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Selecting the best place for accumulation of wastes of angouran lead and zinc mine by using analytical hierarchy process and GIS package

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Abstract

Extent of lands affected by mining activities including waste accumulation areas grows gradually. So it is increasingly necessary to enforce the revival of mines. Gangues from mineral mining and purification factories are environmental problems of mining. Select a suitable location for the accumulation of these substances not only from environmental perspective but also from technical and economic point of view is significant. Gangue dam constructions in optimal locations not only cause reduction in environmental problems but also decrement costs that must be spent to solve the created problems from economic aspect. In this paper, important criteria in locating are considered. Ultimately by using analytic hierarchy process (AHP), these criteria were weighted. After weighting, criteria in order to spatial analysis entered to the Geographic Information System (GIS). At the end, the integration of all the weights with each other, Locations for accumulation of gangues were identified. The result indicates that selected location with using the integrated method and location of the accumulation of waste are conformed.

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Introduction

Protection of environment is one of the significant issues for all countries. Undoubtedly, the most important aspect of the relationship between environment and geology is mining activity and its effects on the environment. Impact of mining activities, particularly Gangue accumulation areas grows over time. So necessity of mine reconstruction should be considered and from early stages of mining operations should be noticed. Along with preserving the environment, lands return to production cycle. So many environmental issues depend on GIS analysis such as: evaluating Environmental contamination, domestic and industrial waste landfills. Researches have been conducted by using AHP, suitable plant species for Songun copper mine have been selected (Alavi *et al*, 2010). Suitable location for SANGAN gangue dam selected by using decision techniques such as: SAW and Topsis (Samavati *et al*, 2011). Accurate selection of waste disposal sites to avoid instability problems is essential. It is much more felt in Great Britain because when in 1966 in Aberfan in south Wales, debris of a waste mass had moved a distance about 610 meters on a of 13 degrees slope and flowed down, 112 students died. Construction waste warehouse at the top of an old fountain is the reason of rupture which caused coal mine waste saturate with water (Matthew R. Bennet, Peter Doyel, 1997)

Pb-Zn Angouran mine is located in the Mahneshan city, southwest of Zanjan. Geographically located in 36˚ 37´ 32.5˝ longitude and 47˚ 24´ 22.5˝ latitude. With an altitude of about 3000 meters above sea level and placed in lal Kan mountains. The mine is one of the most important Pb-Zn resources in the Iran. This ore with an average grade of 25% zinc, 7% lead is one of the largest lead and zinc deposits of the Middle East. One of its features is the expansion and diversification of large deposits of carbonate and Sulfide. Rare mine in the world has this level of variation (Rezaee, 1999).

Extraction method in the lead and zinc mine is stepped and so many gangues produced in the process of exploitation. Some sulfide ores due to low grade and being not affordable are accumulated in the gangues. When the sulfide ores react to weather on the surface, produce acidic mine drainage and cause mobility of heavy metals in the mine and gangues. Because of that choosing a suitable location for the accumulation of this material, not only from an environmental perspective but also from a technical and economic point of view is important.

Location of studying area is shown in fig. 1. Geological map is shown in fig. 2.

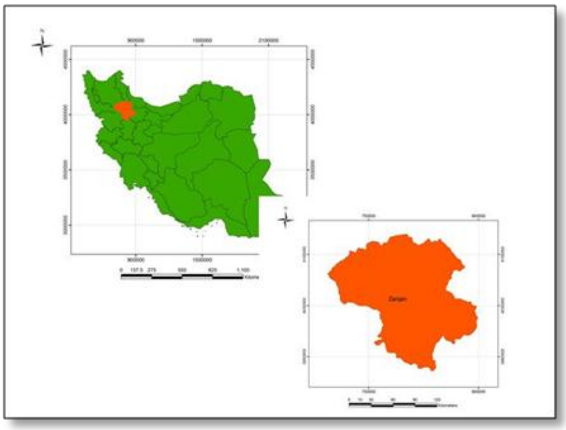

Fig. 1. Location of studying area.

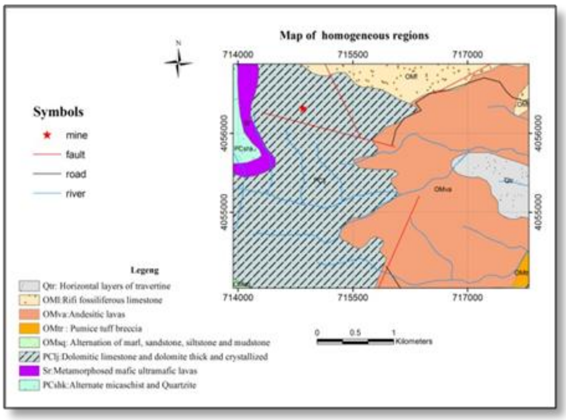

Fig. 2. Geological map of studying area.

