

Geo-information Technologies for Decision Issues of Municipal Solid Waste

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Abstract: The article reveals the potential of information technology in decision issues of municipal solid waste. The technique proposed for definition of ecological and technical potential for ecological optimization of the territory for the purpose of efficient decision-making in the environmental field. Studies are based on the information capacity usage and implementation of geographic information technologies in combination with the methods of remote sensing of the earth. On this basis, the authors have developed mechanisms that will overcome the existing environmental and technical challenges—economic, political and human capital.

Key words: Solid waste, place waste, environmental security, environmental monitoring, natural and manmade threats.

1. Introduction

The relevance of issues of ecological security is to by the increased anthropogenous influence. This is due to the spreading and increasing intensity of hazardous processes. This is also related with the formation of a significant amount of waste and inefficient system of handling them. State environmental security is largely determined by the efficiency of regional environmental policy, which provides security for people, objects and environment from the destructive influence of the full range of environmental, natural and technogenic threats. Potential environmental danger municipal solid waste, the total mass flow of the world which is annually about 400 million tons, of which 80% is neutralized by burial in the ground. This number can be considered without exaggeration a geological scale with significant environmental risk. That is, the formation of landfills and their livelihoods need to be monitored, in order to study the systematic analysis of the situation, it is necessary to identify forward and backward linkages, to analyze the phenomenon of self-assess integrity,

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orderliness and centralization of the provided information. To ensure that environmental safety are required studies, as well as to require the synthesis of scientific with theoretical, scientific with methodological grounds of formation potential environmental threats of natural and technogenic systems. It is also necessary to carry out study and systematization of social, economic, organizational and legal aspects. All this is necessary for environmental safety at places accumulation of solid waste.

For monitoring objects, which adversely affect the environment and human health, more and more widely use geographic information systems [1]. Modern geo-information technology combined with remote sensing techniques make it possible to synthesize model of mapping the spatial distribution of waste disposal sites and allow continuous monitoring are required for the desired object by creating a computer database.

2. Methodology

According to classifier [2] for the successful implementation of these goals requires the use of satellite images of a high spatial differentiation (0.5-15 m) in the spectral range of 0.4-1.1 μm .

Namely, Quick Bird, World View, Geo Eye, Pleiades, Ikonos and others, followed by a comparison of the means of geographic information systems, such as software packages ERDAS IMAGINE and ArcGIS from ESRI [1].

Typically, decryption is carried out in two main ways: visual and spectral decoding. Thus descramble use features, which are divided into direct ones and indirect ones. Direct descramble features characterize the properties of an object containing a direct reflection on the pictures. These include such features, as geometry (shape, shadow and size), brightness (level of brightness, color and spectral image), and structural (texture and structure). By including geometric features related to the size and shape of objects on the ground. Form is the most reliable sign, because it weakly depends on shooting conditions. In addition, the human eye will recognize it mostly in assuredly shape objects. Since the spectral brightness is often affected by external factors, then the deciphering satellite images and search for changes on the ground must be applied in addition to algorithms that are based on the transformation of the spectral brightness and algorithms by using structural features [3].

So, for landfill typical irregular shape, stretching along linear objects (roads, railway tracks, ravines, gullies, etc.) materials and objects that make up the solid waste at the landfill have a high reflection coefficient, which dramatically increases the brightness on space pictures, these are shades like red, white, light yellow, light blue, dark blue and so on. Also, a very important feature of the fine-grained texture is formed by the irregularities of the landfill. While deciphering satellite images using information about the possible location of landfills near the technogenic and natural objects.

With the use of modern technologies, it has become possible to reduce the mass of garbage disposal in sanitary backfill and landfill life extension, and thus save a lot of money. It is known that the arrangement

of 1 ha landfill controlled by the modern technology of leachate drainage and degassing array costs about \$1 million, and even more, because of the difficulty of choosing the appropriate area and over the objection of the population by building new ranges required for a variety of benefits and so on.

For management decisions to grant a land ownership or use under the terms of the lease and subsequent targeted use of land every manager needs information about the location of land. On satellite images by the introduction of geodetic coordinates, you can see the exact location of the object and purpose of its use. Also, this information is necessary to provide cadastral plot number at registration of ownership and use.

To predict the future needs of the technical means of optimizing the ecological state of the environment by using a technique based on the definition of the operator of eco-industrial and eco-investment potential one side, and the operators of the degree of pollution on the other. According to this method, formulas have the form:

$$Q_1(t) = M_0 \Omega_2(t) \quad (1)$$

$$Q_2(t) = \frac{M_0 \Omega_2(t)}{\Pi_0 \Omega_1(t)} = \frac{Q_1(t)}{\Pi_0 \Omega_1(t)} \quad (2)$$

where, $Q_1(t)$ —the future needs of waste treatment; $Q_2(t)$ —future needs of the technical means optimizing environmental protection cities; M_0 —the initial value of the power source (of sources) pollution environment; Π_0 —the initial performance of means optimizing environmental protection cities; $\Omega_1(t)$ —operator of eco-technological potential, which characterizes the magnitude of investment in technological solutions to environmental problems of cities; $\Omega_2(t)$ —operator of pollution degree that describes the ecological state of the environment at a rate of pollution in the form of regression Eq. (2).

There are methodological developments calculate this operator by defining the structure difference

operator [4], the method of self-organization, based on the algorithms of the group, this method is taking into account the arguments and so on [5].

