

Structuring a Database of Remote Sensing Methods and GIS in Reclamation of Disturbed Land

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Abstract

The main large consumer of the products of the coal appear thermal power plants (TPP). The activity of similar energy complexes is connected with the recovery of significant quantities of coal, characterized by the different qualities depending on the region from which they are derived. The process of production of electrical energy is accompanied with the accumulation of a large quantity of waste products (mainly ash and breeze), which are disposed in a over burdens.

Besides the release of polluting aerosols in the process of energy production, constructed over burdens additionally polluted components of the environment especially when it is not identifying measures for their restoration.

The purpose of the paper is:

- To develop a technological scheme for closure and reclamation of landfill of TPP "Rousse - West" by locating in GIS disturbed terrain (tailing pond).
- To build the ASR /Geographical database/ that integrates data from different sources, including field measurements, data from the physical and chemical analysis and others.
- To justify the relevance of this approach in landfills, mines and damaged areas of different types, subject to reclamation.
- A propose for humus reclamation with formation of favorable plant growth conditions and improving of reclaimed area properties acceleration has made.
- Two types of biological reclamation, included artificially grassing with selective usage of grass species medley or afforestation with suitable wood species in combination with grass formations have been under consideration.

For grassing are proposed the perennial wheat forage species: *Festuca pratensis*, Huds., *Festuca rubra*, L., *Poa pratensis*, L., *Trifolium pratense*, L. and *Trifolium repens*, L. For afforestation are proposed wood species: *Robinia pseudoacacia*, L. in combination with grass formation, included *Lolium perenne*, L. and *Alopecurus pratensis*, L.

Keywords: Thermal power plants; Aerosols; Afforestation; Landfills

Introduction

The main large consumer of the products of the coal appear thermal power plants (TPP). The activity of similar energy complexes is connected with the recovery of significant quantities of coal, characterized by the different qualities depending on the region from which they are derived. The process of production of electrical energy is accompanied with the accumulation of a large quantity of waste products (mainly ash and breeze), which are disposed in a over burdens.

Besides the release of polluting aerosols in the process of energy production, constructed over burdens additionally polluted components of the environment especially when it is not identifies measures for their restoration.

It is well known the susceptibility of the tailing ponds to wind erosion, where large areas are contaminated with ash. For this reason, and to reduce the negative /anthropogenic/ impact to adjacent areas around these sites, it is imperative the development and practical implementation of the reclamation plan, consistent with the actual conditions of the area.

The purpose of the paper is:

- To develop a technological scheme for closure and reclamation of landfill of TPP "Rousse - West" by locating in GIS disturbed terrain (tailing pond).
- To build the ASR /Geographical database/ that integrates data from different sources, including field measurements, data from the physical and chemical analysis and others.
- To justify the relevance of this approach in landfills, mines and damaged areas of different types, subject to reclamation.

Materials and Methods

The object of the research is newly tailing pond on the territory of TPP "Rousse-West". The site of the tailing pond is located in western industrial zone, in the "Under Haberman", Ruse town (Figures 1a and 1b).

The so-called new (large) tailing pond began to build in 1982 and its use continued until 1990 when TPP "Rousse-West" proceeded to use natural gas as fuel (according to TPP "Rousse-West"). From that moment, the disposal of waste products practically terminated and arises the need for reclamation of tailing pond built there.

In terms of climate [1], the site falls in the northern climatic region of the Danube lowland in the zone of moderate continental climatic zone. For obtaining a clearer picture of the climatic conditions check tabulated data from the meteorological station in the town. Rousse (Figure 2).

Attached is remote sensing for obtaining and analyzing data from the described site using an ortho photo map of the Republic of Bulgaria where the site localized. The previewing of the image is performed in multi-mode, which allows you to work in a color image. (GRB -Red-Green - Blue). Digitization is the basis for the creation of vector data for analysis in GIS environment.

Vector approach is used for modeling database (DB). Spatial objects are grouped as: polygons (areas) bearing attributes with specified spatial reference system (Spatial Reference System SRS) describing the coordinate space in which specific geometric object is defined. The geographic database was created in a coordinate system WGS_84 UTM 35N Attached tools: intersect and buffer - geoprocessing environments ArcGIS 10.4 for Desktop, Spatial Analyst

In that way the structured data can be output to peripheral devices (GPS), as well as other applications through Interoperability Tools and ensure accurate and precise field work.



Figure 1a: Location of the site.



Figure 1b: Location of the site.

