

## Research Article

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# Integrated fuzzy logic and multicriteria decision model methods for selecting suitable sites for wastewater treatment plant: A case study in the center of Basrah, Iraq

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**Abstract:** In environmental infrastructure projects, decision-making can be complex and challenging because of the inherent trade-offs between environmental, economic, and social considerations. During urban development, wastewater treatment plant (WWTP) site selection is one of the most critical parts of environmental infrastructure. Choosing suitable sites for constructing a WWTP is based on various variables and limits. In the modeling phase of this study, ten criteria were developed from three main criteria to evaluate sites suitable for WWTPs. These criteria were slope, soil type, and proximity from rivers, roads, agricultural lands, railways, oil fields, groundwater, outfall, and residential areas. These parameters and their respective weights were determined based on a literature review, expert knowledge, field observation, and geophysical investigation. The fuzzy analytical hierarchy process (AHP) method, which integrates AHP and fuzzy logic, was used as a multicriteria decision-making, and fuzzy membership functions were performed to determine the criteria weights used with geographical information systems to select all available sites for the WWTP for the center of the Basrah province. The study concludes that the old Hamdan WWTP was located in an unsuitable area. In light of the rapid population growth in Basrah center in recent years, it may be proposed that a new WWTP be built in a new location that meets environmental, economic, and social criteria. This study reveals that 138.52 km<sup>2</sup> (or 9.98% of the total land area) is appropriate for constructing the new WWTP.

**Keywords:** multicriteria decision making, MCDM, Fuzzy analytical hierarchy process, FAHP, waste water treatment plants

## 1 Introduction

The selection of an appropriate site for a wastewater treatment plant (WWTP) is an essential issue before designing and executing it, and doing so necessitates considering a wide range of factors, complicating the decision-making process [1].

The multicriteria decision-making (MCDM) techniques generally allowed for a systematic and unambiguous framework of the issue. With this characteristic, the decision-makers can quickly examine and scale the situation according to their requirements. Municipal wastewater is one of the essential outputs from the WWTP, which poses a serious danger to natural ecosystems. Also, some other environmental conditions should be satisfied due to the fact that the city is affected by the odor and pollution from the WWTP. Hence, it is necessary to take adequate steps toward achieving environmental sustainability goals by developing treatment plants in appropriate sites. There should be considerations for economic and social needs.

Here, it is the necessity to find a method for analyzing the decision in a framework that processes spatial data. In this study, a procedure was implemented in a spatial decision support system based on the combined use of geographical information system (GIS) and the fuzzy extension of the analytic hierarchy process (FAHP) [2]. Ten factors, including slope, soil type, distance from rivers, distance from roads, distance from agricultural lands, distance from railways, distance from oil fields, distance from groundwater, distance to the outfall, and distance from residential areas, were identified for selecting suitable sites for the WWTP.

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