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GEOGRAPHIC INFORMATION SYSTEMS FOR OLD WASTE DISPOSAL SITES AND BROWNFIELDS

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Abstract. In Western Europe, systematic registration and studies of the old waste disposal sites as well as old industrial locations began at the end of 1980s. Those sites were, first of all, potential places of contaminants emission to groundwater. Quantity of data on the subject has increased very quickly. Process of investigations at different stages as well as possible monitoring of contaminated terrains generated huge quantity of measurements and analytic information which could be collected in computer databases.
Simultaneously, these data, together with other information (technological, objects destination and their history, archival maps and pictures) have a cartographic arrangement in the co-ordinate system. These two elements sufficed to actively connect such quantity of information with graphics on maps via GIS. It created completely new quality in registering, classifying, and management of such post-industrial phenomena as old waste disposal sites and brownfields. The use of aerial photos or satellite images as well as digital terrain models (DTM) permitted to considerably broaden knowledge on the investigated terrains. The modern urban and spatial management projects in smaller or larger cities have to take into account the above-mentioned terrains because most often they created considerable difficulties in their sales and development. This is related to the soil, water as well as ground air contaminations which often exceed many times norms and standards in force.
The article presents methodical approach to application of the Geographic Information System (GIS) for developing in Poland research on areas contaminated by men's former activity. The obligatory for the local government lists of contaminated areas should also have their graphical representation. It would facilitate collaboration with planners at every administrative level. A gradual development and mastering of computer technologies in districts administrative offices will permit to create special informative layer called "old waste disposal sites and brownfields" on districts environmental maps. Information contained in such a layer can be created and modified by specialised companies as a result of progress in the individual objects investigations. And it can also be systematically updated by competent officials with user-friendly software during the monitoring process of different environment elements. Such an approach can be a good mechanism for illustrating phenomena of expanding or decreasing a contamination stain against the background of different physiographic conditions as well as of the existing infrastructure.rtrydhshs

Key words: waste disposal sites, brownfields, GIS.

Abstrakt. Od końca lat 80. XX w., kiedy w Europie Zachodniej zaczęto systematycznie inwentaryzować i badać stare składowiska oraz stare lokalizacje przemysłowe, będące przede wszystkim potencjalnym miejscem emisji zanieczyszczeń do wód podziemnych, szybko przyrasta ilość danych na ten temat. Proces badań na różnych etapach oraz ewentualny monitoring dawniej zanieczyszczonego terenu generuje ogromną ilość danych pomiarowych i analitycznych, które mogą utworzyć bazę danych. Jednocześnie dane te wraz z innymi informacjami, np. na temat technologii, przeznaczenia i historii obiektu, archiwalnych map i zdjęć, mają przyporządkowaną lokalizację w kartograficznym układzie współrzędnych. Już te dwa elementy wystarczą, by przy takiej ilości informacji z bazy danych powiązać je aktywnie z obrazem na mapie poprzez GIS.
Daje to zupełnie nową jakość w inwentaryzowaniu, klasyfikowaniu i zarządzaniu takimi zjawiskami postindustrialnymi, jakimi są stare składowiska i stare tereny przemysłowe. Komputerowe przetwarzanie zdjęć lotniczych czy satelitarnych, a także modeli terenu (DTM) pozwala niejednokrotnie znacznie poszerzyć wiedzę o badanych terenach. Nowoczesne projekty urbanizacyjne i samo planowanie przestrzenne w mniejszych lub większych miastach musi obecnie uwzględniać stare składowiska i tereny po-

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przemysłowe, ponieważ są one trudne do zagospodarowania. Wiąże się to z wykrywaniem tam zanieczyszczeń gruntu, wód oraz powietrza gruntowego, nierzadko wielokrotnie przekraczających obowiązujące normy i standardy.
Artykuł prezentuje metodyczne założenia systemu informacji przestrzennej (GIS) dla rozwijających się także w Polsce badań terenów zanieczyszczonych przez dawną działalność człowieka. Pokazuje też, że obligatoryjne dla starostw spisy terenów zanieczyszczonych powinny mieć swój obraz kartograficzny, by ułatwić współpracę z planistami na każdym szczeblu administracyjnym. Stopniowy rozwój i opanowanie technik komputerowych w urzędach, np. w starostwach, pozwoli też z czasem stworzyć dla powiatowych map środowiskowych specjalną warstwę informacyjną o nazwie „stare składowiska i stare lokalizacje przemysłowe". Informacje zawarte w takiej warstwie mogą być tworzone i modyfikowane przez specjalistyczne firmy, jako wynik postępu w badaniach poszczególnych obiektów, a także systematycznie aktualizowane (przyjazne oprogramowanie) w trakcie prowadzenia monitoringu różnych elementów środowiska. Może to być dobry mechanizm ilustrowania np. zjawisk rozprzestrzeniania lub zmniejszania się plamy zanieczyszczeń na tle różnych uwarunkowań fizjograficznych oraz istniejącej infrastruktury.

Słowa kluczowe: składowiska odpadów, tereny poprzemysłowe, GIS.

INTRODUCTION

While conducting geoenvironmental studies in industrialised areas, old historical buildings are often found. Some of them are a showcase of the old industrial architecture; very often they are being even renovated and preserved as tourist attractions. Other, less important, slowly fade into oblivion and fall into decay, and after a while it is difficult to say where they were located. However, after many years, some of these objects are suddenly "rediscovered" during the remediation of the contaminated terrains. As it happens, those rediscovered old factories (gasworks, galvanising factories, tanneries etc.) or waste disposal sites are peculiar reminders of the industrial history, hazardous to people and environment.