Motivation and aims of the study are missing. Author must mention what are the works previously done on this topic and what still needs to be

investigated. It will indicate the necessity of this study.

Write the aim(s) of the study at the end of Introduction.

Materials and methods

In order to have an overview of the region, geological reports were examined. Base maps were collected. Then for data integration and mapping GIS software was used. By using Digital Elevation Model maps (DEM), maps of dip, dip direction, distance from the ore deposit, distance from drainage, distance from roads, distance from residential areas, distance to fault, lithology, and the altitude points were prepared and Classified. The combination of dip map (Fig. 3), dip direction (Fig. 4) and altitude points (Fig. 5) homogeneous zone map was prepared (fig. 6). Homogeneous map of region divided into smaller poly-gons. Each unit of the poly-gons has dip, dip direction and altitude points. After evaluating the preliminary data effective factors were identified. So three factors including: physiographic, geological factors and spatial factors were determined. Parameters of dip, dip direction and altitude of the physiographic criteria, distance from mine, distance from drainage, distance from roads, distance from residential areas and the distance from the fault are related to the location and lithology of region to geological factors.

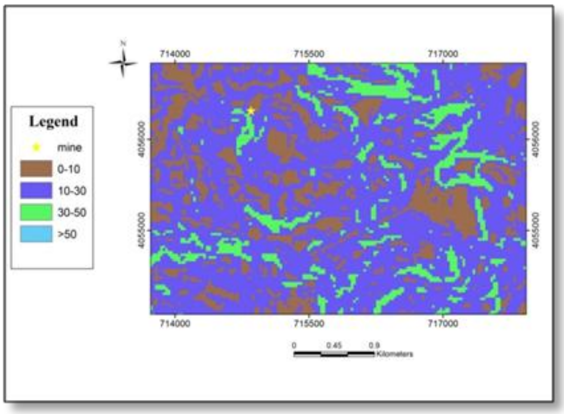

Fig. 3. Dip map of studying area.

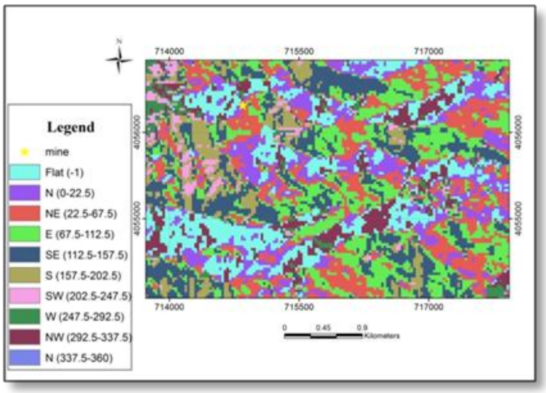

Fig. 4. Dip direction map of studying area.

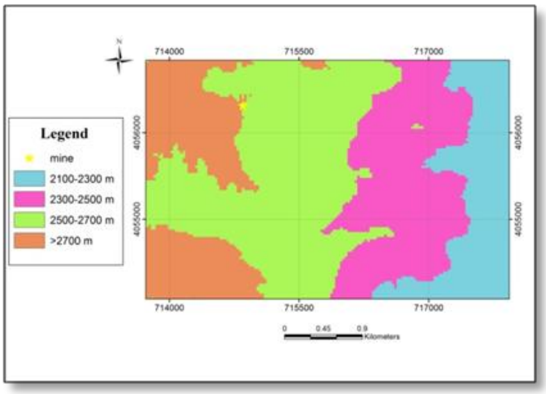

Fig. 5. Altitude map of studying area.

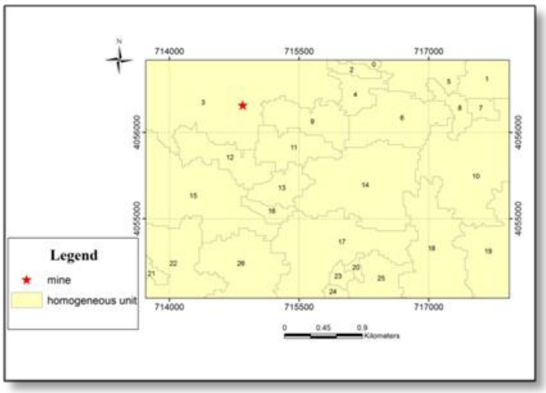

Fig. 6. Homogeneous unit of studying area.

Next, in order to weight the criteria by using AHP, a table was prepared to compare paired criteria (Table 1). This process is a kind of group decision by specialists and experts on the subject. After collection of specialists and experts ideas, judgments were integrated. So quantitative importance of effective criteria in locating, were obtained. The main criteria by using AHP and sub-criteria were valued by using Expert Choice software.

