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Siting a Waste Transfer Station in District 6 of Karaj Municipality to Reduce Pollution

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ABSTRACT

The rapid increase in waste generation, particularly in urbanized and developed regions, presents a significant challenge. Improper waste management leads not only to environmental degradation and pollution but also to substantial risks to public health. Given the complexity of municipal solid waste (MSW) management, effective strategies are essential. Collection, the most expensive part of MSW management, becomes more challenging in large cities with disposal sites far from collection points. In such cases, establishing waste transfer stations with high-capacity semi-trailers can help reduce environmental pollution and operational costs. This study aims to identify the optimal location for a waste transfer station in District 6 of Karaj Municipality. Using Geographic Information Systems (GIS) - based network analysis, the most suitable area was identified according to its proximity to population centers. Exclusion zones were eliminated using the Boolean method, and within the remaining area, zones were prioritized using the Simple Additive Weighting (SAW) approach in accordance with service unit placement criteria. The outcome of this study is recommended sites for the establishment of a waste transfer station serving Districts 5, 6, and 7 of Karaj Municipality.

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INTRODUCTION

In recent years, due to the continuous growth of the urban population and the consequent increase in per capita solid waste production, waste generation has become a significant concern. Annually, 2.01 billion tons of Municipal Solid Waste (MSW) are produced worldwide, of which at least 33% are not managed in an environmentally safe manner. It is anticipated that global waste generation will reach 3.40 billion tons by 2050 (Kaza et al., 2018). MSW includes non-biodegradable materials (such as tires, plastics, and leather), biodegradable materials (like plant residues, paper, food, and textiles), and relatively degradable materials (such as cardboard and wood). An effective MSW Management system requires comprehensive strategies for waste reduction, collection, composting, recycling, and disposal. In this context, Integrated Solid Waste Management (ISWM) which comprises principles, activities, policies, and planning strategies offers a modern, environmentally friendly framework, prioritizing waste management

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through reduction, reuse, recycling, and disposal. It involves strategic decisions, including site selection for waste facilities, choice of treatment technologies, and allocation of waste to appropriate processing units and landfills (Asefi & Lim, 2017). To ensure sustainability, such a system must be economically viable, environmentally effective, and socially acceptable, thereby preventing both short- and long-term detrimental impacts on the environment and human health (Khoshbeen et al., 2020).

A waste transfer station is a technically established location allowing the discharge of non-hazardous waste and its temporary storage prior to transportation to final disposal sites (Cobos-Mora et al., 2023). In urban areas, transfer stations (TSs) are constructed to receive and temporarily hold MSW collected by primary collection vehicles (PCVs), and subsequently transfer the MSW via secondary collection vehicles (SCVs) to processing or final disposal facilities (Yadav et al., 2016). Many European countries—such as Germany, Belgium, Austria, the Netherlands, Denmark, Sweden, Norway, and Finland—currently incorporate TS into their MSW management systems (Zemanek et al., 2011). A TS plays a pivotal role in collection systems by reducing transportation costs, compacting MSW to decrease volume, minimizing urban traffic congestion, and mitigating air pollution (Cui et al., 2011). These stations not only serve as sites for the temporary storage and loading of MSW onto larger vehicles designated for transporting waste to final disposal or landfill sites but also have the capacity to accommodate additional functions. A TS may include material recovery and processing facilities, parking areas for collection vehicles and semi-trailers, leachate treatment installations, repair workshops, and more. In the past, more than 1,200 primary and secondary waste depots existed across Tehran's streets and enclosed urban areas. After the temporary storage of MSW at these sites, lorries would load the collected waste and transport it to the Abali or Aradkouh disposal centers. With the implementation of ISWM, these numerous depots were replaced by 11 TSs situated throughout Tehran. According to the most recent comprehensive MSW plan for Tehran in 2021, due to concerns about environmental pollution, it was recommended that TSs of Zanjan and Harandi be ceased, leaving 9 active TSs across the city (Tehran Municipality Studies Center, 2021). Today, the most cities of Iran have been equipped with waste transfer stations.

The collection and transportation of MSW typically make up about 50 to 70% of the total expenses in a MSW management system (Rada et al., 2013; Tavares et al., 2009). A case study in Taiwan demonstrated that the optimal siting of TSs effectively reduced the direct costs associated with the MSW management system (Chang & Lin, 1997). Nonetheless, it is crucial to note that although the operation of TSs can lead to reduce waste transportation costs, they also pose adverse environmental impacts. If the necessary preventative measures remain unaddressed, these impacts can undermine public health and wellbeing. In this regard, a study conducted on Tehran's Darabad TS, employing a SWOT analytical approach, indicated that the severity of environmental impacts could be minimized by applying ecological criteria as far as possible (Nabi Bidhendi et al., 2020).

Identifying a suitable site for the establishment of a TS can be a challenging process. The suitability of a site for a TS depends on technical, environmental, economic, social, and political factors, requiring a balance among them. An ideal location may not always be central to MSW generation or have natural protective barriers in densely developed areas. Sometimes, less-than-ideal sites may be the best option considering transport, environmental, and economic factors. Public concerns, especially those near the site, must also be addressed (USEPA, 2002). The selection of appropriate criteria for siting TSs has been addressed in numerous studies. For example, Nilchiyan (2002) employed a multi-criteria analysis approach to determine a suitable location for a TS in District 22 of Tehran, considered criteria such as accessibility, distance between MSW generation centers and the disposal site, land use, geology, topography, prevailing wind direction, costs, and available land area. Through pairwise comparison, 9 potential sites were identified. In another study, a multi-criteria evaluation model was used to rank 12 suitable locations for constructing TS in Mashhad. In this research, soil and geological characteristics, slope, and distances from residential areas, MSW generation centers, waterways, faults, and access roads were selected. Each of the utilized criteria was standardized using a fuzzy subset, and a linear function was employed to rank each criterion (Rafiee et al., 2011).