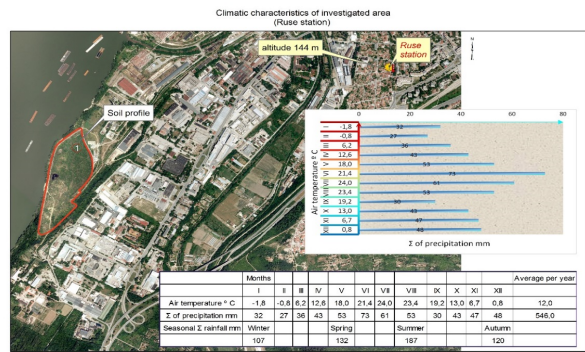


Figure 2: Climatic characteristics of investigated area.

Soil cover, spread in the research area, is varied. There are Typical Chernozems (Calcic Chernozems), medium sandy-loamy, low and medium eroded; Leached Chernozems and alluvial-meadow soils - on floodplains of the rivers Danube and Ruse Lom [1].

Typical Chernozems (Calcic Chernozems) are described with soil profile (Figure 3) chemical characterization (Figure 4) and mechanical composition of the soil (Figure 5).

Typical Chernozems are distributed as a broken line parallel to and south of the calcareous Chernozems from the Lom river to Roussenski Lom river. They have also low distribution in Shumen-Varna region and Dobrudja plateau.

Depending on depth of humus horizon, the most widely distributed are medium typical Chernozems, developed on loess and loess parent materials.

Typical Chernozems not differ significantly from the calcareous Chernozems. The thickness of humus horizon varies too widely, but often it is from 50 to 70 cm. The transitional horizon is poorly designed and has slight thickness (20-30 cm). The C horizon is well defined and has significant levels of calcareous tubular and granular concretions.

Typical Chernozems are characterized by higher humus content (2.5-4.0 %) compared with the calcareous Chernozems, and the total stock of organic matter in the one-meter active soil layer is higher.

The pH activity (pH in H₂O) of the surface non-calcareous horizon is neutral, and in the calcareous horizon it is slightly alkaline to alkaline.



Figure 3: Profile of Typical Chernozems (Calcic Chernozems).

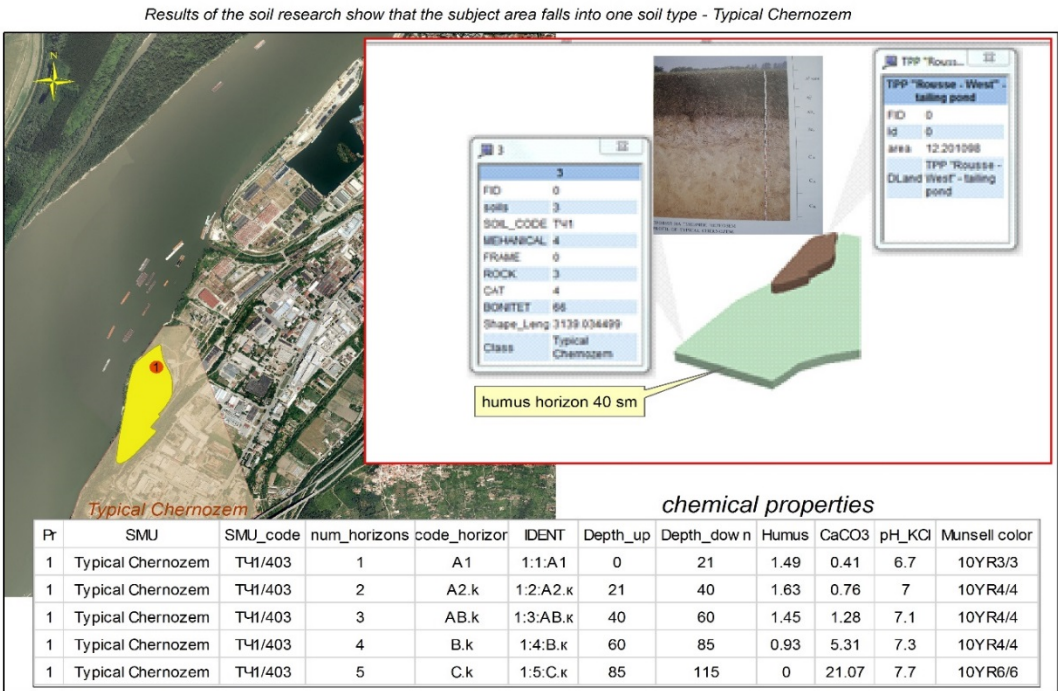


Figure 4: Chemical characterization of Typical Chernozems (Calcic Chernozems).