Table 1. Paired comparison.

Criteria	Physiographic	Spatial factors	geology
Physiographic	1	1/3	2
Spatial factors		1	3
geology			1

According to analysis by AHP, it is determined that Incompatibility rate is 0.05 (Inconsistency rate must be equal or less than to 0.1) which shows a comparison of the test is accurate enough. Analyzing weighting of criteria demonstrate that criteria of locational factors have the highest weight (594) and criteria of geology has the lowest weight (157). After applying the weighting coefficients according to classified maps, coding was applied to each class. Ultimately, the data for location analysis entered to the GIS software by combining all weighted values, suitable locations For waste accumulation was detected (Fig. 8). The final map was classified into 5 classes, specified homogeneous units with red color have highest Rate and dark blue units have the lowest rate for locating (fig. 9).

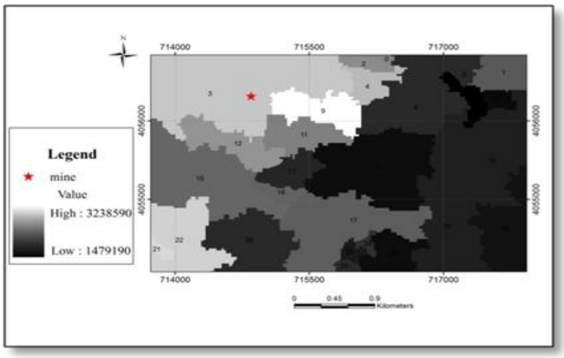

Fig. 8. prioritization map of area.

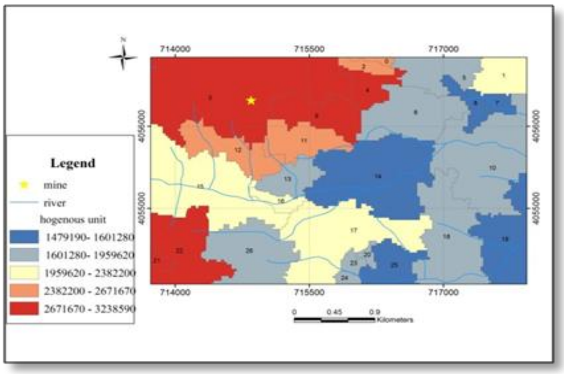

Fig. 9. final classified map.

Results and discussion

With considering the collection of certain factors, suitable areas for mineral gangue accumulation were identified. It should be noted that identified areas according to so many advantages are the best locations for this purpose. In the operational phase studies parameters should be identified with the negative points in order to do necessary actions for resolving problems. To check the accuracy of final map, it is conformed to maps and geological reports and aerial photographs. Results also indicate high accuracy of the used method for locating.

Discussion

Produced gangues in the mine increase concerns about the impacts on environment pollution, especially accumulation of gangues usually cause mining waste seepage. It is resulted from leakage of uncontrolled water in the landfill. Lack of consideration in controling hydrostatic pressure leads to failure and causes an increment of wastes and infection in the large area. Structural stability depends on the characteristics of the waste, storage location and site condition. Inappropriate site selection for waste accumulation has devastating effects on the environment. According to the requirements of environmental regulations, environmental restructuring projects should be considered from start of mining, so in this study we try to choose the best place for this purpose. According to the results, five areas have high priority for the waste accumulation. First area is ninth homogeneous unit which is located in a distance of 550 meters of the fault and 1 kilometer of rural road. Dolomitic lime stones and dolomite rocks of the region are thick and crystallized. Second areas are 3, 4, 21, 22 homogenous units. In these areas dolomitic lime stones and dolomite rocks also are thick and crystallized. Units 3, 4 and 21 are located within approximately 550 meters of the fault, while unit 22 is farther from the fault. Considering the location and provided description, first area in terms of accumulation of gangues is the best place. So according to the conformity of selected site with the current accumulation place, in order to reduce environmental pollution, improvement of the location with local engineering principles is required.

Conclusions

Since the pollution from mining activities, particularly metallic mines such as lead and zinc is due to inappropriate site selection for gangue accumulation, because of that using methods for locating and investigate the possibility of contamination and determination of contaminated sites can help to better management of mining activities. The findings in this study, the ability of geographic information systems in modeling and locating, and assist to show environmental planning. According to the criteria which were weighted by using AHP, help planners to make better decisions based on location data. Surely, if accurate criteria be used more and more, better results can be expected. Thus, results demonstrate that integration of AHP and GIS techniques can be considered as suitable techniques to determine appropriate sites for different types of activities.

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