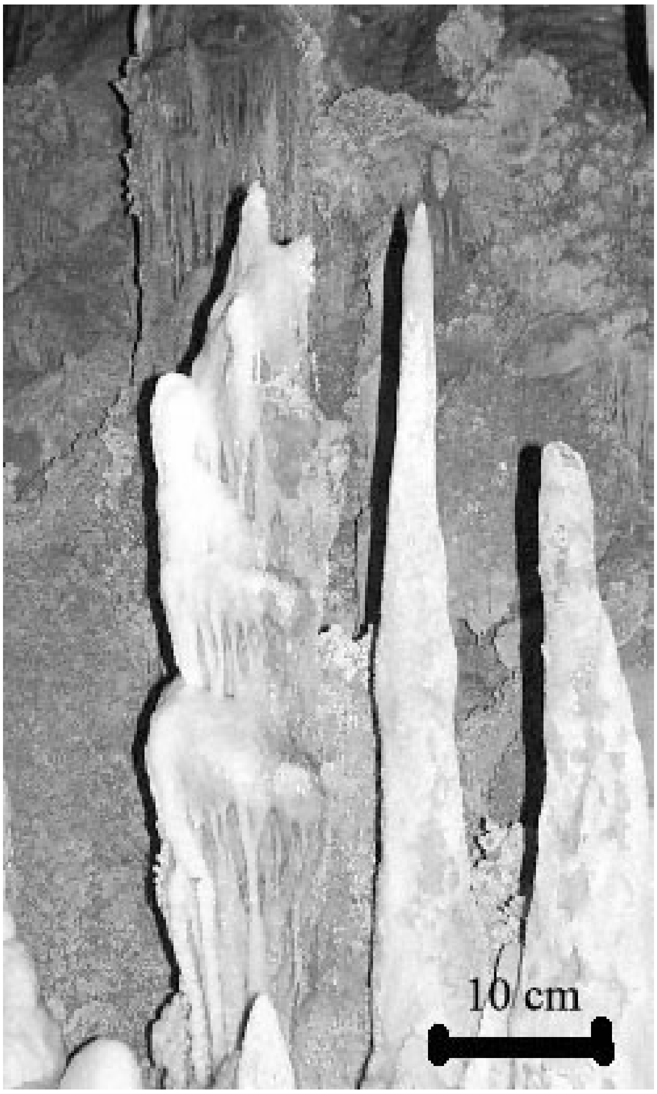

FIG. 4 - Dripstones in the Nagyharsány crystal cave (photo by K. Máté).

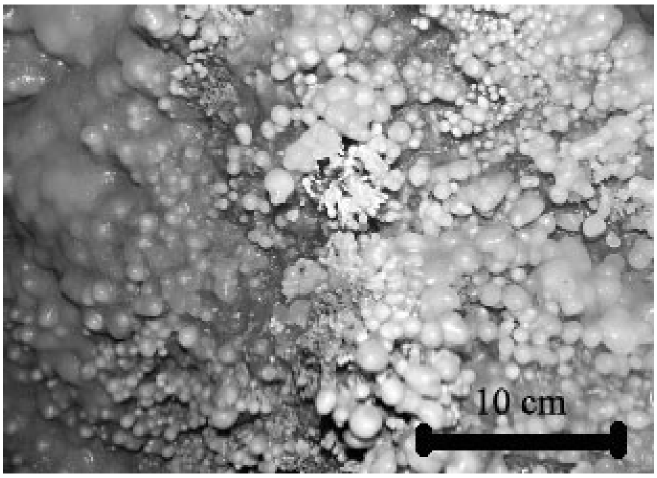

FIG. 5 - Botryoids in the Nagyharsány crystal cave (photo by K. Máté).

environmental concerns for the consequences; the need for whole life-cycle planning, which includes advance planning for reclamation, ahead of quarry extensions; and the need to construct new cement works further away from built-up areas, because of air and water pollution concerns, which often mean that new access roads have to be constructed (Misra, 2002). There is also pressure to reduce the clinker spoil/cement ratio, to find uses for the by-products and to minimise environmental damage during cement production. Further, increasingly, local communities, recognising the long timescale, emphasise nature conservation ahead of short term financial benefits. Hence, economic optimisation has to be sacrificed to observe guidelines for the protection of biodiversity and karst landscapes. Nevertheless, economic arguments dictate that the cement works has to be built within 30 km of the source limestone quarries.

Three possible sites emerged in preliminary planning (fig. 1): at Bükkösd (where after two refusals, a third vote brought positive endorsement from the local community); at Királyegyháza (a greenfield site) or at Kővágószőlős (a brownfield site of a former uranium ore enrichment plant).

ENVIRONMENTAL IMPACTS

Presently, the enlarged Bükkösd quarry seems to be the most probable location for the new cement works. However, there are associated environmental risks. The quarry, operated by the KÖKA Company, is located on the boundary of the Western Mecsek Protected Landscape, next to a north-south ecological corridor along the Bükkösd stream and to forests of high vulnerability (Lóczy & *alii*, 2002). The area also belongs to the Western Mecsek Ecotouristic Region. However, authors of the Environmental Impact Statement for the enlarged Bükkösd quarry suggest technological and engineering solutions which may mitigate many of the environmental problems (Csonka & *alii*, 2005). For the alleviation of the damage caused to the ecological corridor, for instance, it is suggested that constructing a bridge would provide a means for animal communication. Naturally, there is concern that this and similar measures might suffer during the usual cutting of costs once the project is approved.