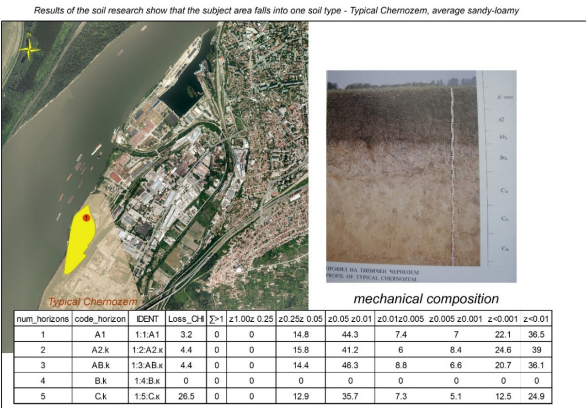


Figure 5: Mechanical composition of Typical Chernozems (Calcic Chernozems).

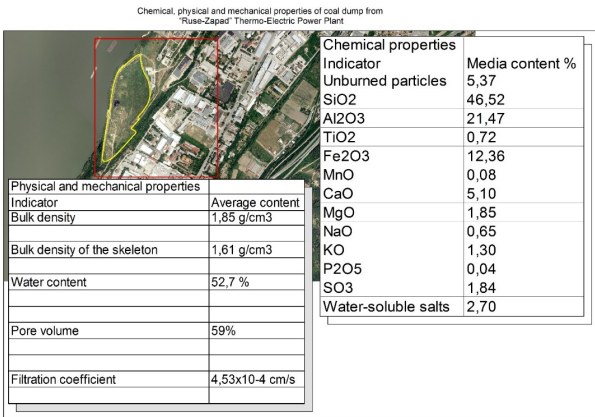


Figure 6: Chemical composition and physico-mechanical properties of the ash from the tailing pond of TPP "Rousse-West".

Exploring the possibilities for the design of the reclamation activities of the new (large) tailing pond required to be conducted analyzes to determine chemical composition and physico-mechanical properties of landfilled industrial waste materials (fly ash from burning coal). The corresponding results are shown in Figure 6.

Results and Discussion

Data concerning the chemical composition and physico-mechanical properties of the waste material from the tailing pond studies (Figure 6) revealed the presence of elements that would cause local pollution of environmental media (soil, water and air). The successful reclamation of the area will help eliminate the risk of wind erosion and will provide

an opportunity to explore new and effective ways of managing the reclaimed area which, according to the conducted geodetic survey totaled 122 dka.

Methods for reclamation of disturbed areas (Figure 7) are mentioned several times in the scientific literature [2-5]. Generally they cover restoration of the land by spreading humic materials on landfilled waste or geologic materials or through their direct utilization (when missing humic materials). In this case, the existing landfill humus, located at about 12 km from the site, allows the implementation of the first method (with spreading of topsoil).

Stage 1: Technical reclamation

Due to the process of disposal of technological waste different size hills were formed, the technical phase of reclamation includes mostly mechanized activities related to site clearance of grown trees and shrubs and overall alignment. After leveling the terrain filling of humus layer should be done with a capacity of about 40 cm, which power is justified in a number of scientific publications [2-4] and is regulated by the application of Regulation № 26 for reclamation of disturbed areas, improvement of low lands, removal and utilization of the humus layer [6]. The use of humic material will contribute to creating favorable conditions for the development of vegetation and prevent sputtering ash.

Stage 2: biological reclamation

After the technical preparation of the damaged areas comes their biological recovery. This is the stage during which implement different ideas about the economic direction of reclaimed lands (grass, afforestation, agricultural use). Determining the future use of the recovered lands depends on many factors such as type, chemical composition and physico-mechanical properties of bedding materials, availability of surface humus layer and climatic conditions.

The most common variations of biological reclamation of disturbed areas are grassing and reforestation. There is also the option to use the land for agricultural purposes, which is allowed only when the materials constituting technical reclaimed area are suitable physico-chemical properties. Even in these cases, however, few requirements of the crop plants to soil conditions and diet may lead to unsatisfactory results from the biological reclamation. As an example of suitable geological materials for agricultural purposes can be identified Pliocene clays from the East coal basin [7] and marl from Pernik [8].

In this paper the case is of reclamation of industrial land (tailing pond), created by the disposal of fly ash from coal combustion, which imposes the requirement for grassing or afforestation of large tailing pond of TPP "Rousse-West". In practice, similar objects are not allowed to be used for agricultural production in accordance with Regulation № 8 on the conditions and requirements for construction and operation of landfills and other facilities and installations for the recovery and disposal of waste [9].

Option for grassing

Grassing of technical recultivated tailing pond is one of the favorable ways for future use of the area and quickly minimization of the wind erosion with minimal investment. In this case it is appropriate to give priority to the widespread in natural grassland species. The composition of grass mixtures can include perennial cereal forage species: Tall fescue (*Festuca pratensis*, Huds.), Red fescue

(*Festuca rubra*, L.), meadow grass (*Poa pratensis*, L.). The choice of grasslands is consistent with the qualities of the different types, resulting in a small rigor to the climatic and soil conditions, tolerance development at grass mixtures, durability, resistance to colds. Important qualities of the grass mix is the ability to develop robust and resistant to trampling turf [11], with which the area will be protected to a high degree of processes of erosion. To expand the diversity of species in the mixture can include perennial forage legumes, red clover (*Trifolium pratense*, L.) and white clover (*Trifolium repens*, L.).

