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UNDERGROUND TOURIST ROUTES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

PODZIEMNE TRASY TURYSTYCZNE W PROCESIE ZRÓWNOWAŻONEGO ROZWOJU

Recent years paved the way for progress focused on maximising the financial and political profits, leading in consequence to a social and economic crisis and environmental disasters. In response to those negative impacts, the concept of sustainable development appeared, understood as the need to improve life quality at the same time retaining social balance, bio-diversity of species and the variety of natural resources.

A society that is active and has a full awareness of those issues will play a major role in sustainable development. On one hand, it will control the impacts the economy has on the environment, whilst on the other, the condition of the social capital guarantees the continuity of the progress envision and planning of its implementation.

Protection of old underground sites is in line with the principles of sustainable development. Well preserved underground sites opened to visitors are a part of the cultural heritage, ensuring that historic, cultural , natural and utility values are maintained. Recently a great deal of attention has been given to revival and revitalisation of old historical underground sites and giving them a new function. Revitalisation and preservation of old abandoned excavations is a most complicated process aimed at restoring the functional utility of abandoned or disused infrastructure.

Practical design should envision activities well in line with natural processes. Underground sites being preserved and adapted have to be visitor – friendly and acceptable, being a vital component of cultural heritage viewed in the context of sustainable development. Engineering problems involve not only the practical application of science, but also the way the world is defined. That is why the social and even spiritual aspects of revitalisation projects are recalled: recreation of human interactions with the nature and with the entire surroundings.

Underground tourist routes should be harmonised with land development in the area and the residence patterns that have emerged over centuries. Well – preserved and protected excavations are the relics of the past, are part of the cultural heritage and become a rich source of knowledge about history.

Keywords: sustainable development, underground tourist routes, revitalisation of old underground sites

Ostanie lata przyniosły rozwój skoncentrowany na maksymalizacji zysków ekonomicznych i politycznych. Doprowadził on do kryzysów środowiskowych, społecznych, a nawet gospodarczych. Przyczyniło

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się to do powstania koncepcji zrównoważonego rozwoju. Jest to dążenie do poprawy jakości życia przy zachowaniu równości społecznej, bioróżnorodności i bogactwa zasobów naturalnych.

Bardziej świadome i aktywne społeczeństwo ma do odegrania kluczową rolę w zrównoważonym rozwoju. Z jednej strony jest regulatorem wpływu gospodarki na środowisko, zaś z drugiej kapitał społeczny zapewnia ciągłość wizji rozwoju i planowania jej realizacji.

Ochrona zabytkowych podziemi bardzo dobrze wpisuje sie w proces zrównoważonego rozwoju. Zachowane i udostępnione zabytkowe podziemia są częścią dziedzictwa kulturowego i mają za zadanie zachowania wartości historycznych, kulturowych, przyrodniczych, a także użytkowych. W ostatnich latach obserwuje się intensywny rozwój działań zmierzających do wykorzystania zabytkowych podziemi do celów użytkowych. Problem rewitalizacji zabytkowych podziemi, a więc przywracanie "do życia" starych wyrobisk, jest bardzo skomplikowanym procesem przywracania pierwotnych funkcji nieczynnym lub zdegradowanym obiektom podziemnym.

W procesie projektowania bardzo ważne są działania zgodnie z procesami naturalnymi obowiązującymi w przyrodzie. Zabezpieczane i adaptowane podziemia muszą w rezultacie działań człowieka być "przyjazne" i akceptowane przez użytkowników, będąc elementem ochrony dziedzictwa kulturowego człowieka, a więc częścią składową zrównoważonego rozwoju.

Problemy techniczne występujące przy adaptacji zabytkowych podziemi są nie tylko praktycznym zastosowaniem nauki, ale także sposobem definiowania świata. Poszukuje się społecznego, a nawet duchowego wymiaru rewitalizacji; uzdrowienia relacji z przyrodą i z całym otoczeniem.