Various methods have been employed to determine the optimal locations for TS. In one study, a mathematical programming approach was utilized to identify suitable TS locations in Istanbul, with the model guided by economic criteria to select the most cost-effective site (Kirca & Erkip, 1988). In another investigation, a Geographic Information System (GIS)-based multi-criteria decision analysis, incorporating the Analytic Hierarchy Process (AHP), was utilized to identify suitable areas for the construction of a TS (Cobos-Mora et al., 2023). In the southeastern region of Izmir, GIS was utilized to identify potential sites for a TS, optimize its location, and improve waste collection routes for different vehicle capacities through vehicle routing problem modeling. The results indicated that incorporating a waste TS into the area reduced collection time and the number of shifts by 9%, while employing larger vehicles reduced these metrics by 25% and 17%, respectively (Höke & Yalcinkaya, 2021). In Coimbatore, India, the siting of a construction and demolition (C&D) waste TS was conducted using a GIS-based multi-criteria analysis. Criterion weights were determined using the AHP, and the final suitability map was generated through Weighted Overlay Analysis (WOA) within a GIS environment, providing valuable insights for local decision-makers to select the optimal location for the TS in the study area (Devaki & Shanmugapriya, 2023).

Establishing a waste TS with processing equipment offers a flexible waste management solution for major cities. However, siting such stations within urban areas can have negative impacts, including increased traffic, noise, unpleasant odors, and higher social, environmental, and economic costs if poorly located or designed (Lin et al., 2020). Currently, Karaj city in Iran is served by three waste TSs. However, one of these stations, located in District 6 of Karaj Municipality, is constrained by inadequate space for waste transfer operations and is situated within a residential neighborhood, causing significant inconvenience to residents. This study aims to identify a new, environmentally, economically, and socially suitable location for a TS to serve Districts 5, 6, and 7 of Karaj Municipality. Therefore, a GIS-based network analysis was initially conducted to delineate the service area and assess the centrality of land parcels within the study region, with a particular focus on service area analysis. Exclusion zones were removed using the Boolean method, and the remaining areas were prioritized with the SAW approach.

MATERIAL AND METHODS

Study Area

Alborz Province, encompassing an area of approximately 5182 km^2, is situated between latitudes of 35° 50’ N and 36° 31’ N, and longitudes of 50° 60’ E and 51° 50’ E. According to the latest national divisions published in the 2023 Statistical Yearbook of Alborz Province, the province comprises 7 counties, 18 cities and 331 inhabited villages. The population of Karaj, based on the 2017 national census, was 1,592,492 and Among Iran’s major cities, it has the highest population growth rate, with a simple growth rate of 3.14%. The Karaj city is in latitude of 35° 53’ N and longitude of 50° 96’ E covering a geographical area of 162 km^2. The map of Karaj along with its municipal districts, located in Alborz Province, is presented in Fig. 1. The climate of the region is temperate and dry, which receives an average rainfall of around

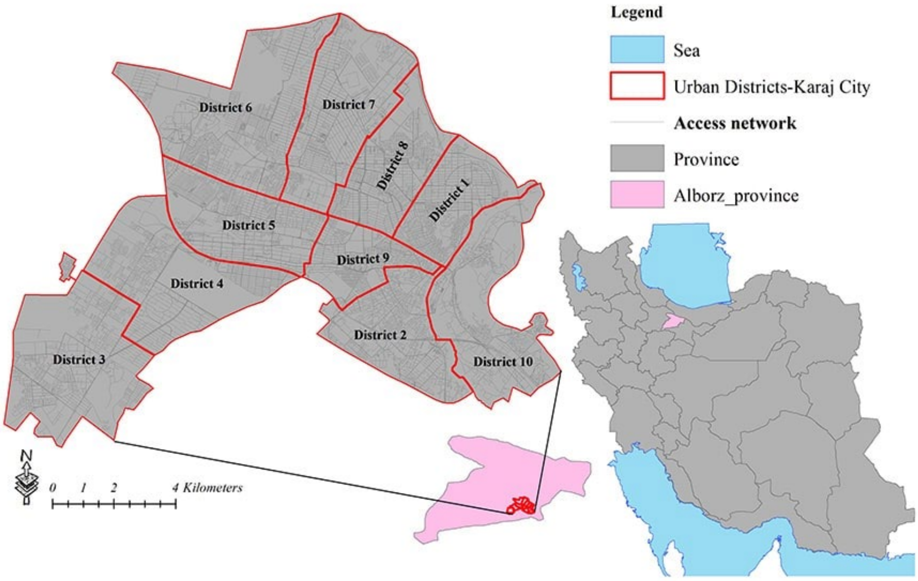

Fig. 1. Map of municipal districts within Karaj city

240 mm/yr, with the majority falling during the winter and spring months. Humidity levels are generally low throughout the year, averaging around 38%.

Based on data received from the Karaj Municipality, the average daily MSW generation per person in 10 districts of the Karaj metropolitan area is 699 grams. The physical analysis of the MSW generated in Karaj consists of 78.4% organic materials, 6.1% plastics, 5.9% paper, cardboard, and corrugated materials, 1.9% textiles, 1.6% glass, 1.5% metals, 0.8% bone, 0.5% wood and 3.4% other materials. Of the daily produced MSW amounting to 1200 tons in Karaj city, approximately 90% is transported to the Halghe Dareh disposal and processing center, where it is subsequently disposed of. The Halghe Dareh center, spanning approximately 153 hectares, is the only landfill site in Alborz and has long been designated as the sole MSW disposal facility for Karaj city and its surrounding areas.

Table 1. Exclusionary siting criteria for TS.

