Geospatial Evaluation of Trace Elements Pollutants in Cd. Juarez, Chihuahua, Mexico.

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Abstract

The Asarco smelting plant is located at the border region between Mexico and United States within the Paso del Norte Region, (Chihuahua, Texas and New Mexico). For more than 100 years this smelting plant was active in its productive process of metal smelting, generating probable impacts to the environment and potential pollution of surrounding soils and water. Discharge of heavy metals emitted to the atmosphere on the form of lead, cadmium and arsenic have been reported in soils on the US side of the area of study by other workers, none of these potential pollutants have been reported in Mexico The area of study of this research is situated in zones located within Mexican territory, on a radius of 7 km from ASARCO's location. This paper evaluates a GIS procedure while applying methodological applications of thematic digital cartography, using ARCGIS 9.2 for the geospatial analysis of the natural variables and wind speed and wind direction evaluation at the study site. Special classification procedures where applied based on the characterization of landscape units using geomorphologic considerations of variables such as: geology, vegetation, topography, surface hydrology, and climatic regional factors. Results show a draft classification of soil types at the area of interest which could have been contaminated by these emissions to the atmosphere. Furthermore, GIS procedures reflect the delimitation of the area of influence by georeferencing the tower of emissions and mapping the geospatial extension of soil types and future potential specific monitoring sites, reducing field work at the research area. FAO soil classification taxonomy shows dominant soils types as, Regosol and Solonchak at the research area. Landscape Units with major risk to pollution where located at specific geomorphologic features such as in riparian areas/fluvial systems, which are the main tributaries to the international Rio Bravo/Rio Grande.

Key words: Pollution, soil, metals and metalloids, smelting.

Introduction

Pollution is an anthropological phenomenon that affects directly and indirectly to both ecosystems and human life in general, (Miller, 2004). In regards to soil pollution, the negative effects of pollutants are increase since its contamination causes harmful impacts in the quality of the environment putting at risk human health by direct exhibition to contaminated soil. In Mexico one of the larger border cities along the transboundary region is Cd. Juarez, Chihuahua. In this city, there are approximately 1.5 million people and it is considered the most important border city of the country and the sevent in the nation,(INEGI 2005). Along with El Paso, TX, Cd. Juarez conforms part of the binational metroplex with approximately 2.5 million inhabitants in 2006, representing the biggest border city of the world, (Flores 2006). The smelting plant of lead and copper American Smelting and Refining Company (ASARCO) is sited at this transboundary region. In 1887, ASARCO was establish in El Paso, Texas, which is located on the floodplain of the Rio Grande/Rio Bravo, bordering the states of Chihuahua, Texas and New Mexico. In 1899, company was finally establish and it is assumed that for more than one century it emitted hundreds of tons of lead, arsenic, cadmium and zinc in the metropolitan area of Juarez (in "colonias" located at the north west of Cd. Juarez, specifically at colonias Anapra, Ladrillera and Felipe Angeles), as well as in bordering areas to El Paso Texas, and Sunland Park, New Mexico, potentially affecting thousands of persons,(Garcia et al., 2003). On the other hand, environmental impacts such as potential source of soil's pollution surface water pollution to the international Rio Bravo/Rio Grande and to subsurface groundwater to the transboundary aquifer found at the Hueco Bolson. This paper, addresses the potential contamination of the surrounding soils and water located in a perimeter of 7 km from the location of the presently establish ASARCO plant. The main objective of this study evaluates the analysis of the geospatial distribution of sampling points while applying GIS procedures on soil and water testing for metals and metalloids enhancing the efficiency of sampling field work.

Materials and Methods

Geospatial analysis was taken while applying GIS procedures using Arc GIS 9.2 (ESRI) identifying INEGI´s (1996) major GIS coverage themes, scale 1:250,000, on natural resources of the area, such as Soils, Geology, Geomorphology, Topography, Hydrology, Vegetation Cover, Groundwater, and other

themes such as urban polygons representing the geospatial distribution of the potentially affected "colonias". Landscape Units (LSU) where generated based on a standardized GIS procedure evaluating the geospatial correlation of five major natural resources assets: Geology, Topography/Hydrology, Geomorphology, Soils, and finally Vegetation Cover. The final analysis done to these coverages integrated a table of attributes under the GIS environment with a comprehensive-correlative information to take decision on soil and water sampling points with an enhanced ground truth proposed plan to reduce field work time within a 7 km sampling area radius from ASARCO.

Results

Preliminary results show dominant shallow winds (from surface to 100 m height) at the study site are from north and northwest towards the south and southeast into Mexico´s territory. Wind speed has been classified as strong and very strong during a period from November until February. The rest of the year, wind speeds have been recorded at approximately 20 km/ hr. These velocities are important to the project since they are related to the spread of the emission cloud coming from the ASARCO towers, which as previously stated, these are dominant into Mexico affecting its neighboring communities. There are approximately 16 groundwater wells around the 7 km buffer zone, which provide potable water to the community on the Mexican side of the study area. All of these wells will be monitored for metals and metalloids on subsequent phases of this study. Surface elevation at the study site were estimated on the range of 1150 meters at the river floodplain to 1500 meters on the hills at the Sierra de Juarez. These elevations were important to define the LSU and their potential for soil sampling based on the clay percentage content to define the planned field work.

Litosols are the dominat soil type characterized by is shallow depths not exciding 10 cm. which are characteristics of these geological features. Also, Regosols were located at the study site which are related to very shallow soils mostly related to the local geology. The most important feature on the soil are where the identified soils on the main tributaries to the international Rio Bravo/Rio Grande. These tributaries incorporate many stages of soil lenses integrating clay, sand and gravels. As a result of the geospatial analysis on these natural features, a considerable number of soil samples will be taken at these geomorphic features considering the resulting LSU. Soil samples are planned to following stages of this research while considering two levels of sampling. First level at the depths of 0-30 cm and where possible, a second depth of sampling from 30-60 cm. As a proposed "snap shot" of potential contamination on the research area, a total of 156 samples are going to be taken. Later, if these areas become positive to metal and metalloids testing, a second sampling phase will take place. Soil and water samples will follow standar methods procedures applying Mexican standards such as NMX-AA-132-SCFI-2006; and the NOM-147 of metals and metalloids.

Conclusions

ASARCO is a smelting plant that was establish in the international region emitting contaminants to the atmosphere for more than 100 years. Risk to human health has been documented on the US side; although, in Mexico´s territory documentation of this potentential contamination to soils, water and the environment in general is limited of non-existant.Preliminary results shows that the dominant soils at the study zone are: Litosol, Regosol, and Solonchak.Regosols soils are near the Sierra de Juarez whereas, Solonchaks are in a perimeter of 200 m. near to the international Rio Grande/Ro Bravo.. Sixteen groundwater wells are consider for sampling located on a radius of influence from the ASARCO tower of emissions. Whereas, 156 soil sampling points are considered. We have demonstrated that GIS procedures help on the geospatial analysis to define potential sampling sites for soils and water, both surface and subsurface, enhancing field work and reducing time frames on the planned work. Although, this study shows only preliminary results from a geospatial analysis while analyzing LSU, the outcomes are encouraging since the next steps on the study will take place mostly at ground thrusting all these selected sites. The application of the geospatial technologies coming mostly from GIS and Remote Sensing, are recommended for the next steps on the research.

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