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EXTENDED ABSTRACT

Spatial Assessment of Risky and Safe Sites for Solid Waste Landfills (Case study: Isfahan Province, Iran)

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1. Introduction

According to the estimations, about 80% of municipal and rural solid waste in Iran is disposed in landfills. This rate is similar to some countries like Greece or Croatia in Eastern Europe. However, there is a pivotal tendency, particularly among industrialized and developed countries like Germany, Japan, Belgium and Netherlands, to reduce the rate of landfilling solid wastes less than 1% through the recycling, composting and reuse (EEA, 2016). The European Union has set 10% as its vision for limiting the rate of solid waste landfills by 2035. Despite the will of reducing solid waste landfills worldwide, its application is inevitable, particularly in developing countries like Iran. Therefore, spatial analysis and zoning safe areas is the primary step for protecting the environment against the pollutions in these sites.

In the last decade, there are quite numerous researches that aimed on optimizing the location of landfills through the combination of multi criteria decision making and spatial analysis tools, like geographic information systems (GIS) (Özkan et al. 2020; Şimşek and Alp, 2022). However, they were usually confined to a city area, used a few criteria, and emphasized to specific case studies. This conventional approach can highlight the locations where landfills might have the least environmental risks in a small scale. In addition, the accumulation of these researches can highlight some critical criteria and geographic layers. Although, we believe that in larger scales, optimizing the locations of landfills should be finalized by detailed quantified environmental impact assessment, like life cycle assessment (LCA) (Kumar et al. 2020). Prior to any technical decisions, a spatial survey is required to filter the risky regions for zoning landfills.

This study uses GIS tool with 70 layers and criteria to classify the large area of Isfahan province, centre Iran, into risky and safe zones. Accordingly, the status of existing 210 solid waste landfills, disposal stations, and facilities are checked based on national guidelines and regulations. Here, the states and cities with the highest environmental violations are highlighted.

2. Methodology

The required data of 70 geographic layers with their last updates (2016) were obtained from official organizations. Moreover, based on the spatial regulation of landfills, some buffering zones were defined. For example, the distance of buffer zones (BZ) between any waste management site and surface water resources (lakes, rivers, reservoirs, and diversion dams), residential areas (cities, industrial or rural towns, and nomads),

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and protected environmental areas were set 1Km. The distance of BZ for transit infrastructures (roads and railways) set as 300m while it is increased to 500m for energy-based infrastructures (power plants, refineries, gas and power distribution systems). The distance of BZ for modern man-made touristic places (hotels and hostels, museums, and camping sites) and historic places (mosques, shrines, caravansary, castles, etc) with cultural inheritance were set 3km. The BZ for springs and Qanats set as 400m, faults or seismic areas 200m, and for domestic and international airports set as 3 and 8km, respectively. In addition, the total area of aquifers with shallow water levels (less than 5m depth), forests and pastures, endangered plains, and mining sites set as risky zones. In these layers, the maximum scale of layers was 1:50000 as it shows that the highest error was 10m in this study.

The spatial assessment by BZs in the large scale of province indicates that 57% of the entire area should be classified as restricted and risky zones for waste management sites. Aquifers, surface waters and environmental protected areas were the most effective layers in this step. As shown in Fig. 1, the largest clear area is located on the east side and central of province. However, clear spots can also be found in western regions.

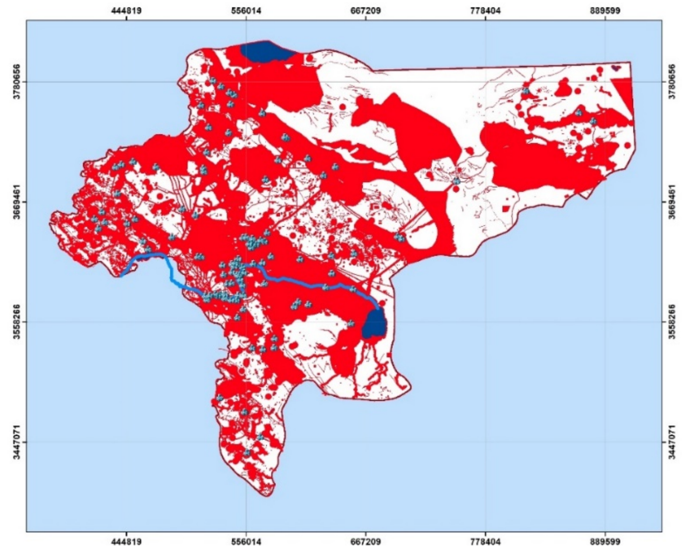

Fig. 1. Risky (Red) and safe (White) zones of Isfahan province for solid waste landfills