Systematic studies of the old waste disposal sites and former industrial locations have been conducted in Western Europe since 1980s (Altlasten-Handbuch, 1988). Due to the environmental threat, especially to soils and groundwater, methodology of those studies is constantly developed. Still more advanced technologies are employed. In effect, the amount of data from the investigated terrains is rapidly growing. Various stages of specialists investigations generate vast amounts of measures and analytic information. Obtained information are the spatial data, since it can be placed in 2-D or 3-D space, in a proper co-ordinate system. It seems natural that the obtained results can be actively linked with the graphics on a map via GIS.

APPLICATION OF GIS SYSTEMS TO WASTE SITES AND BROWNFIELDS STUDIES

The process of studying old waste disposal sites and brownfields with application of GIS offers completely new quality in registration, classification, and management of the post-industrial sites processes. Computer processing of aerial or satellite photos, and digital terrain models (DTM), often permits to considerably broaden knowledge on the investigated terrain. Modern urban projects and spatial management of towns or cities have to take into account the above-mentioned terrain because they often create considerable difficulties for resale and development. This is related to the detection of soil, water as well as ground air contamination there which often several times exceeds valid norms and standards.

During the first stage of investigations, reconnaissance of historical events is conducted which enables sometimes determination of the range of necessary analytic works. It is extremely important from ecotoxicological and economic point of view because it makes possible the determination of the main contaminant and the scope of necessary analyses.

While conducting the research, questions: "when ?", "what ?", "where ?", and "how ?" arise. Based on the collected materials, a computer database can be created. Archiving the discovered historical cartographic and photo-interpretative data in a GIS system permits for orientation of materials in a proper co-ordinate system, and forms a basis for further comparative analyses. This highly facilitates answers to the frequently asked investigative questions. In this way, basis for a database is formed in which informative layers as well as descriptive and graphic materials are collected. Photos or schemes are attached via active links to their location in space.

After initial reconnaissance, technical works are performed that is sampling and chemical analyses. Localisation of measurement points in GIS, connected with a database containing results of analytic analyses, will become a base for interpolation works in Surfer and/or ArcInfo programs. On this basis, maps illustrating he distribution of individual parameters are created via interpolation t, for instance, *Geochemical atlas of Poland* (Lis, Pasieczna, 1995) and atlases of urban agglomerations (Nałęcz, 1998; Lis, Pasieczna,1999). Use of geostatistical methods enables testing of various schemes in order to obtain the distribution which the best represents the reality (Lantuejoul, 2002).

During the next stage, analyses are performed in order to assess the environmental risk. Based on historical materials and analytic studies, causes of contamination can be established most accurately. In this stage, spatial analyses of changes over time in terrain management are very helpful.

Comparing series of aerial photos taken at different times, one can trace successive stages of the terrain transformations. One can also find useful satellite images enabling various spectral analyses except for graphic observations. For many years, satellite photos were not used in the detailed studies because of the low picture resolution. However, at the end of the 1990s, also civil satellites enabled to get pictures of about 1 m resolution (IKONOS, QuickBird). The digital terrain model (DTM) artistically illustrating natural phenomena, especially in connection with satellite or aerial photos, can also be a valuable interpretative complement. Based on the collected information, analyses and comparison of studied objects are made, e.g. in the area of a voivodship. These works are aimed at environmental risk assessment for individual objects (Irmiński, 1996). Assessment of such risk is a kind of objects ranking, based on comparison of local conditions of the individual objects, except for the already mentioned reconnaissance results. On this basis their classification will be made. Such ranking can be created with the use of a GIS system on certain conditions. It is important to state accurately which element of the environment is especially valuable in a given case. It can be, for example, a housing estate with a municipal intake or a single farm with a well, nature reserve or agricultural areas, etc. Elaboration of a proper classification methodology can be a basis for spatial analyses supporting and automating the ranking process.

As a result of performed study, a huge database of spatial data is created which can be utilised in many ways. In general scale, it is possible to present the set of objects together with the desired classification, e.g. advancement of studies, occurrence of important contaminants or environmental hazard. The choice of an object in a digital database enables transition to a detailed scale because most information is collected and presented in such a scale, only. This makes possible comparison of research results with data on local infrastructure, i.e. roads, gas mains, water intakes etc. which is important while planning necessary remediation works. Thus, already at the stage of planning and collecting geoenvironmental data, information on the infrastructure can be used in order to form such a base that offers a possibility of compilation and comparison.

CONCLUSIONS

The open structure of a database and analytic capabilities of GIS are the basis for performing spatial analyses supporting the decisions on the studied objects impact on the surrounding, and on the hazard to natural environment. Local administration at municipal and district level still more often use digital geodetic and ground maps. GIS databases enable supporting the processing of the natural data collected in administrative units (Nałęcz, 2002). This offers hope that administration will have a similar approach to archiving, processing and utilisation of data resources on environmental hazard with the use of GIS programmes. Precise and quick comparison of the knowledge on old waste disposal sites and old industrial locations with local requirements (urban development, environmental protection etc.) gives an opportunity to avoid many planning mistakes (Irmiński, 2001), and can better serve financial resources planning for the possible cleaning works and remediation of the degraded areas.

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