Category	Iran	USA (USEPA, 2002)
Floodplain Area	Floodplain with a 100-year return period.	Floodplain plains
Karst Area	Areas with limestone formations prone to dissolution, fissures, or rainwater accumulation.	-
High Permeability Soil Area	Soils with high infiltration and percolation rates increase the risk of groundwater contamination from wastewater generated during station cleaning.	-
Unstable Area	Marshes and swamp lands.	Swamps
Area with Inappropriate Morphology	Environments with multiple slopes, prone to landslides and avalanches.	-
Cave Area	Environments containing limestone caves, mines, and deep manual excavations.	-
Residential Areas	Distance between the TS and residential areas less than 300m.	-
Airport	Distance between the TS and airports less than 8000m.	-
Parks and protected Areas	National parks, mountainous parks, and protected areas for plant and animal species.	Parks, hunting grounds, and habitats of endangered and protected plant and animal species.
Cultural and Historical	Religious, historical, and cultural sites.	Protected areas of historical and archaeological significance.
Agricultural Areas	-	Prime agricultural land

Research Method

According to national regulations, TSs can be located within permissible city boundaries based on the municipality's comprehensive plan and zoning documents (classified as category III). GIS, a powerful tool for managing and analyzing spatial data, was employed to identify suitable sites for locating TS. In decision-making processes, GIS facilitates the integrated analysis of both spatial and non-spatial data within a unified framework (Ağaçsapan & Çabuk, 2020). To minimize collection costs, the initial step involved the application of GIS-based network analysis to determine the service area and assess the centrality of land parcels within the study area, specifically through service area analysis. Locations were ranked according to distance, with sites within 500 m classified as highly suitable and those beyond 10000 m classified as minimally suitable. In the second step, exclusion criteria were identified based on "executive guidelines for siting, constructing, and operating waste transfer stations", and USEPA guideline (USEPA, 2002). Areas unsuitable for establishing TSs were detailed in Table 1. By overlaying the layers, a map was extracted that possesses the highest degree of centrality and is situated outside the exclusion areas.

Using Table 2, which outlines criteria for sitting TSs based on global and national regulations, the prioritization of suitable locations within the identified zone from the previous section was conducted applying the Simple Additive Weighting (SAW) method. This multi-criterion decision-making technique involves direct score estimation by the decision-maker. The scores and corresponding desirability levels, which form the basis for evaluation, are detailed in Table 3. Maps of each characteristic were classified in GIS according to these values.

In this study, various criteria including distances from settlements, waterways, fault lines, topography, and access roads were incorporated into the analysis. Equal weights were assigned to all criteria, and scoring was carried out based on the constraints presented in Table 4. Using GIS software, the ranking process identified the highest-priority locations that met the technical and spatial requirements.

Table 2. Criteria for appropriate distance from waste transfer stations

Row	Parameter		Maximum	Minimum	Iranian Establishment Regulations
			(USEPA, 2002), (Environmental Agency of England, 2016), (Department of Sustainable Development, 2016), (Alberta Environment, 2008)		
1	Transport Distance (to landfill)		25000 – 30000 m	-	-
2	Buffer Zone		30 m	5 m	-
3	Human Settlements	Residential areas	500 m	30 m	250 m
4		Sensitive Receivers	1000 m	200 m	150 m
5		Commercial and Industrial Areas	500 m	30 m	-
6	Water Bodies	River	500 m	30 m	150 m
7		Lakes and Marshes	915 m	30 m	150 m
8		Coastal Lines	500 m	30 m	-
9		Drinking Water Sources	500 m	30 m	150 m
10	Infrastructure	Roads	30 m		-
11		Railways	50 m		-
12		Airport	3000 m	15000 m	-
13	Protected Areas		500 m	200 m	150 m

Table 3. Priorities and scores used in the SAW method

Priorities	Numerical Value
With Absolute Importance	9
Very High Importance or Desirability	7
Strong Importance or Desirability	5
Weak Importance or Desirability	3
Equal Importance or Desirability	1
Preferences Between Distances	8, 6, 4, 2

Table 4. Classification of TS criteria and their scores

Classification	Distance from Settlements	Score	Distance from Waterways	Score	Distance from Faults	Score	Distance from Access Roads	Score	Slope Classes	Score
Class 1	0-250m	1	0-150m	1	0-500m	1	0-100m	10	< 5%	10
Class 2	251-500m	7	151-500m	7	501-1000m	7	101-150m	8	5 -10%	7
Class 3	> 500 m	10	>500m	10	> 1000m	10	151-300m	6	> 10%	4
Class 4	-		-		-		301-500m	4	-	
Class 5	-		-		-		> 500m	2	-	

RESULTS AND DISCUSSION

Distance from population centers

One of the key factors in identifying a suitable location for a TS is its distance from population centers, which is influenced by population density, per capita waste generation, and the daily amount of waste produced. Higher population density is correlated with increased waste generation (Pan et al., 2019). Accordingly, the population centers of Districts 5, 6, and 7 of Karaj Municipality were identified using maps of residential areas and population density over the network. Fig. 2 (a) illustrates the population density of these districts in persons per hectare, Fig. 2(b) highlights the population centers within each district, and Fig. 2(c) shows the access network. Through network

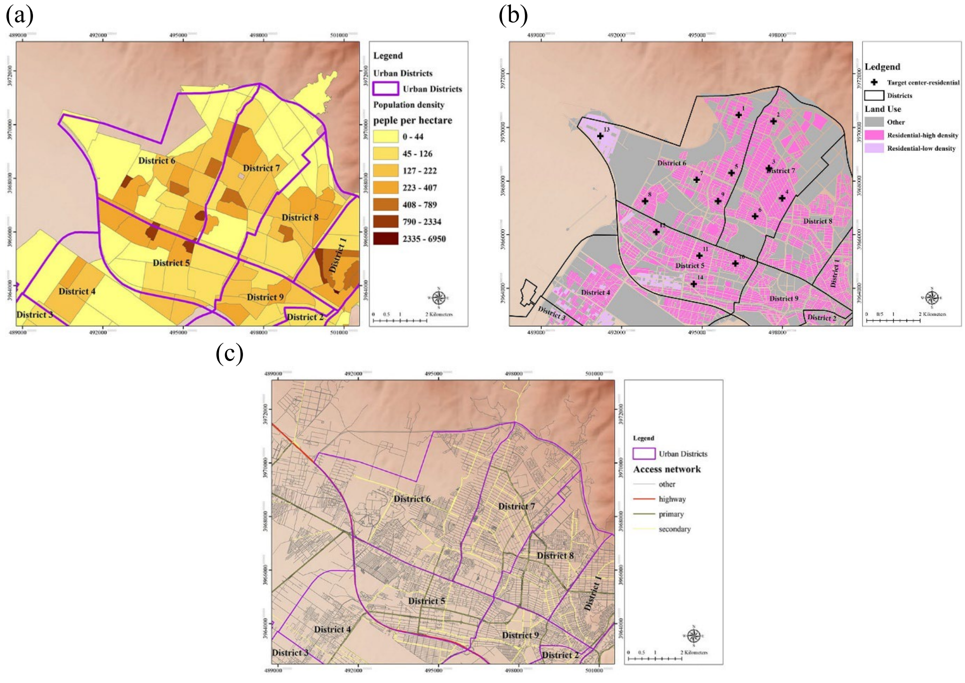

Fig. 2. (a) Population density, (b) Population centres, (c) Access network of the study area