Podziemne trasy harmonizują z miejscowymi uwarunkowaniami przyrodniczymi oraz ukształtowanym przez wieki krajobrazem osadniczym. Zabezpieczone wyrobiska sięgają dorobku kulturowego dawnych pokoleń i są przyczyną rozwoju i edukacji historycznej społeczeństwa.

Słowa kluczowe: zrównoważony rozwój, podziemne trasy turystyczne, rewitalizacja zabytkowych podziemi

Introduction

Sustainable development is defined as social and economic development in which political, economic and social activities are integrated, sustaining the natural balance and stability of biological processes and the basic needs of communities and individual persons, both in the present and in future generations, can be satisfied.

Art. 5 of the Constitution of the Republic of Poland has it that "The Republic of Poland shall safeguard the independence and integrity of its territory and ensure the freedoms and rights of persons and citizens, the security of the citizens, safeguard the national heritage and shall ensure the protection of the natural environment pursuant to the principles of sustainable development".

The ICOMOS (International Council on Monuments and Sites) declaration from Xi'an (China) has it that " Protection and conservation of the world's cultural heritage is a component of sustainable development of the civilisation".

1. Sustainable development as the determinant of practical design and investment projects

Sustainable development is understood as the process of life quality improvement while taking into account social equality, bio-diversity of species and management of natural resources. It is a process that provides for better quality of life that should not lead to destruction of natural ecosystems sustaining the life on the planet or exhaustion of all natural resources thus jeopardising the ability of future generations to meet their own needs. In other words, while aiming at improving the life quality now, we should not condemn others to life in poverty (Gerwin, 2008).

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The concept of sustainable development was first propounded two decades ago in an attempt to set up a framework for management of progress, because progress targeted only at maximisation of political and economic profits would often lead to an environmental, social and even economic crisis. Sustainable development is not a credo to be accepted, but an inspiration to testing new ideas, experimenting and lifelong learning. Sustainable development requires that the foresight principle should be adopted (restricting all potentially threatening activities) alongside the prevention-based approach (act before the problems actually arise). Growing awareness of these issues and more active society have a major role to play in sustainable development. On one hand, the society is a tool for reaching this goal (controlling the impacts the economy has on the natural environment), on the other hand the condition of the social capital determines the progress patterns (high quality of social capital provides for continuity of the progress envision and planning of its implementation) (Bergier & Kronenberg, 2010).

Protection of old underground structures agrees well with the principles of sustainable development. Well-preserved and restored underground structures are the part of national heritage and the purpose is to retain their historic, cultural and natural value, at the same time ensuring their functional utility. Recently concentrated efforts have been made to adapt old underground structures and put them into new use (Wieja & Chmura, 2012).

The model example of revitalisation of old disused underground structures is the former gold mine in Złoty Stok, where gold (and arsenic) mining began several hundred years ago and continued until the 1950s. When the mining activities ended, the abandoned mine quickly turned into ruin. However, following the resolution of the town council and thanks to the activities of local enthusiasts, the new interesting underground tourist route was opened to visitors. There are nearly 150 thousand visitors annually who take part in a variety of mass events and learn about the history of the region. In 2007 the underground tourist route was named after Ignacy Domeyko, the most famous Polish geologist (Mikos & Chmura, 2008).

History of mankind is invariably linked with broadly-understood underground space. Primitive men lived in caves and grottoes, which served them as shelter, food storage, as well as the place where religious rites were performed and where the dead were buried. Further development

Fig. 1. Shaft Gertruda in the gold mine, currently the entrance to the tourist route

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of *Homo sapiens* involves the use of natural resources. Throughout the history of mankind, various resources were being obtained and used, leaving voids. Preservation and adaptation of those remnants plays a major role in protection of the cultural heritage.

2. Revitalisation of historical underground structures

2.1. Main objectives in design of underground tourist routes

Revitalisation and preservation of old abandoned mines is a most complex process of restoring the primary functions of disused or battered underground structures. In the course of the process the underground space can be given a new function, thus promoting the re-establishment of social networks, particularly in regions where the post-industrial infrastructure has to be redesigned and re-constructed to create the new quality of life.