Botanical surveys identify 30 protected plant species and 11 community habitats of outstanding importance on the western slopes of the Mecsek Mountains and close to the quarry. In addition, a bird refuge area also overlaps with the area to be developed. From an ornithological perspective, the area is most valued for three rare bird species, all particularly sensitive to disturbance. These are the tawny pipit (*Anthus campestris*), a reclusive ground-nesting insectivorous bird; the even more reclusive corncrake (*Crex crex*), a meadow-dweller and the colourful bee-eater (*Merops apiaster*), which breeds in loess bluffs mostly along streams. There are also several unique and protected insect species (*Coleoptera* and *Trichoptera*). It is paradoxical that the exploitation of a commonly found resource (limestone) should endanger the survival of a range of rare and irreplaceable landscape attributes.

However, the greatest number of environmental objections to the new limestone quarrying concern noise pollution. Quarry operations will take place in two shifts and on each occasion 35,000 to 40,000 tonnes of rock will be blasted away, a process with direct impacts up to 1200 m distance. The noise experienced by quarry workers will reach 110 dB in some phases of rock treatment (breaking up, sorting, grinding). Although, the topographic situation is relatively favourable; the site lies in the «curve» of the stream valley, so the upstream and downstream sections may be protected to some extent by the shading effect, the disturbance will be audible for long distances.

A key concern is preserving the quality of karst aquifer. To achieve this, a 10-m thick protective layer of limestone will be retained intact. However, this is not capable of protecting accidental contamination from accidental oil spills. Traffic problems linked to rock transport is another major local environmental concern. It is thought that the railway would be a more environment-friendly option than present road transportation. All the above refer to the quarry enlargement. No EIS has been prepared for the cement works yet. However, this will need to address additional issues, especially air pollution.

AN ATTRACTIVE ALTERNATIVE

Recently technological developments suggest that, in future, there may be less need for limestone quarrying to manufacture cement (Cembureau, 1999). Since 2002, Heidelberg Cement has been exploring a technology that uses metallurgical slag as 6% of the raw material. The addition has the advantage of reduced heat demand but more energy is needed for grinding the hard slag. Further, since metallurgical slag has some CaO content, CO_2 output is reduced.

Further ahead, experimental technologies are being developed that aim to use another problematic waste material, the rubble from demolished buildings, in cement manufacture (HeidelbergCement 2006). Such work looks to a future when it will no longer be necessary to cut scars into the scenery of limestone mountains landscapes in order to supply the construction industry.

REFERENCES

BELICZAY E. (2004) - *Együtt vagy egymás ellen (For or against each other)*. Lélegzet, 2004, október. 2 pp. http://www.lelegzet.hu/archivum/2004/10/3119.hpp Accessed on 16.03.2006.

CEMBUREAU (1999) - *"Best available techniques" for the cement industry*. CEMBUREAU (The European Cement Association), Brussels. 236 pp.

CSONKA P. (project leader) (2005) - *A Bükkösd I. kőbánya kapacitásának bővítése 150 000 t/év termelésről 1 000 000 t/év termelésre. Részletes környezeti hatástanulmány (Expansion of the stone quarry Bükkösd I from 150,000 tonnes per year to 1,000,000 tonnes per year capacity. Detailed Environmental Impact Statement).* TOTAL Kft., Pécs. vii + 109 p. + appendices.

ERDŐSI F. & LEHMANN A. (1984) - *A környezetváltozás és hatásai (Environmental change and its impacts).* Mezőgazdasági Kiadó, Budapest. 300 pp.

HAAS J. (1994) - *Magyarország földtana. Mezozóikum (Geology of Hungary. Mesozoic).* Lecture notes. ELTE, Budapest. 119 pp.

HeidelbergCement (2006) - *Geschäftsbericht 2005.* HeidelbergCement AG, Heidelberg. http://www.heidelbergcement.com/html/d/uploads/a313/GB_2005_D_print+pdf. Accessed on 11.03.2006.

LEHMANN A. (1995) - *Földrajzi tanulmányutak a Mecseken és környékén (Geographical trips in Mecsek Mountains and environs).* 2nd edition. JPTE, Pécs. 150 pp.

LÓCZY D., FÁBIÁN SZ.Á., GYENIZSE P., KOVÁCS J., NAGYVÁRADI L. PIRKHOFFER E. & SZABÓ B. (2002) - *A Nyugat-Mecsek természeti értékei (Natural values of Western Mecsek Mountains).* Manuscript report for the Duna-Dráva National Park Directorate. Institute of Geography, University of Pécs, Pécs. 135 pp.

LOVÁSZ GY. (ed.) (1977) - *Baranya megye természeti földrajza (Physical geography of Baranya County).* Baranya Megyei Levéltár, Pécs, 70-74.

MISRA K.K. (ed.) (2002) - *Toward a Sustainable Cement Industry. Substudy 11: Management of Land Use, Landscape, and Biodiversity.* World Business Council for Sustainable Development, Conches-Geneva. 11 pp. http://www.wbcsdcement.org/pdf/ sub_land_use_and_biodiversity.pdf. Accessed on 12.02.2006.

TENGLER T. (1997) - *A természeti környezet antropogén változásai Villány térségében (Man-induced changes in the natural environment at Villány).* Papers from the Department of Physical Geography, Janus Pannonius University (JPTE) #5. Pécs. 16 pp.

VIGASSY T. & LEÉL-ŐSSY SZ. (2001) - *A Beremendi- és a Nagyharsányi-kristálybarlang (Crystal caves at Beremend and Nagyharsány).* Karsztfejlődés VI. Department of Physical Geography, Berzsenyi Dániel College, Szombathely, 241-249.

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