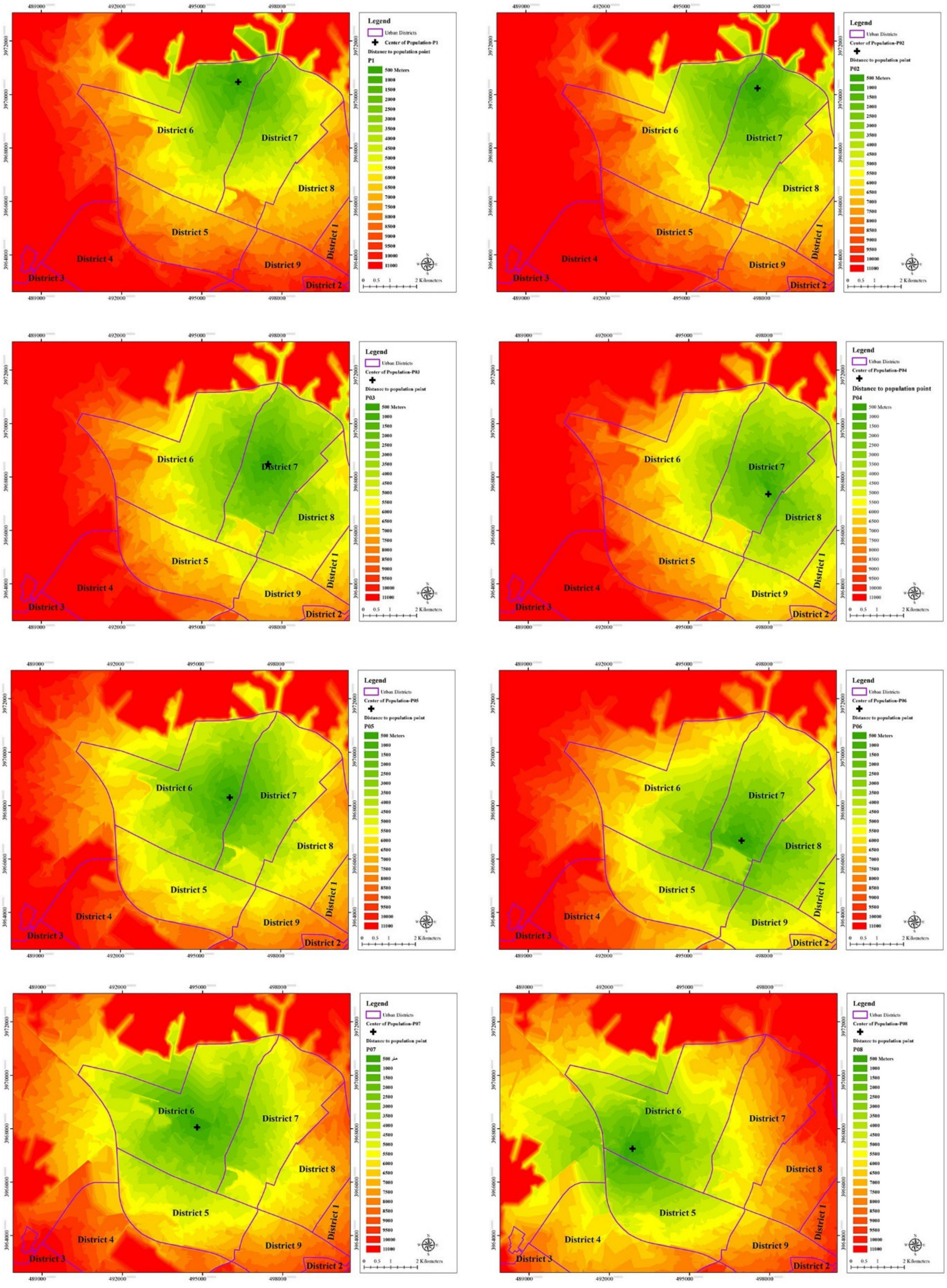

Fig. 3. Distance from population centres in Districts 5, 6, and 7 of Karaj municipality