Elaborate analysis shows that among 210 existing landfills and waste management sites in Isfahan province, only 34 sites (16%) are located in the environmentally safe areas, while the others has at least one spatial environmental violation. 54 sites (26%) have only one violation, while 2 spatial environmental violations were observed for 45 sites (21%). About one third of sites (37%) have 3 or more spatial environmental violations classified as inappropriately located (IL) sites. This number reduces to one tenth (9.5%) for sites with 5 and more spatial environmental violations which are classified as areas with severely inappropriate locations (ILS). Therefore, SIL and IL were introduced as sites with the primary and secondary priorities for relocating, respectively.

Among 176 waste management sites with at least one spatial environmental violation, municipal solid landfills (65%) and the dumping and landfills of construction wastes (20%) were the most prevalent areas (Fig. 2). However, if areas with the potential of elevating risks, such as steep slopes (>15%), restricted plains for water extraction, areas with groundwater level between 5-10m, river banks with BZ of 1-2km, and thalwegs are added to 69 layers, the allowable area for solid waste landfills would be reduced from 43% to 29%. This reduction can highlight regions where implementing a waste management site is conditional and requires elaborate engineering techniques to reduce any adverse environmental impacts, particularly in events like floods (Fig. 3).

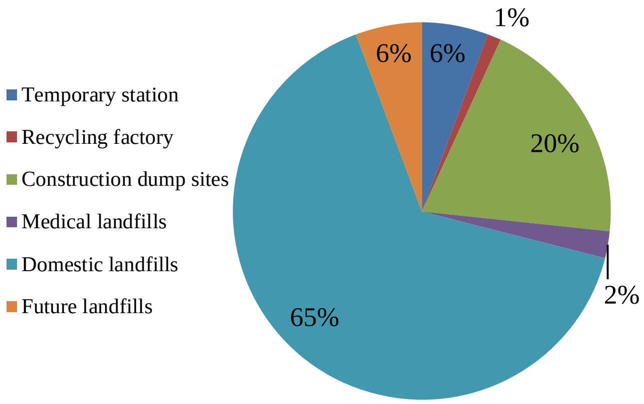

Fig. 2. Distribution of violating sites and landfills based on their application

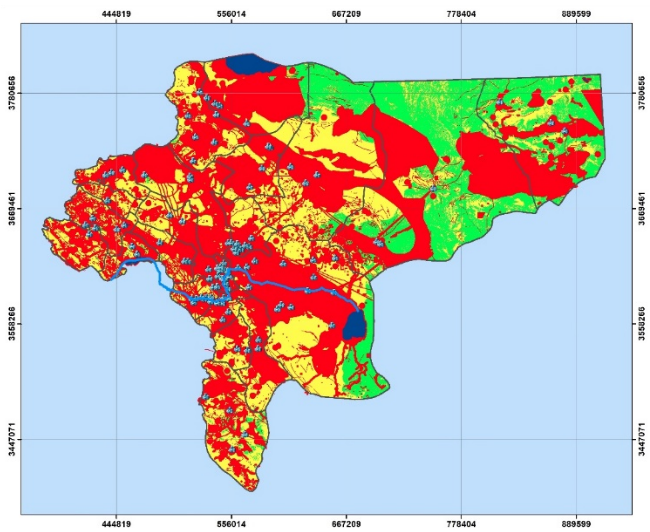

Fig. 3. Distribution of risky (red), conditional (yellow) and safe (green) zones for solid waste landfills

4. Conclusion

This study with 70 layers of GIS and their BZs in a large scale of Isfahan province, centre Iran, could classify regions for the implementation of solid waste management sites and landfills. This approach determined risky, conditional, and safe areas by considering all critical layers including surface and groundwater resources, faults, touristic, residential and environmental protected areas, infrastructures, etc. Accordingly, the existing sites were highlighted based on the number of violations in which IL and SIL sites prioritized for relocating. It is also recommended that slope, thalweg, restricted agricultural plains, and rivers with greater BZs should be added to other layers for safer waste site management.

5. References

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