

Evaluation of Landfill Sites as per Mysuru-Nanjangud Master Plan (2031) using Weighted Overlay Method in GIS Platform

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Abstract

The Mysuru-Nanjangud Master Plan 2031 designed to drive urban expansion by incorporating 117 villages, creating new residential layouts, promoting IT-BT, industrial estates, satellite townships, tourism, a peripheral ring road and a proposed film city near Mysuru Airport. These proposals could significantly increase waste generation and strain the existing landfill plant at Vidyaranya Puram, which processes 200 tons per day, even though the current waste volume exceeds 500 tons per day. The purpose of this study is to identify decentralized landfill sites for Mysuru-Nanjangud Master Plan-2031 that are both socioeconomically and environmentally acceptable using Weighted Overlay Method (WOM) in a GIS platform. Thematic layers included lithology, geomorphology, soil, slope, Land Use Land Cover (LULC), rainfall, groundwater, drainage, and lineaments, which were prepared using toposheets and satellite images. The landfill suitability map was prepared by overlaying all essential thematic layers and assigning weights as most suitable, moderately suitable, least suitable, and unsuitable. The result suggests that 39.25 sq.km was highly suitable, 222.28 sq.km was moderately suitable, 239.29 sq.km was least suitable and 6.419 sq.km of the area was unsuitable. This study underlines the importance of GIS-based technologies in selecting suitable landfill sites, which is consistent with its primary goal of identifying optimal locations.

Keywords: GIS, Landfill sites, LISS-IV, Mysuru-Nanjangud Master Plan-2031, WOM

1. Introduction

Landfills are engineered locations designed to hold and manage solid wastes, which play a crucial role in global waste management systems [1]. These sites are significant sources of methane (CH₄), a strong greenhouse gas, which might grow by up to 10% by 2025, if current trends continue [2]. Open dumping poses risks such as soil contamination, water pollution, and air quality degradation due to fire or decomposition [3]. Living near hazardous waste landfill sites can pose serious health hazards owing

to exposure to chemicals, pollutants, and contaminated resources [4]. However, their management differs greatly between countries due to disparities in regulations, technological capabilities, and environmental concerns [5]. Developing countries frequently have difficulties in implementing a modern waste management system due to financial constraints and limited infrastructure [6]. The world generates over 2 billion tons of municipal solid waste each year, with projections

indicating a 70% increase by 2050 [7]. Much of this growth is expected in developing countries, where waste management infrastructure is frequently inadequate [2] and [8].

Many regions, particularly those in the Global South, lack reliable waste collection and treatment services, forcing people to rely on open dumps or unmanaged landfills [8] and [9]. Inadequate regulations and enforcement limit the implementation of sustainable waste management practices [8] [9] and [10]. Waste pollution and mismanagement cost the global economy hundreds of billions of dollars per year [11] and [12]. Landfills include valuable materials that could have been repurposed or salvaged, adding to resource inefficiencies [2] and [8].

Municipal Solid Waste (MSW) is becoming increasingly prevalent in developing countries like India, particularly in large metropolitan industrial cities and towns of States such as Karnataka, Maharashtra, and Gujarat [13]. There is a remarkable difference between the amount of waste generated, collected, processed, and recycled that lies unmanaged in different parts of the city for months and years [14]. Over 64 million people in India reside near the 50 largest landfills, with low-income groups incurring disproportionate health hazards [15]. Only 21% of solid waste is processed nationally, with cities such as Ahmedabad depositing 4,200 metric tons per day at Pirana landfill, worsening leachate and methane risks [16]. Uncollected rubbish is frequently deposited on vacant land, adjacent to lakes and wetlands, or burned in residential areas.

Landfills like Mavallipura of Bengaluru intrude on peri-urban commons, disrupting livelihoods and destabilizing ecosystems [15] and [17]. Such activities offer major health concerns to residents and domestic animals, with children and elderly and pregnant women being the most affected [4]. As a result, deposited waste frequently clogs the drainage system, increasing the chances of floods and the harm it causes to life, public health, and property [18]. Even when waste is collected, it is frequently discarded in low-lying areas or at random locations throughout the city [19]. Properly managed landfills use methods such as gas recovery devices to limit methane emissions and their impact on climate change [10]. The primary objective of this study is to identify optimal landfill sites by Mysuru-Nanjangud Master plan 2031 adopted by the Mysuru Urban Development Authority (MUDA), Govt. of Karnataka [20].