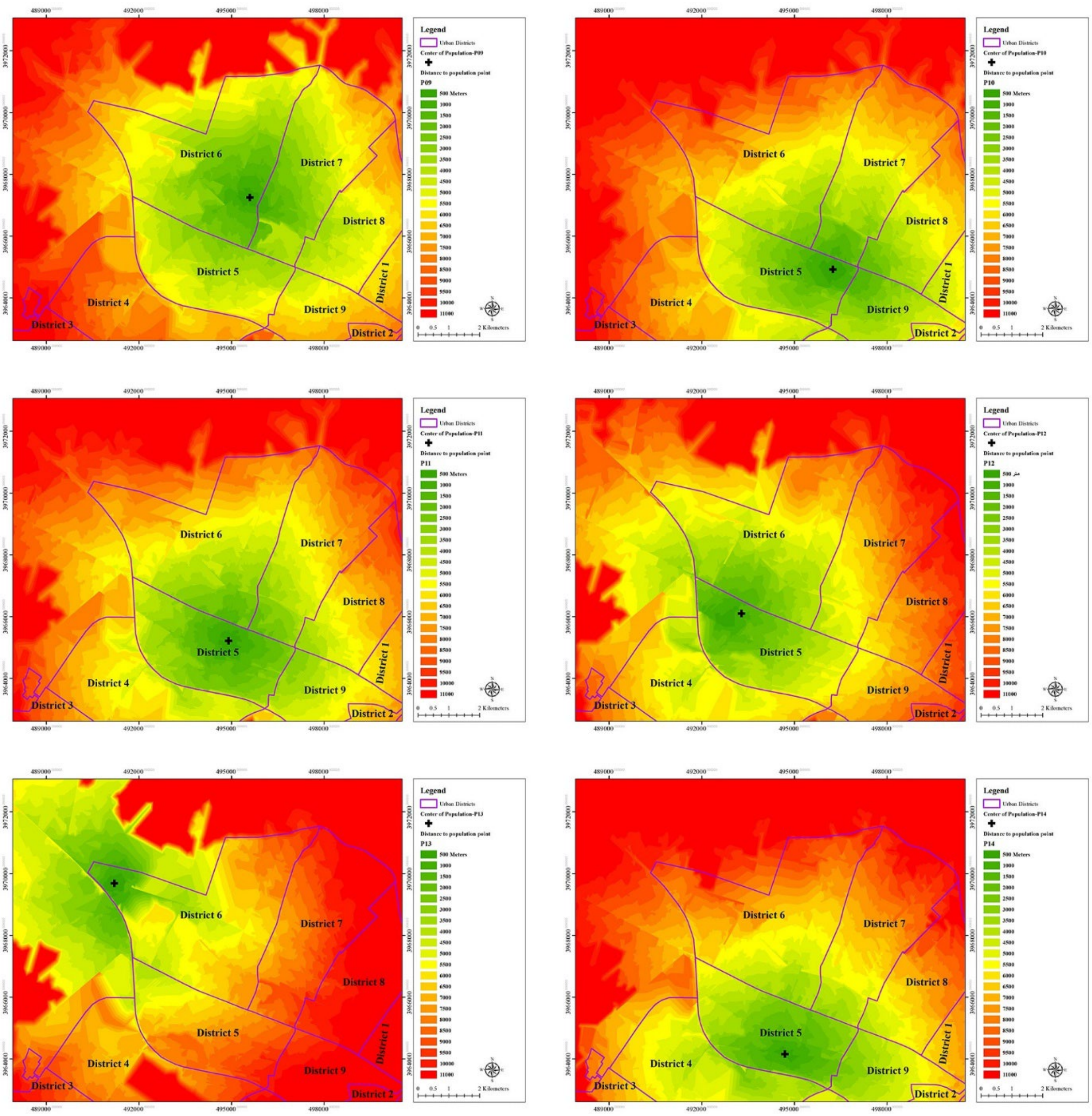

Fig. 3. Distance from population centres in Districts 5, 6, and 7 of Karaj municipality

analysis, the service area for the population centers was determined, and the centrality degree of lands in the study area was calculated based on distance scoring.

Fig. 3 illustrates the distances from the population centers within Districts 5, 6, and 7, along with their respective desirability levels on the network. As the distance of the TS from population centers, waste generation areas, and residential zones increases, the site becomes more favorable in terms of minimizing residential interference. However, from an economic perspective, closer proximity to population centers is desirable, as proximity to population centers is desirable, as shorter distances reduce waste collection and transportation costs, making the location more economically viable. Areas located within 500 m of population centers were assigned the highest priority, while those situated beyond 10,000 m were considered the least desirable. By overlaying the layers of distances from population centers, Fig. 4 was generated, highlighting the most suitable areas for siting the TS based on this criterion.

Exclusion Zones

In this phase, the Boolean method was employed to exclude areas identified as unsuitable for the establishment of TS, as specified in Table 1. Prohibited zones, including residential areas, airports, protected areas, cultural and historical sites, and similar locations, were identified and removed from consideration. To facilitate this process, a land use map was generated (Fig. 5(a)). By overlaying the relevant layers, the resulting output (Fig. 5(b) delineates the areas unsuitable for the siting of TS based on the defined exclusionary criteria.

According to the national regulations governing the establishment of service units, TSs are classified as category III service units, which are permissible within the designated city boundaries as defined by the comprehensive municipal plan and zoning documents. Considering the regulatory framework, centrality degree, proximity to population centers, and exclusion zones for TSs, Fig. 6(a) identify a suitable area of approximately 50 hectares. As depicted in Fig. 6(b), the selected location is situated approximately 24 km from the Halghe Dareh disposal site via the access network. This distance provides economic justification for the establishment of a TS and the transportation of waste to the disposal site.

In general, in accordance with the national guidelines, locating a transfer station at a distance exceeding 15–20 km is more cost-effective than shorter distances. Rathore and Sarmah (2019) demonstrated that establishing TSs significantly reduce transportation costs when the distance between waste generation centers and disposal sites exceeds 15 km. Specifically, the cost of

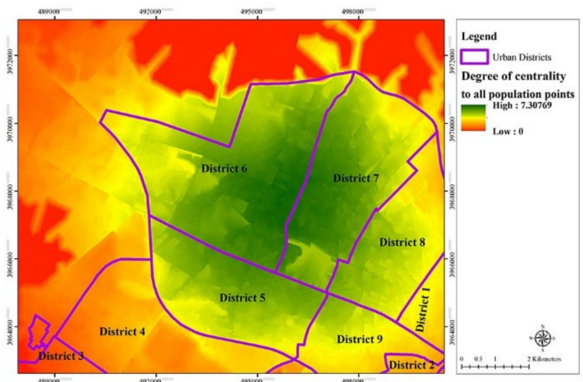

Fig. 4. Favorable areas in terms of distance from population centres

(a) (b)

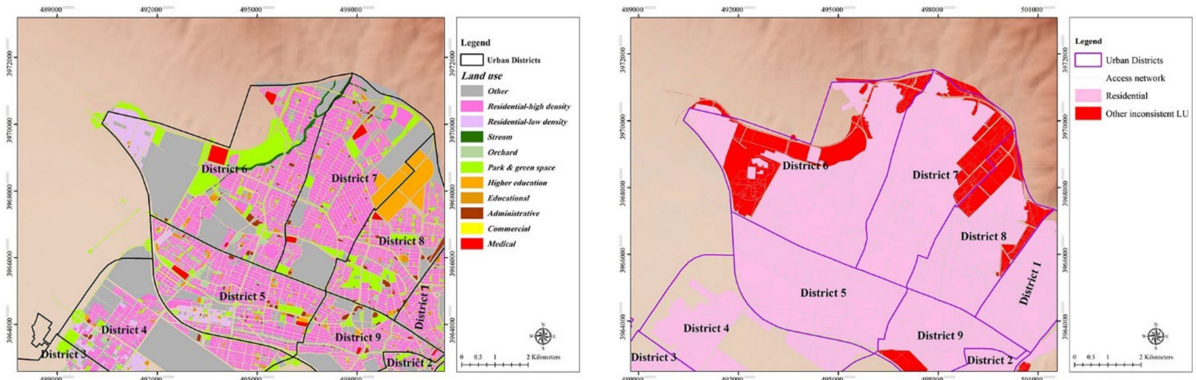

Fig. 5. (a) Land use map, (b) Prohibited areas for establishing waste transfer stations in districts 5, 6, and 7 of Karaj municipality