A good example of the revitalisation scheme is the Lower Silesia Coal Basin, where the land was put to different use. Intensive coal mining which continued for many years wrought havoc to the local ecosystems. The closure of cost-ineffective mines in 1998 was an incentive for land reclamation and extensive work began to maximise its potential as a tourist asset. Excellent location of the town in a picturesque neighbourhood, in the vicinity the Książ Castle and with the nearby mountains give an impetus to the development of tourism in the area.

Obtaining the finance from the EU support funds allowed major projects to be undertaken: "Revitalisation of a former coal mine Julia and its adaptation to be furnished with cultural spaces" and revitalisation of the former colliery Katowice and adapting it to be turned into the New Silesian Museum.

Fig. 2. Coal mine Julia in an old photograph

The Culture Park was established using the facilities of the Industry and Engineering Museum set up after the mining activities in the coal mine ceased. A comprehensive plan was designed,

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involving several cultural institutions. The exhibition in the Museum would show the history of coal mining in the Lower Silesia region, where the Polish, German and Czech influences would mix, with the touch of the Jewish and French. Several cultural institutions and non government organisation have their residence in the region. The abandoned mine excavations and tunnels were turned into a subterraneous tourist route whilst reconstructed surface buildings house the exhibition rooms, multimedia rooms, artistic workshops and a library.

Fig. 3. Visualisation of the revitalisation plan of the coal mine Julia

The revitalisation scheme for the coal mine Katowice was suggested in which the post-industrial land with the old historical infrastructure were to become a part of the New Silesian Museum.

Fig. 4. Coal mine ‘Ferdynand” (Katowice) in 1935

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The New Silesian Museum has its residence in the southern section of the former coal mine "Katowice'. Historical infrastructure will be restored and adapted to be turned to new functions:

- hoist building in the shaft "Warszawa' – to be turned into a catering facility;
- clothing store house – to be used as an exhibition building- Polish Scenography Centre;
- Hoisting tower in the shaft "Warszawa" – to be turned into the vantage point (Cała & Ostrega, 2013).

The following design objectives were formulated in the context of the principle of minimal interference with the urban development plan of the old historical mine:

- turning the existing buildings into exhibition, catering facilities or vantage points
- underground location of newly-designed facilities (Cała & Ostrega, 2013)

The enterprise is supported through the European Regional Development Fund.

Fig. 5. Visualisation of the revitalisation plan of the coal mine Katowice

Mine revitalisation projects have their own specificity, involving the assessment of the working conditions of buildings and structures and of the feasibility of adapting its spatial structure to the projected needs or as a tourist attraction. These analyses determine the scope of work required to secure and protect the old infrastructure being revitalised. The key aspect is determining the adequate strategy for protecting underground facilities of historical value and, first of all, the target function has to be defined at an early stage.

Revitalisation schemes often interfere with the structural design and form of the underground infrastructure, which is often necessitated by the poor condition of mine workings, their complex structure, difficult access and applicable legislation having relevance to restoration of historical monuments. That is why each adaptation plan should provide for individual approach to solving engineering problems faced during supporting and revitalising underground objects of historic

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value. As a result, an underground facility will be turned into a new spatial structure put to a new use. The scope of work, therefore, involves extensive integration, reconstruction, maintenance, restructuring and modernisation jobs.

2.2. Safety underground

Safety considerations are of primary importance when planning the adaptation and use of old underground infrastructure, from the stage of pre-development, to actual securing jobs and then when the facility is already in use.

The safety of those structures is determined by the risk levels of the natural hazard occurrence:

- rock sliding sometimes reaching to the surface and giving rise to deformations and discontinuities,
- variable and limited size of mine excavations;
- water hazard;
- gas hazard and oxygen-free atmosphere.

