

Aerial imagery and geographic information systems used in the asbestos removal process in Poland

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Abstract. The purpose of the study is to present how Geographic Information Systems are used in monitoring of the asbestos abatement process. Asbestos containing products were used in many economy branches. Since it was proved that asbestos is harmful for human health, legal actions were taken in order to discontinue the usage of asbestos containing products. Legal regulations in EU and in Poland were enforced. In Poland monitoring of the asbestos removal process is done with the usage of the Electronic Spatial Information System for Monitoring of Asbestos Products Removal. The research area is whole territory of Poland including national, provincial and local level of detail. System development was based on geodatabase which integrated data from various sources: National Register of Boundaries, General Geographic Database of Poland, orthophotomap, land and property register and database of asbestos containing products. Descriptive data were implemented with the usage of the geocoding tool. Land parcels were built into the system as known reference points which provide a reference structure for locating asbestos containing products in space. Monitoring is done using GIS tools at three levels of management (national, provincial and local). It includes preparation of vague range of maps and spatial analysis in order to undertake proper actions. Methods used and results obtained proved that until now the system is useful for decision making purposes and for monitoring process. Proposed solutions were appreciated by EU.

Keywords. asbestos, aerial imagery, spatial analysis used for asbestos removal process, monitoring of asbestos removal, Poland.

1. Introduction

Asbestos is a natural resource which had vague applications in the economy. Due to its physical and chemical properties asbestos was used as component for construction materials in architecture, road building, industry and many different economy branches. During the scientific surveys it was proved that asbestos is harmful for human life and health. Especially exposure to asbestos dust was treated as a threat to human health leading to asbestos-related cancer diseases.[1]

Taking into consideration its harmfulness for human health and despite of its usefulness in many human activities, legal regulations were enforced ensuring that asbestos should be removed safely until the end of 2032. In Poland the whole process is done under the auspices of Ministry of Economy enforcing the Program for Asbestos Abatement in Poland.[2]

As it is mentioned in Council Directive 87/217/EEC of 19 March 1987 on the prevention and reduction of environmental pollution by asbestos, the main aim is to lay down measures and to supplement provisions already in force, with a view to preventing and reducing pollution by asbestos in the interests of the protection of human health and the environment.[3]

Asbestos containing products were mainly used in Poland for the construction of roofs and buildings elevations as well as for the industry machinery and buildings. The biggest problem of the asbestos removal process is insufficient knowledge about the quantity of asbestos products to be abated.

Asbestos containing products are scattered across the country and their precise amount is unknown, though the estimates made in 2003 indicated that approx. 15.5 million tonnes of asbestos containing products were used in Poland. There are still projects done on inventory-taking activities and still the amount of asbestos products used is not estimated however each year there are additional data gathered.[2]

In order to make the monitoring process effective and efficient, Electronic Spatial Information System for Monitoring of Asbestos Products Removal in Poland was applied. The main aim of this activity was to present and analyze results of inventory taking done by local governments and to improve management of the abatement process.

2. Research area

Research area consisted of the whole territory of Poland. Due to the differentiation and precision of required data in order to undertake analysis and monitor the direction of the process, the system construction was based and therefore divided into three levels of management.[2]

2.1. National level

National level is the highest level of analysis. Poland consists of 16 provinces (voivodships). National level is used by Polish administration to manage and monitor the Program realization on a highest level of precision. National level was established to embrace information aggregated to the areas of provinces. It enables to obtain information about general trends and progress made in asbestos abatement process. It is mainly used for general reporting purposes.

2.2. Provincial level

Provincial level is the second one in order after the national level and was chosen in reference to the territorial division of Poland. There are 380 districts specified in Poland. Data are gathered and analyzed for provinces divided into districts. This level is mainly used by provincial administration to plan activities to be undertaken and report results to national level.

2.3. Local level

Local level is the lowest level of analysis since the last level of administrative division in Poland is local government. There are 3.479 local governments which are obliged to gather data on asbestos usage and abatement. These data constitute the basis for the operational activity of the system and embrace the most accurate information in reference to the unique record where the asbestos products are used.