transporting waste via semi-trailers (SCVs) accounts for only about 30% of the transportation costs incurred using PCVs for the same volume of waste (USEPA, 2002; Eiselt & Marianov, 2014). The guidelines from Turkey, Colombia, and New York city recommend a waste transport distance of either 25–30 km or 30 minutes, whichever is greater (JICA, 2013; New York State department of environmental conservation, 2017). The economic benefits are further enhanced when the TS incorporates Material Recovery Facilities (MRF), enabling additional reductions in waste transportation costs.

Suitable Area for Establishing a Waste Transfer Station

At this stage, the site selection process was conducted in accordance with the criteria outlined in Table 2—concerning the minimum permissible distances for the establishment of urban service facilities—and Table 4. The criteria included maintaining a minimum distance of 250 m from settlements, 150 m from other population centers, 150 m from waterways, an appropriate distance from fault lines, 150 m from access roads, ensuring that the land slope fell within an acceptable range. Land slope influences the volume of earthwork and has notable economic implications. By applying the defined criteria, the generated map (Fig. 7) illustrates the areas identified as suitable for TS establishment.

Fig. 8 illustrates the degree of desirability ranging from 1 (least desirable) to 9 (most desirable). Accordingly, Fig. 8(a) highlights nine high-priority locations identified as suitable for establishing TS. A higher score indicates a higher priority for site selection. To determine favorable and unfavorable locations, areas with scores exceeding 8 were classified as suitable, while those scoring below 8 were considered unsuitable, as shown in Fig. 8(b).

Optimization models incorporate the placement of TS as a key objective in addressing MSW management challenges. Additionally, factors such as the number of required TS (Yadav et al., 2016), type of waste (Asefi et al., 2015), routing (Asefi & Lim, 2017), cost minimization (Eiselt & Marianov, 2014), TS capacity (Kůdela et al., 2019), and time optimization (Monzambe et al., 2021) have been extensively explored in TS-related research. However, a comprehensive assessment of site suitability for TS establishment— encompassing all environmental, social, economic, and technical variables and their complex interactions— remains a significant challenge and may even be impractical in certain contexts (Cobos-Mora et al., 2023).

Traditionally, the primary criterion used for determining the location of a TS has been the minimization of transportation costs, as it is generally more cost-effective to transport large quantities of MSW over longer distances using high-capacity vehicles than to use smaller ones.

(a) (b)

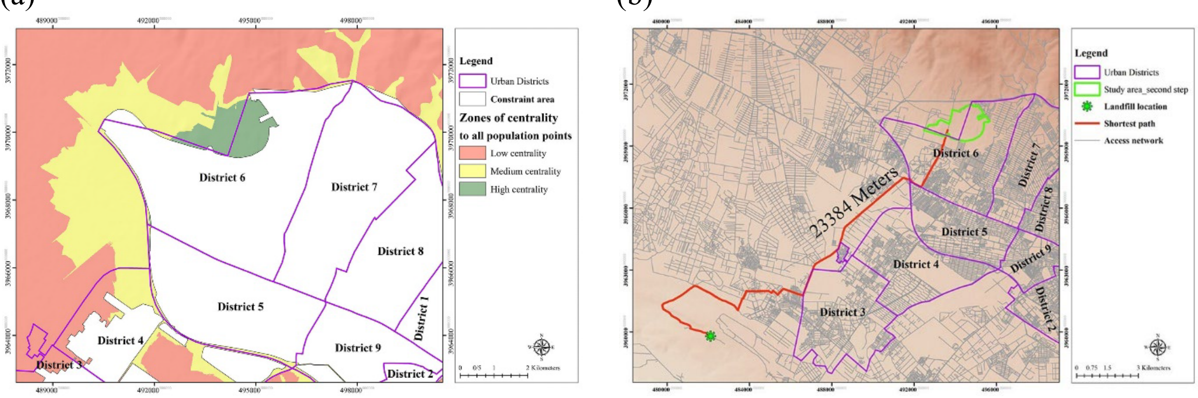

Fig. 6. Transfer station area – (a) Centrality degree and prohibited zones, (b) Distance from selected TS to Halghe Dareh disposal site on the access network