One has to bear in mind, however, that these hazards frequently co-occur. This is of primary importance at the stage of prospecting and securing and supporting jobs which are often long-lasting and costly.

Fig. 6. Caving-in underground the Nagórzyckie Grottos and the subsidence on the surface

All types of roof support and underground construction technologies are applied. The top priority is that all jobs have to be carried out in accordance with the mining industry standards and the personnel should be alert to any threatening dangers from unstable rock strata (Wieja & Chmura, 2011). The facility being secured should ensure the 100% safety level and as well as high levels of visitors' satisfaction.

Roof securing and protection can be effective as long as the impacts of planned activities are known beforehand and forecasting the effect of scheduled mining operations is of primary importance, particularly when considering the deformation of rock strata near the surface (Florkowska, 2012).

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Mining practice teaches us that it is required that basic principles should be adapted and strictly observed, having relevance to:

- design of underground tourist routes taking into account all potential hazards which may arise during the supporting work and when the route is put to use;
- using the mining technologies for supporting and development of the underground excavations by experienced staff;
- working out the criteria and principles defining when the underground tourist routes can be open to public;
- defining the principles and frequency of regular assessment of the working condition of underground tourist routes.

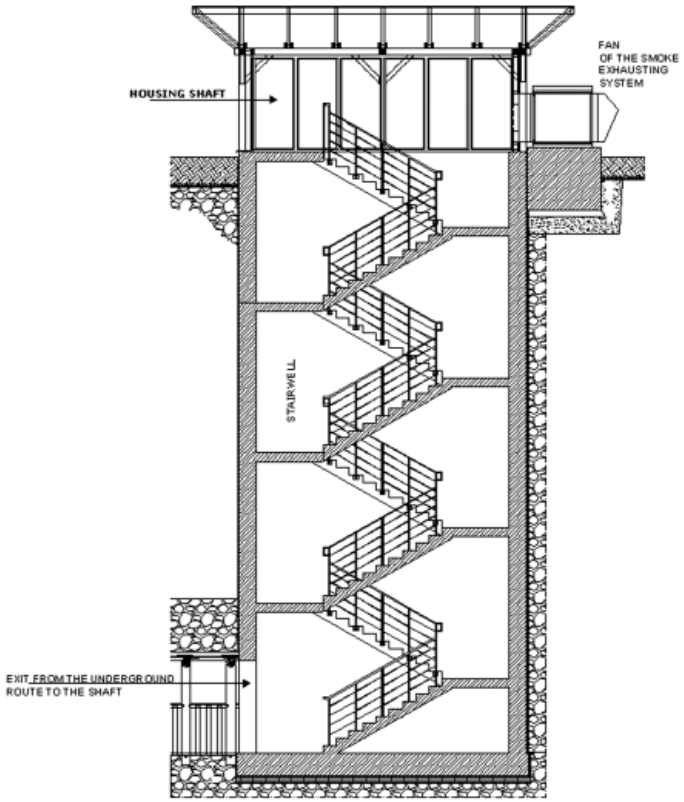

Fig. 7. Design of a evacuation route in the Nagórzyckie Grottos in place of the cave-in

2.3. The influence of the geological and mining conditions on the underground tourist routed being designed

The specific use to which the old mine workings can be put is determined by the geological and mining conditions of the rock strata, where the mine workings tend to constrict, leading to

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reduction of voids and rock sliding. Unfavourable geological conditions will further enhance this risk.

It is required therefore, that the mining and geological conditions should be established prior to any protection works and adaptation of old underground facilities. It is of primary importance in the case of underground tourist routes, due to their specificity. The mine workings and galleries are not deep underground and are often embedded in rock strata where the geotechnical conditions are most unfavourable, posing the potential threat to overlying structures. It is frequently the case that unfavourable conditions in the rock strata coincide with adverse hydrological conditions and surface water inflows negatively impact on stability of underground structures.

