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Impacts of the New Inventory of Environmental Liabilities in the Mining-Metallurgical Region of Santa Lucia, Cuba

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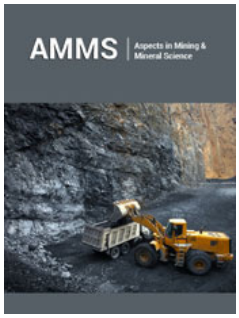

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Abstract

In the mining-metallurgical region of Santa Lucia, the previous studies on the analysis of the impacts of the extractive activity and the associated technological processes have not made an approach to the accumulated environmental liabilities through the use of management instruments. New theoretical references are proposed in the classification of inventories of Environmental Liabilities (EL) associated with the mining-metallurgical activity and its support activities. The Geographic Information System (GIS) is used as a tool from a spatial data infrastructure platform (IDE) with support in ArcGIS from a Database Management System (DBMS). In the research, theoretical methods were used, such as historical-logical analysis, the systemic approach and analysis and synthesis. As empirical methods, documentary analysis was used and the most up-to-date conceptual and legal references on the subject are exposed, with emphasis on the Latin American and Caribbean region. For the survey of the EL, the method of geological itineraries is used in three sectors of the study region. An inventory of 62 Environmental Liabilities (EL) is reported, broken down into 16 mining, 31 chemical, seven sanitary, five technological, and three agroforestry liabilities. Through a GIS developed for the environmental liabilities of the study region, it allows effective management in pursuit of the mitigation of the negative impacts generated to exposed ecosystems, based on the analysis of geology, hydrogeology, tectonics and the model of digital elevation of the terrain.

Keywords: Mining; Metallurgical; Environmental liabilities; Hydrography; Inventory; Ecosystems

Introduction

In the mining regions, the origin of the deposits, the processing technologies, the nature of the associated economic sectors and the development of the environmental policies that are applied, are determining factors for the mitigation and remediation of the environmental problems caused to the different ecosystems exposed [1,2]. Among the main socio-economic activities that generate a wide environmental footprint on ecosystems, the following stand out: the prospecting and exploitation of mineral resources, the metallurgical processes induced for their treatment, the use of non-metallic mining resources for the development of the materials industry of construction; the exploitation of forest resources, with the consequent low use of the available timber and non-timber potential, due to technological limitations. The generation and inadequate disposal of high volumes of solid waste due to various human activities, lead to the fragmentation of ecosystems. These liabilities require comprehensive management actions to minimize their risks [3-5]. In the Latin American and Caribbean region, as a regularity, the business and government authorities of Argentina, Chile, Bolivia, Colombia and Peru, assume environmental liabilities, such as the set of negative variations caused by anthropic action, under natural conditions, that affect the balance of ecosystems and the good living of communities [6-8]. The approach to environmental liabilities, regardless of the source, their nature and the magnitude of their impacts, requires tools that contribute to the inventory, characterization and management of their risks effectively. To this end, the use of tools based on Geographic Information Systems (GIS) with Spatial Data Infrastructure (SDI) platforms, contributes to developing comprehensive analyzes of these liabilities at the level of technologists and decision makers, as well as to project and estimate the extent of

its impacts on recipient ecosystems [9]. In the mining-metallurgical region of Santa Lucía, the preceding studies on the inventories of environmental liabilities, as well as the analysis of the impacts of the extractive activity and the associated technological processes, have not carried out an approach to the accumulated environmental liabilities through the use of Geographic Information Systems (GIS) for comprehensive spatial analysis of the data generated, which limits its management.

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The study area is located in the Minas de Matahambre municipality to the northwest of the Pinar del Rio province (Cuba), the natural limits of the territory are marked with the Santa Lucia river, the Name of God river, with the Sierra de los Organos and the Gulf of Santa Lucia. Starting from the application of the geological method of irregular itineraries, the routes for the mapping of environmental liabilities were drawn. For decades it has been subjected to the intense development of mining-metallurgical, forestry, fishing, port and agricultural activities; which has led to the environmental deterioration of the territory. The polymetallic deposits and metallurgical processes have been exploited without an integral management of the operations carried out, with the consequent activation of weathering processes and the dispersion of polluting elements towards the components of the environment [10-12]. The classification, distinction and typologies of environmental liabilities are defined according to the anthropic factors that generate them, according to the components that denote their danger and magnitude and by the response to the remedial action that is established. The direct proportion between the exploitation of available mineral resources and the emission of waste in its immediate, close or indirect environment is correlated. Establishes key premises on the durability of the modifications to the previous natural conditions and the continuity or persistence of the negative effects of the environmental liability.

As a result of updating the inventory of environmental liabilities in the area under study Santa Lucia, a total of 62 PAs are recorded, associated with the main sectors and activities carried out in the region. Of these, 16 mining liabilities, 31 chemical liabilities, seven sanitary, five technological and three agroforestry. Therefore, 76% are Chemical Environmental Liabilities (CEL) and Mining (MEL), which corresponds to the socio-economic characteristics and historical evolution of that region. In addition, 11% are Sanitary (SEL), 8% are Technological in nature (TEL) and 5% Agroforestry (AEL), according to the new classification established by the authors [3]. With the inventory of environmental liabilities for the Santa Lucia study region, a total of 22 cartographic representations were developed according to the types of liabilities and the bio geoenvironmental elements of interest to the GIS, managing to integrate all the geographically referenced information, allowing the information to be analyzed space, edit the data and present the results of all the geospatial operations performed. As part of the results of this geographic representation making use of GIS and in particular ArcGIS software, the map of each type of AP was developed.

According to the superposition of layers for each mapped variable, it is found that the correlation of the types of AP with the response to the defined remediation action, it is evident that liabilities with responses, perpetual (PEL) and persistent (PSEL) prevail, which is characteristic of the footprint generated from mining extraction processes as a non-renewable resource and the associated technological processes. Surface acid drains are of great importance in interpreting the relationship between hydrography and EL, since the identified patterns of density of types of liabilities and frequency can be used as a criterion in the dynamics presented by these two environmental variables. It is found that the greatest number of representations of the EL coincide on alluvial deposits and marsh deposits, corresponding to the most fragile aquatic and mixed ecosystems (coastal and inland wetlands), which facilitates a greater degree of dispersion of the polluting elements of these chemical and mining liabilities in these most vulnerable areas. The geoscientific data processing and the bibliographic study of the work carried out in the development of the research, contributed to the integration of all the identified and mapped liabilities in a single cartographic model by means of the weighted sum of all the environmental liabilities variables analyzed in the maps generated previously. The cartographic model obtained in the research work constitutes an unprecedented geo-cartographic and management tool for the region under study, with which prospective conditions are created to develop studies on the management of risks caused by environmental liabilities according to its nature, as well as to model and estimate the degrees of dispersion of the polluting elements generated by each liability.

Conclusion

A new conception was established and used to classify and define Environmental Liabilities (EL) based on the nature of the anthropic factors that generate them, the nature of the active components that characterize them and according to the nature of the response to the remedial action that is taken proposes, which constitutes a valuable tool without precedent in the scientific-technological literature available. The tools and computer models used in the investigation allowed the updating of the inventory of environmental liabilities in the mining-metallurgical region of Santa Lucia, with a record of 62 EL and the obtaining of a Geographic Information System (GIS) that corroborates the preceding analyzes on the sources of environmental pollution in the area under study.

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