Option for afforestation

The nature of the waste materials building surveying site requires the selection of tree species for reforestation to give priority to those that are sustainable and capable of developing under not so favorable soil conditions. Besides the trees, as the leading type, it is reasonably to include grasslands that will provide rapid and sustained development of the vegetation cover. Thus, in practice at a later stage, after the gradual development of species, the chemical, physical and microbiological soil conditions will be created, similar (but not the same) of these differences in the natural soil, distributed in the area.

We suggest for reforestation to use locust (*Robinia pseudoacacia*, L.), which tolerates air pollution in cities. The species is characterized by toughness at low and high temperatures, which corresponds to a sharply pronounced according to Dimitrov and Doychev [1], continental climate - cold winter with minimal rainfall and hot summer with maximum rainfall (Figure 2). Important quality of the acacia (white lilyak) is the very rapid growth and its development of a deep and strong root system which grows with a central root, reaching 1,5 m depth. This creates the prerequisites for improving the properties of the reclaimed area in depth.

To create a plant litter under acacia plantation it is appropriate the use of grass mixture of ryegrass (*Lolium perenne*, L.) and foxtail (*Alopecurus pratensis*, L.). We considered the selection of these grass species due to their widespread as dissemination plants. Rapid, initial development of ryegrass will accelerate the creation of healthy turf. This is one of the reasons why it is widely used to create lawns [10].

The after reclamation period and the expected growth of acacia plantation (parallel and green mass) will increase the shading of the soil surface. During this period comes the role of the fox tail, with its full development in the third year of sowing, good tolerance to shading and long and good retention in the grass composition [10].

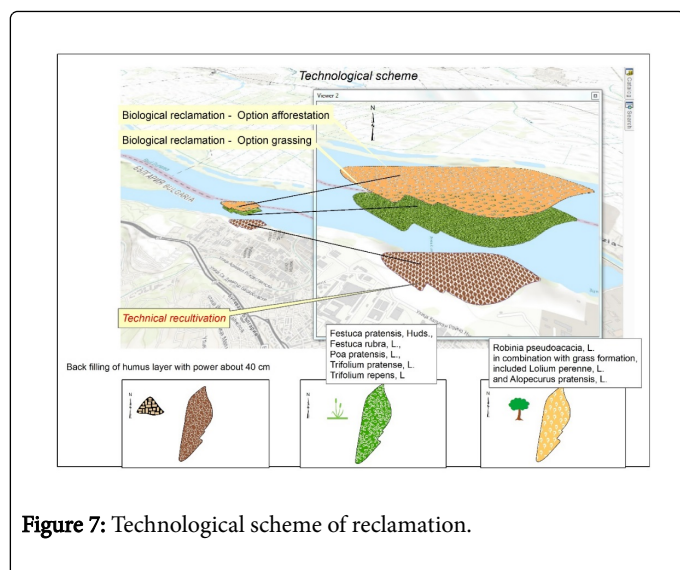


Figure 7: Technological scheme of reclamation.

Conclusions

The application of remote sensing methods to register the disturbed areas is accurate and affordable option for creating secondary information that is subject to processing and analysis in GIS environment. This is a relatively new approach for the territory of Bulgaria and is in the process of creation.

The role and importance in the application of satellite methods:

- The visual interpretation of the image (size, shape, shade), reveals certain relationships between spatial and spectral characteristics of the object.
- Digital satellite and aerial images are a major source of geographic information that allows for the structuring of a geographical database (ASR) generated by layers Theming.
- Create vector data model in which geometric properties of objects are presented with discrete elements (points, lines and polygons).
- Monitoring of objects and updating the attribute information in time and space allows for the creation of thematic maps and convert the output to various formats.
- The introduction of vector data and aerial photographs in GPS (Global Positioning System) allows for precise positioning and

implementation of reclamation methods on the field, based on already gathered preliminary information with image material.

- The creation of an electronic archive of damaged areas will allow for proper planning of reclamation activities, track the results of their implementation and maintenance of soil fertility of degraded and contaminated land and soils.
- Accelerating recovery processes of large tailing pond of TPP "Rousse-West" and eliminating the risk of wind erosion is related to the application of humus reclamation, providing faster recovery on the pitch.
- Favorable variations in the biological stage of reclamation are grassing or afforestation area with appropriate grass mix or combination of tree species in grasslands.

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