When old subterraneous mine workings are being adapted, utmost care is taken to counteract those threats. A good example of well-adapted facilities are grottoes and caves. We have been involved in several projects involving the supporting and adapting natural caves. We were responsible for roof propping and protecting the cave Obłazowa in Nowa Biała, in vicinity of Nowy Targ. Archaeological excavations which continued for several years posed a threat to the cave stability when lower and lower silt layers were reached. The support and propping method had to be found to reconcile the need of personnel safety and possibility of penetrating lower and lower strata (Chmura, 2009).

We completed the project involving the support and adaptation of a karst site in an old open-cast Kadzielnica in Kielce. Penetration and protection works were continued for over five years, resulting in the opening of a spectacular underground route and a newly-reconstructed amphitheatre was open, intended for hosting major events.

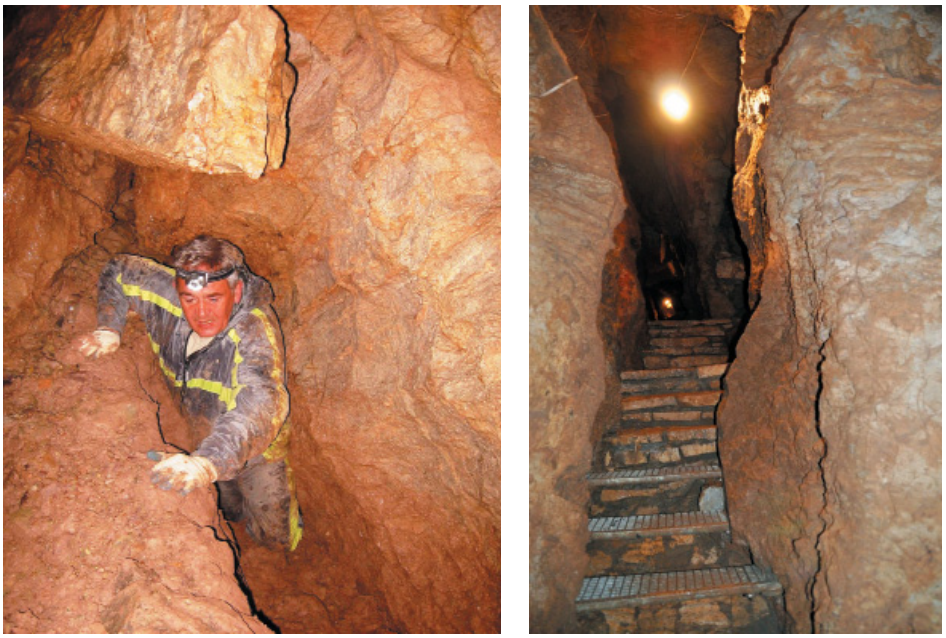

Fig. 8. Kadzielnica Cave in the Geopark in Kielce- penetration works at the excavation site (on the left) and a section of supported and secured tourist route (on the right)

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2.4. Natural environment as the major determinant of design objectives

One of the major issues involved in protection of cultural heritage of man is environment protection. The fundamental feature of the natural environment is maintaining the natural balance in constant interactions with humans. Environment is where all natural geographic processes take place, involving the Earth' geological structure, water systems, flora and fauna. Its main feature is bio-diversity- a consequence of the presence of different features at various points on the Earth.

The natural environment is where men lives and pursue their activity, resulting from a variety of interactions between natural forces undergoing constant evolutionary processes. Human activity associated with excessive mining of minerals and inadequate resource management has led to the degradation of the environment in many places or is posing a serious threat to the ecosystems.

The concept that needs to be recalled at this point is the *best available solution* whereby the best solution possible is sought that is available in the given circumstances (Bergier & Kronenberg, 2010). When this principle is adopted, the aesthetic, functional, cost-effectiveness, operational and financial aspects are addressed already at the stage of the design process taking into the economic, social, environment and cultural context.

Hence the design objectives should envision activities well in agreement with the natural processes. As a result of human activities, supported and adapted underground sites must be 'visitor-friendly' and acceptable to users.