3. Results and Discussion

The authors propose a different, improved and adapted to the current economic conditions and methodological peculiarities of economic statistics method for determining the operator of eco-technological potential. As the characteristics of the structure of the operator of eco-technological potential environmental optimization of the cities, it is appropriate to use size of investment of the indicators of (public and attracted investment from other sources—institutional, private, etc.) in environmental activities. This indicator is the most informative, because the availability of patent information in the absence of funds for its practical use yet provides environmental optimization. The proposed rate is pretty tough statistic reporting, laid in the budgets of various levels and has resulted in a relative form, which is very informative because it allows the scientist practitioner to visualize and correlate the extent of the desired and actual environmental performance. Since this operator is a dimensionless quantity, by taking its value in the base period 1, it can be expressed this value in the forecast period as follows:

$$\Omega_1(t) = 1 + V \quad (3)$$

where, V —growth rate of the value of investing in accrual basis, i.e., cumulative curve size eco-investments. Attach investment in nature conservation can be represented as a process, and therefore it is possible to identify a trend, which is approximated by an exponential function:

$$V = \frac{2V_0\alpha}{V_{end}} \exp[\alpha(t_1 - t_0)] \quad (4)$$

where, V_0 —amount of investment in the base period (early trend), V_{end} —size of the investment at the end of the trend compared to their size in the base period.

If the authors take the size of the investment in the base period for the unit, Eq. (5) has the form:

$$V = \frac{2V_2\alpha}{V_{end}} e^{at} = 0.0534 \exp(0.16t) \quad (5)$$

The effectiveness of decision-making in the environmental field is achieved through adequate monitoring capability information, the full implementation of environmental management geo-information technology in combination with the methods of remote sensing and development on this basis, mechanisms will overcome existing ecological and technical problems of least cost economic, political and human capital.

To establish a true picture, the object of degradation was carried out detailed surveying of the territory. Identification was dimensions of the investigated territory and its total area. With modern high-precision surveying equipment—electronic total station and GPS (global positioning system)-receiver by Swiss company Leica, a detailed geodetic output of each individual land plot for information on the extent of soil degradation was made [6]. As a result of computer processing of geodetic results measurements, the authors obtained coordinates of the land plot, coordinates the objects of every land degradation.

In raster overlay of digital maps, the authors received bitmap area of land defined by drawing an array means ArcINFO/ArcGIS Spatial Analyst modules and ArcScene/3DAnalyst, which include individual set of geospatial thematic layers in vector or raster form and attribute data in tabular or textual forms the object of study [7]. By space shot, the authors scale the plan for scale tracts of land and as a result was obtained space image array, which hardly differ in size and area (Figs. 1 and 2). Figs. 3 and 4 present the results on the example, which was studied landfill in the Kiev region, Ukraine. Analyzed landfill covers an area of 15 ha. It is located in a ravine near the road 1.8 km from the village Tarasivka and 1.6 km



Fig. 1 Solid waste landfill in the Ternopil region, Ukraine.



Fig. 2 Landfill in Kyiv region, Ukraine.



Fig. 3 Operating window ArcGIS.

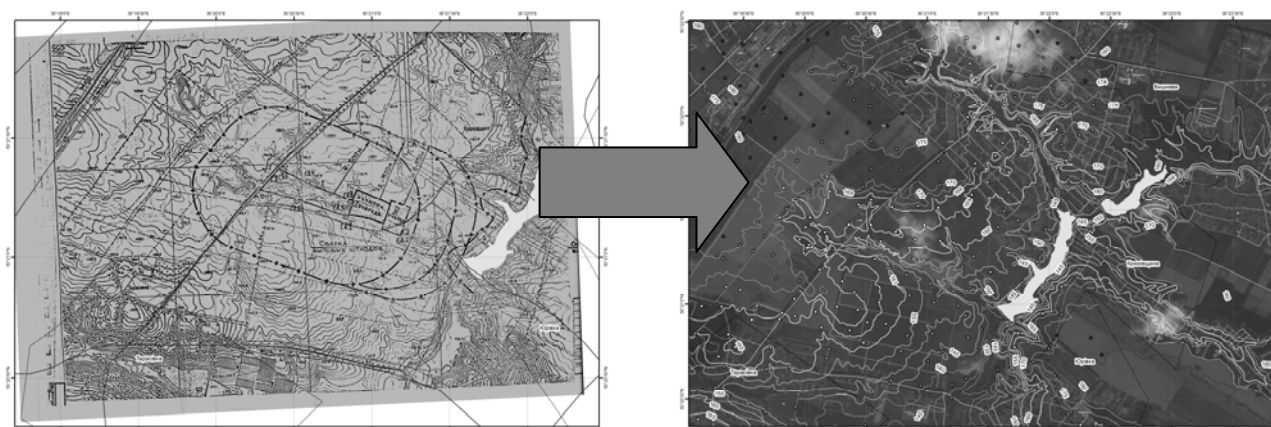


Fig. 4 Raster map of the study and the results of its processing.

from the village Kryukovshchina. One of the features is the location close to the landfill the lake (1 km). This lake has fisheries and recreational value to the population of nearby settlements. Permanent drainage flow forms a small river Siverko [8] (1 km).

To work with the satellite images, funds software package ERDAS IMAGINE was raised. It allows to implement a wide range of processing functions, visualization and analysis of space images and to use geographic information.

4. Conclusions

The results of prediction of environmental conditions allow with reasonable accuracy to estimate environmental perspectives of development of the settlements, identify a list of factors which the future will have the strongest impact on the environment. And also it will allow develop a set of measures to reduce their negative impact, improvement of industrially-polluted area. The results will contribute to the perspective ecological optimization for the territory of geological social systems. The proposed approach can be used to create predictive models of urban landscapes and adaptive digital maps.

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