3. Data used in system development

System development required the usage of different data sources gathered for the area of Poland by Geodetic and Cartographic Central Documentation Centre.[4]

3.1. National Register of Boundaries

National Register of Boundaries is the official database containing details of the administrative division of Poland and areas of provinces, districts and local governments. It is the basic source of

information for Geographic Information Systems and as such was used in development of Electronic Spatial Information System for Monitoring of Asbestos Products Removal in Poland.

3.2. General Geographic Database of Poland

General Geographic Database of Poland contains spatial data infrastructure at the accuracy of maps of 1:250.000 and less. Taking into account the precision it was used for the national and provincial level. Database contains information about shape and localization of objects and spatial phenomena. It consists of many layers among which it was chosen to use for the system development: land use and land cover, protected areas, transport and geographical names.

3.3. Orthophotomap

Orthophotomap is used in the system as a source of basic data for the local level. Usage of this layer enables to assess the accuracy of data gathered by local governments through the database of asbestos-containing products. It is dedicated for presentation and verification purposes of inventory results at the local level.

3.4. Land and property register

Land and property register is used for the local level. Data gathered in database of asbestos containing products have assigned the attribute from the land register - which is the registration number (parcel identification number). It allows to locate each object which has the necessary attributes collected in database in reference to land register.

3.5. Database of asbestos containing products

Database of asbestos containing products is the tool performed for Ministry of Economy to gather and process information derived from the inventory taking of asbestos containing products done by local governments. It is the source of descriptive data which is connected to the land register through the unique registration number.

4. Electronic Spatial Information System for the Monitoring of Asbestos Products Removal in Poland

Geographic Information Systems are based on geodatabases. These databases are the sources of information for all of the queries, analysis and management processes. Database Management System enables the storage of spatial data and potentially the access to the system by many users. Geodatabases should have the proper data structure and indices in order to realize queries and transactions effectively. Safety of the system and transactional model of access are the crucial conditions of the system's successful operation.[5]

System development was based on a relational geodatabase which integrated data from various sources. Reference databases and glossaries were implemented in system development process. It was decided that land parcels may be built into the system as known reference points. They provide a reference structure for locating asbestos containing products in space. Parcels are measured and can be described and expressed in GIS since they have a hierarchical framework and form closed polygons.[6]

The key task in developing data model was to define the set of data to be used in the system construction as well as relationships between them. They were validated then against user's requirements for filling, updating and accessing data at a later stage. Basic data modelling principles

were applied, such as no duplication, simplicity and clarity of data.[7] Database which is the basis for the Electronic Spatial Information System for Monitoring of Asbestos Products Removal in Poland was founded on the set of tables which are interconnected through the unique ID. It was decided that the parcel identification number will take the role of ID attribute. The assumption was made that after Topographic Database of Poland reaches the fully operational capacity, it will be changed into the unique Topographic Database ID of building.

It was also decided that orthophotomap will take the role of the basic raster layer on which all other vector layers were displayed (i.e. National Register of Boundaries, General Geographic Database of Poland, land and property register). Orthophotomap reflects the real state of land use and land cover. It allows to verify and complete the data collected in land and property register as well as data gathered in database of asbestos containing products.

Basic data are gathered by local governments through the database on asbestos containing products in a descriptive form. Among them the following are crucial for system development:

- Administrative localization (province, district, local government, city/town/village, street, number of property),
- Geodetic data (number of geodetic region, parcel ID number which consisted of the unique attributes 12 digits: province, district, local, geodetic region, land parcel identification number),
- Asbestos data (quantity of products, type of products, state of products, i.e. when they should be abated according to legal regulations, type of buildings with products used, quantity of products abated).

Descriptive data from database of asbestos containing products were implemented into the system with the usage of the geocoding tool. It was done by exploiting the unique registration number of object (parcel identification number) and/or the object address data. See Figure 1.



Figure 1. Geocoded data derived from database of asbestos containing products.