Numerous projects have been completed where abandoned and degraded underground passages and the overlying structures have been successfully integrated with the land features. On one hand, old historical buildings and structures were saved from degradation, on the other- their surroundings were vastly improved, too.

3. Old historical subterraneous facilities in the context of sustainable development

Protection of old historical underground sites is an element of protecting the man's cultural heritage- a vital component of sustainable development. Supporting and adapting underground sites involves the aesthetic, environmental issues, urban development, and natural and social aspects.

As regards aesthetics, the individual vision is developed of the interior and of the surroundings. Environmental issues include the reclamation of degraded land and materials and their effective disposal. Urban development consists in arrangements of the outside space in the context of utilisation of the underground infrastructure. Natural aspects include the landscape protection. Of particular importance are social issues, such as encouraging the activity of local communities in areas with high unemployment levels. These are mostly those regions where unemployment levels increased sharply as a result of economic restructuring. Of major importance in this context is recalling the ethos of craftsmen formerly employed in the construction sector. Specificity of protecting and adapting underground sites requires that traditional technologies should be revived both when running the adaptation project and when activating the local communities. Rejection of traditional approaches and technologies limited the development of individual talents, restricting the means of creative expression and independence of so many people. The education system

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providing little vocational training bears some responsibility for the structural unemployment problems. It is recommended, therefore, that the option should be restored where the career path of "an individual craftsman' could be chosen again (Krier, 2001).

3.1. Social participation

The concept of participation can be broadly defined as the citizens' presence, more or less active, in social, public and political life. It means individual participation in group and communal activities at places where they belong or reside. In particular, that refers to their active presence in the organisation and functioning of local citizens' groups and non-government organisations, involving voluntary work on the permanent or temporary basis. That means the citizens' participation in decision-making processes in their local communities. This aspect is rather complex and multi-dimensional, involving a variety of relationships, in other words recalling the sphere of human interactions, contacts and interrelations between the local authorities and members of the local community (Krier, 2001).

Research reveals that emotional bonds between the members of local communities are chiefly formed in response to the need to solve common problems. The strength of those bonds is the consequence of the fact that the majority of individual needs can be well satisfied on the level of local community and through their involvement in the life of the local community, individual people are able to directly control its dynamics and directions of development. Evolution of the local government's role and hence participation of local inhabitants in the public life involves their being engaged in management of local issues. Thus, they become the subjects of social self-organisation and integration, furthering the development of the local community, as its co-creators.

3.2. Design of underground tourist routes in the context of social participation

Social communication is an interactive process. On one hand that means that local authorities effectively pass on information to inhabitants, on the other- that information transmission channels are provided to get the feedback from inhabitants. A number of underground tourist routes appeared thanks to the commitment of local inhabitants who spotted the opportunity to turning old abandoned objects to a new use, which encouraged a number of people to act. That in turns would lead to reduction of unemployment levels and would help create new jobs.

The willingness to identify the problems and needs of local communities is the necessary condition for initiating a real and effective communication on the local level. A wrong diagnosis can mean that further activities of the local authorities in the area of communication would be futile, making the inhabitants lose their interest and understanding.

Strong commitment on the part of the local community in Kamienna Góra led to the decision and resolution of the Town Council to adapt the old underground tunnels in the town centre and turn them into a tourist route. The tunnels driven during the World War II at first housed a factory that manufactured aircraft and missile parts. The excavations, abandoned and devastated for 60 years, would be reconstructed and with the support of EU funds, the new underground tourist route would be opened. The town, already attracting numerous tourists, could now boast a new and unique site.