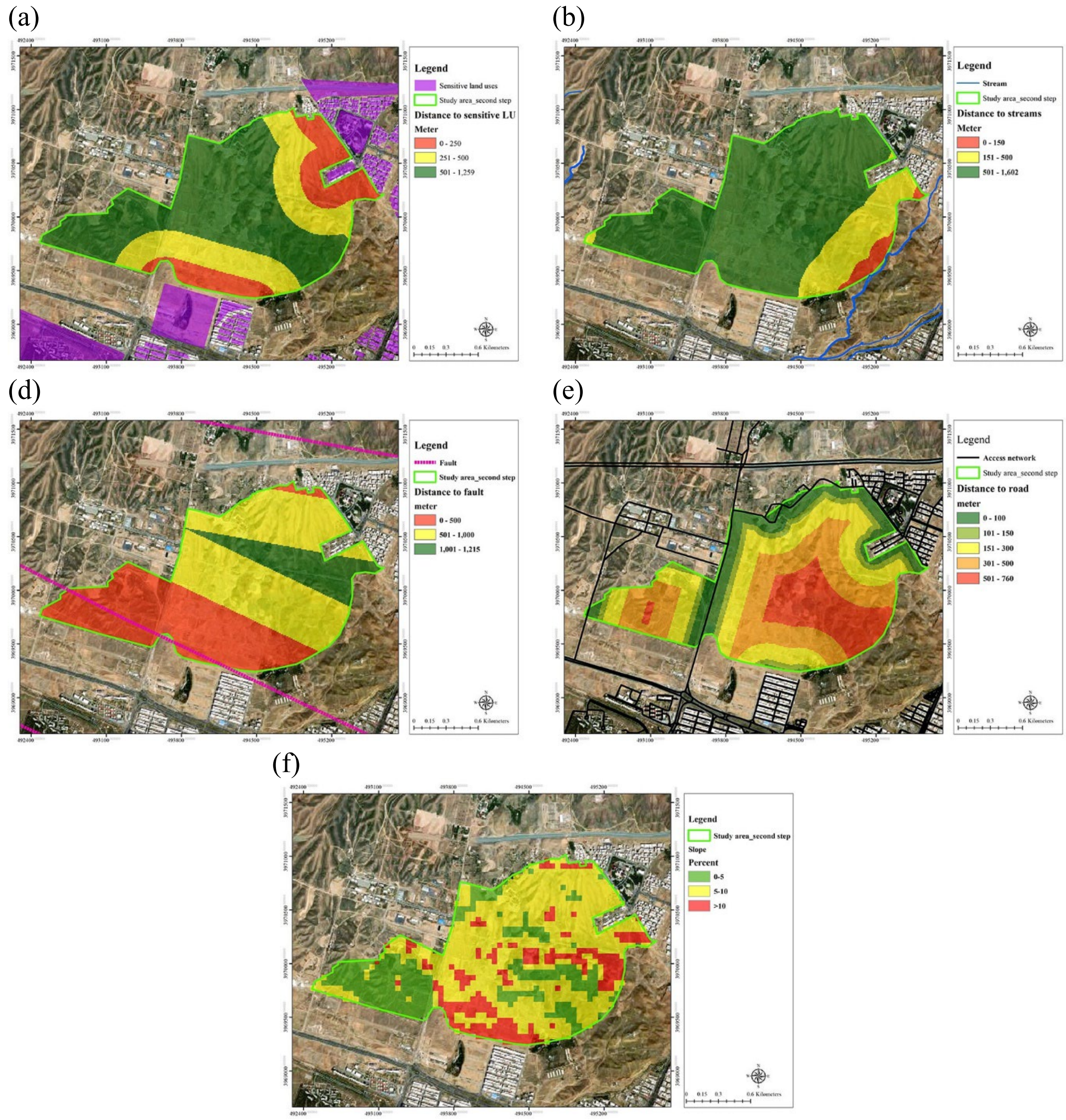

Fig. 7. Location prioritization: (a) Settlements (0 - 250 m: least desirable; > 500 m: most desirable), (b) Waterways (0 -150 m: least desirable; > 500 m: most desirable), (c) Faults (0 - 5000 m: least desirable; > 1000 m: most desirable), (d) Access Roads (0 - 100 m: most desirable; > 500 m: least desirable), (e) Topography (0 - 5% slope: most desirable; 5 to 10% and > 10% slope: least desirable)

Using life cycle assessment techniques, Bovea et al. (2007) evaluated the environmental factor to assess the feasibility of incorporating TS into MSW management systems and quantified the environmental impact both transportation and TS construction in a region of Spain. The results indicated that the inclusion of TSs led to an average reduction of 8–16% in environmental impacts compared to direct transportation of collected waste to processing facilities.

The proximity of TSs to population centers is a critical consideration, as it directly affects public health by mitigating adverse impacts associated with TS operations. These impacts include the spread of bacteria through wind (Hasbiah et al., 2021), noise pollution, and the release of gases and unpleasant odors. For instance, Chang et al. (2019) reported that highly

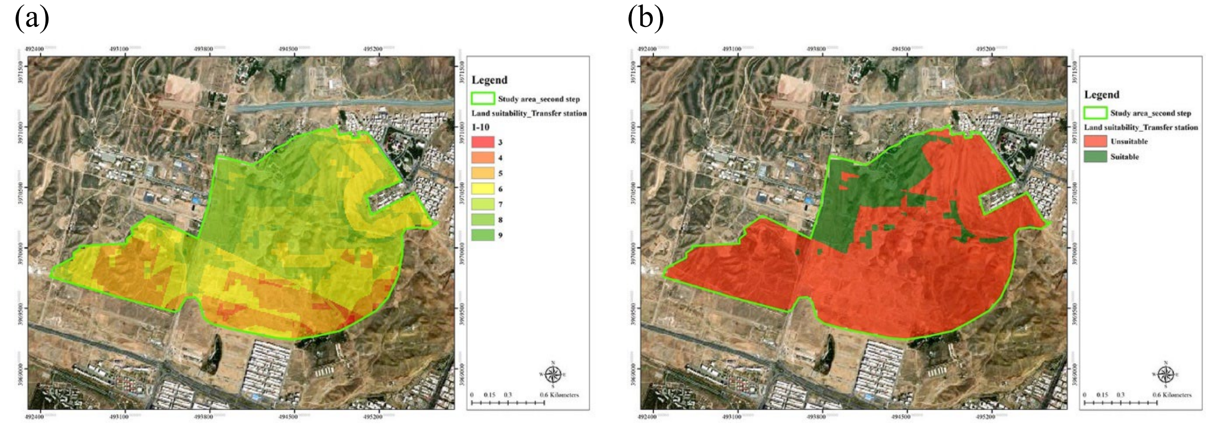

Fig. 8. Desirability of land for establishing waste transfer station: (a) Priority ranking of areas (b) Suitable and unsuitable zones