Geocoded data is the basis for system development. Analysis are done at three levels of management with the use of:

1. maps of asbestos distribution presenting the asbestos distribution throughout the country in a given intervals of quantities of asbestos used (see Figure 2),
2. maps of the urgency of asbestos removal presenting how will the process of asbestos removal progress until 2032 (data of final asbestos abatement) (see Figure 3),
3. maps of quantities of asbestos abated showing how the asbestos abatement process is proceeding (see Figure 4).

For each period a set of maps is prepared and interpreted. For national level there is a set of 16 maps prepared: one for each type of analysis (in total 64 maps). For provincial level there is a set of 380 maps prepared, also for each type of analysis (in total 1.140 maps). At the local level there is prepared one additional analysis which refers to the verification of the quantity of asbestos containing products used.

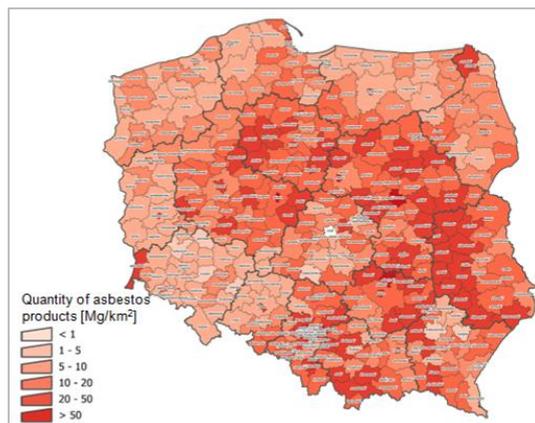


Figure 2. Asbestos containing products distribution in Poland. National level.

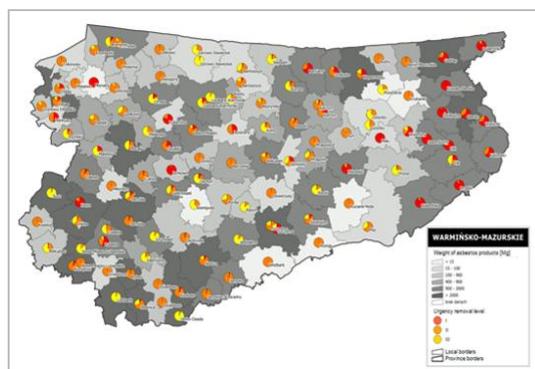


Figure 3. Level of urgency of asbestos removal. Provincial level.

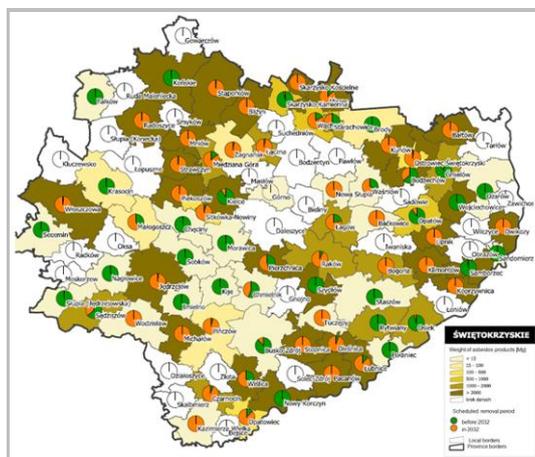


Figure 4. Quantities of asbestos abated and plans for removal. Provincial level.

At a present stage the system is fully operational on national and provincial level. The local level is still being improved because of the ongoing modernization of land and parcels register undertaken by Polish governmental authorities.

5. Conclusions

The Electronic Spatial Information System for the Monitoring of Asbestos Products Removal based on Geographic Information System is used for presentation of inventory taking of asbestos containing products as well as for verification purposes. It is the main tool for monitoring of the im-

plementation progress of the Program for Asbestos Abatement in Poland. Spatial analysis and results interpretations are main indicators of the realization of the Program.

Activities undertaken, results obtained and implementation of the monitoring requirements were appreciated by EU Parliament. In 2013 according to European Parliament resolution of 14 March 2013 on asbestos related occupational health threats and prospects for abolishing all existing asbestos (2012/2065(INI)) Poland was appointed the only country in EU who have adopted the action plan for asbestos-free country and monitors its realization.[8]

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