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Fig. 9. Tunnel in the Park Mountain in Kamienna Góra- before the restoration work and the entrance to the underground tourist passage

New tourist attractions in the area coupled with the decline of the industry have led to the establishment of a major recreation centre in the vicinity of Tomaszów Mazowiecki. The Sulejowski Reservoir, vast areas of virgin woods make an excellent recreation and tourist site, popular among residents in Warsaw and Łódź. An open-air museum of the Pilica River was established, an attraction for those interested in the history of the region. Springs pulsating with clear blue water lure the throngs of holiday-makers. The Nagórzyckie Grottoes, abandoned and disused for years, were also adapted and put to new use. This site, once an underground sand mine, is absolutely unique in the European scale. In response to local initiatives, several projects were begun involving the preservation, adaptation and opening those excavation sites for visitors, thus adding new tourist assets in the area.

Fig, 10. Entrance to the Nagórzyckie Grottoes

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3.3. Integration of local inhabitants

The further step should involve the integration of local inhabitants working together to solve a problem or handle a certain issue.

In order that integration should be effective, the inhabitants need to be given full information about the problem, possible solutions and projected outcomes, in the course of meetings with local inhabitants or through the use of local media. Next, steps should be taken to gain the inhabitants' trust and understanding so that they should accept the information and proposal, for instance relying on opinion leaders. Well thought out actions should raise the inhabitants' awareness of the issue and help them get involved in local matters.

Social promotion is another aspect. These activities are undertaken to add to the common interest in the given local administration unit or to help retain its positive image, and to present the administration unit as a marketing product to encourage potential investors and other target groups to consider the offer (Chmura & Wieja, 2011).

A major step in the project is the improvement of local infrastructure and the surroundings of the newly opened route (parking areas, roads, access paths, parks, green areas).

The newly developed object should fit in with the surroundings. In accordance with the relevant laws, the visitors' safety underground should be guaranteed and the required levels of psychological comfort and engineering features have to be provided.

4. Protection of cultural heritage and ecosystems in the context of sustainable development

In the context of sustainable development, a major aspect to be considered when securing and adapting old excavation sites is integration of the existing buildings and structures with broadly understood natural ecosystems. That is why the protection of cultural heritage and of the environment should be treated as top priority issues in the investment strategies.

Buildings and structures being upgraded and adapted to be put into new use should be biologically, functionally and visually integrated with their surroundings. Practical design should be based on the knowledge of local resources and the fundamental physics of structures. Engineering problems involve not only the practical application of science, but also the way the world is defined. That is why the social and even spiritual aspects of revitalisation projects are recalled: recreation of human interactions with the nature and with the entire surroundings.

Practical design and construction of underground routes have to take into account their functional utility, aesthetic aspects, maintenance cost savings and investment expenditures required to meet the economic, social and cultural requirements. In practice, such approach requires high levels of environmental culture. Underground tourist routes should be harmonised with land development in the area and the residence patterns that have emerged over centuries. Preserved and protected excavations are the relics of the past, are part of the cultural heritage and become a rich source of historical knowledge.

Recently a great deal of attention has been given to revival of natural constructions, closely linked with the mother- Nature. These projects involve also broadly-understood adaptation and revitalisation of old historical underground sites. New functions of newly opened underground infrastructure led to the opening of interesting tourist routes and health spas, sacral buildings and education facilities used for the purpose of vocational training.

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Fig. 11. Excavations in the uranium mine in Kowary where radon treatments are offered

Revitalisation of old underground sites is well harmonised with principles of sustainable development.

5. Conclusions

In Poland now several schemes have been undertaken aimed at restoration, preservation and adaptation of old historical underground infrastructure and putting it to a new use. Adaptations of old abandoned mine excavations and tunnels in Poland began many years ago. The best-known example is the salt "Wieliczka", where the first visitors, including by rulers and VIPs, were admitted several hundred years ago. In the early 20th century the Cretaceous sites in Chełm were opened to organised groups of visitors. At that time first attempts were made to adapt old caves and caverns and turn them into underground tourist routes. After the World War II numerous projects were initiated involving adaptation of old mines and turning them into underground tourist routes.

The research team from AGH-UST vastly contributed to the securing and preservation of the most spectacular and valuable underground sites. The team has been involved in such projects for years, making a significant contribution to protection of cultural heritage.

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