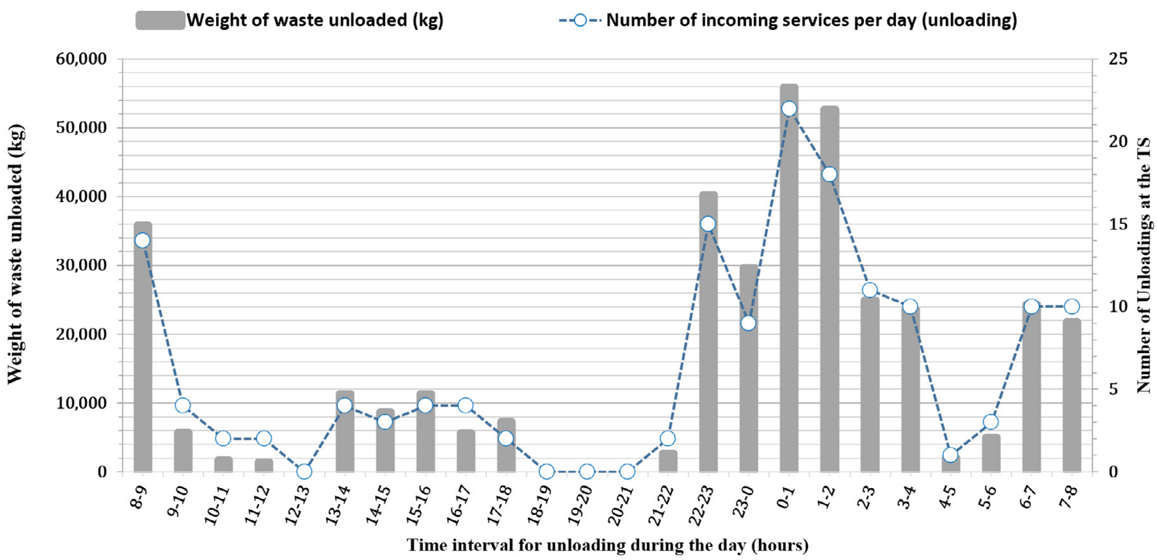

Fig. 9. 24-hour incoming MSW data to the TS from 8:00 AM on may 2, 2024, to 8:00 AM on may 3, 2024

concentrated osdors can significantly affect areas within a 500-meter radius. Furthermore, volatile organic compounds (VOCs) emitted from TS facilities may pose serious acute and chronic health risks (Liu & Zheng, 2020; Sarkhosh et al., 2017). In the present study, the distance between the proposed TS and the population centroids exceeds 500 m, ensuring compliance with recommended health and safety guidelines. In general, to ensure full compliance with environmental requirements, sites located farther from population centers are considered more favorable.

Waste Production and TS operational units within project horizon

Fig. 9 illustrates data collected from the existing TS in District 6 of Karaj Municipality, depicting the incoming waste tonnage over a 24-hour operational period from 8:00 am on May 2, 2024, to 8:00 am on May 3, 2024. The analysis indicates that peak waste intake occurs during two timeframes: 10:00 pm to 4:00 am and 6:00 am to 9:00 am. During these intervals, the highest number of collection and service vehicles is allocated to the TS. The total MSW collected from Districts 5, 6, and 7 amounts to 371,400 kg/day, with an average incoming rate of approximately 15.5 tons per hour. At present, the daily incoming MSW to the TS in District 6 is approximately 380 tons, consistent with the average tonnage recorded for May, June, and July 2024.

In the 30-year project horizon, the daily incoming waste to the TS is projected to be approximately 690 tons per day. It is worth noting that an annual growth rate of MSW of 2% has been assumed, accounting for projected changes in source separation practices over a 30-year planning horizon. The capacity of the TS is determined based on the projected mass and volume of incoming MSW throughout the station's operational lifespan. The space allocated for a TS consists of operational functional units (such as waste weighing, unloading, and loading operations), support functions (including management and control operations, operational landscaping, and assistance with mechanized unloading and loading), welfare and service facilities (including all facilities dedicated to staff needs), and auxiliary functions (covering all mechanical and electrical facilities, guard kiosks, and vehicle parking areas).

The primary function of a TS is to facilitate transfer MSW from PCVs to SCVs. The TS located in District 6 of Karaj Municipality has been specifically designed to prioritize this service. The transfer platform comprises three main components: barrier walls, specialized ramps for waste collection and transfer vehicles, and a waste shooting system. In addition to these core elements, the total area of a TS must also include sufficient space for supporting infrastructure such as MRF, vehicle washing stations, repair shops, parking areas for semi-trailers and collection vehicles, administrative and welfare spaces for staff, and facilities for initial leachate collection and treatment. Firefighting systems and wastewater management systems, particularly those handling surface runoff and facility washing must also be incorporated. In compliance with the national Clean Air Act, industrial units are required to allocate a minimum of 10% of their operational space for green spaces. Although TSs are classified as service units, their potential for generating pollution, odors and suspended particles necessitates a high priority for green space. From an aesthetic standpoint, incorporating natural barriers around perimeter of the site can serve both functional and visual purposes. Furthermore, many publicly managed TSs, as opposed to private ones, allow public access to certain facilities. Proper design, establishment, and operation of TS facilities can significantly reduce adverse environmental impacts on the surrounding environment (Zemanek et al., 2011).

CONCLUSION

The primary objective of this study is to determine optimal locations for siting a waste transfer station in Districts 5, 6, and 7 of Karaj Municipality. The analysis began with GIS-based network analysis to evaluate the centrality of land within the study area, emphasizing proximity to population centroids as a key parameter for minimizing waste collection costs. Subsequently, areas deemed unsuitable for the TS establishment were excluded based on criteria outlined in the guidelines. Within the remaining feasible zones, potential TS locations were identified and ranked into 9 categories based on factors such as proximity to residential areas, waterways, faults, and local topographical conditions. GIS tools were utilized throughout the process for spatial layer integration and site prioritization. From an environmental standpoint, the establishment of TSs poses several concerns, including the emission of unpleasant odors, noise pollution from waste vehicle operations, leachate leakage into the surrounding environment, the attraction of insects and pests, visual pollution of the landscape, and potential public health risks. Therefore, it is essential for the TS to be located at a sufficient distance from residential areas to minimize potential negative impacts. However, increasing the distance of TS from these areas results in higher waste collection and transportation costs. In this study, the proposed TS location was found to be more than 500 m away from the population centers, and the distance from the Halghe Dareh disposal site was approximately 24 km, thereby justifying the need for the establishment of the TS. Moreover, the incorporation of green spaces plays a significant role in improving the physical environment and mitigating the visual and ecological impacts of the TS.

GRANT SUPPORT DETAILS

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CONFLICT OF INTEREST

The authors declare that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

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