2. Methodology

2.1 Mysuru-Nanjangud Master Plan-2031

It is a comprehensive urban development policy that will govern the orderly growth of the Mysuru-Nanjangud Local Planning Area (LPA) until 2031 [21]. The plan encompasses a total LPA of roughly 507.40 sq.km, which includes the rapidly urbanizing Mysuru city and its surrounding areas, as well as Nanjangud town [21] (Table 1). The plan seeks to portray Mysuru as an attractive investment destination, with a focus on non-polluting industries such as IT-BT, services, and tourism [22]. Special development regulations are suggested to preserve the city's rich and unique cultural legacy while also protecting natural elements such as water bodies, hills, and valleys. Major infrastructure proposals include the development of a Peripheral Ring Road (PRR) to control traffic, reduce congestion, and sustain the city's projected population growth, expected to double by 2031 [21]. Improved transportation links, such as mono/metro rail systems, are also considered.

The plan addresses the need for decentralized economic activity by proposing new district commercial centers and satellite townships to reduce congestion in the central business area and more fairly distributing growth. The master plan is structured into three volumes- data collection and analysis, draft proposals, and zoning with development control regulations, which ensure systematic implementation and monitoring. The plan is shaped by Mysuru's historical growth tendencies, current development demands, and estimates for the next two decades. It integrates state and regional policy and is overseen by the Karnataka Urban Development Department (KUDD) and the Mysuru Urban Development Authority (MUDA) [21]. The conservation of heritage monuments, the ecological buffer of Chamundi hills, protection of urban lakes and tanks, development of Nanjangud as a twin city of Mysuru, with dedicated industrial and residential zones, are all being considered through specific legislation. The Mysuru-Nanjangud Master Plan 2031 provides a robust framework for managing urbanization, protecting heritage and ecological assets, and promoting sustainable economic growth in the region [21]. This analysis highlights the importance of appropriate solid waste management infrastructure in the proposed sites to accommodate expected population increase and urban expansion in both Mysuru and Nanjangud.

Table 1: The brief demographic profile and MSWM of Mysuru and Nanjangud [21]

Items	Number/ Quantity	
	Mysuru	Nanjangud
Area	128.42 sq.km	14.765 sq.km
Wards	65	31
Zones	9	-
Door to door collection	100 (%)	100 (%)
Solid waste generation	300 g/ capita/ day	-
Segregation and Processing Plants	9 (8 Operational)	0
Waste Generation	402 TPD (tons per day)	28.5 TPD
Waste collected	394 TPD	-
Waste processed (Composting)	202 TPD	0
Waste processed (Decentralized Composting)	45-90 TPD	-
Inert rejects landfilled	90-100 TPD	-
Existing Landfill Site	Vidyaranya Puram (200 TDP), Kumbara Koppalu (02)	0
Proposed Site (110 acres)	Bettadabeedu Village, HD Kote Tq	Mahadevapura
Estimated Population (2031)		21,000,000
Estimated waste generation (2031)	630 T	33 MT

Table 2: The quantity of MSW generated from different Sources of Mysore city [26]

Sl. No	Name of the Wastes Sources	Number	Unit of generation per day	Estimated quantity (Tons/day)
1.	Domestic	938,386	360 gram/capita/day	338
2.	Commercial	20,329	1.0 kg/unit/day	20
3.	Hotel and Restaurant	716	30 kg/unit/day	21
4.	Marriage and Functional halls	124	50 kg/unit/day	6
5.	Street Sweeping			17
Total MSW generated per day in tons (includes areas covered beyond MCC limits)				402

2.2 Municipal Solid Waste Management (MSWM) in Mysuru

Mysuru is widely recognized as one of India's cleanest cities, largely due to its innovative and effective Municipal Solid Waste Management (MSWM) system [23] and [24]. The city produces around 450-500 tons of municipal solid waste per day, with 40-60% of which is organic waste [23] and [24] (Table 2). The Mysuru City Corporation (MCC) has implemented a combination of centralized and decentralized systems, focusing source separation, community engagement, and scientific processing methods [25]. Mysuru generates about 500 tons of solid waste every day, but its current waste processing infrastructure has struggled to keep up [23]. The central composting plant in Vidyaranya Puram was originally designed for 150 tons per day and later upgraded to 200 tons per day; however, this is still insufficient considering the city's current waste generation [23]. As a result, excess waste has been dumped at the site for over two decades, resulting in a vast buildup of about 0.6 megaton of legacy waste across 22 acres [26]. Current landfills may reach capacity faster, forcing reliance on temporary sites or illegal dumping, as observed around Mysuru lakes. Transporting waste to distant

landfills may raise costs and inefficiencies, as the study area may expand to 509 sq km (2031) from 92.21 sq km (1981) by integrating 117 villages into the Mysuru-Nanjangud Waste plan in 2031.

2.3 Description of the Study Area

The Mysuru-Nanjangud Master Plan 2031 encompasses a southern region of Karnataka state known for its rich cultural heritage and diverse environmental conditions [27] (Figure 1(a)). Mysuru is a prominent cultural and historical city, while Nanjangud is recognized for its agricultural and industrial activity. The region has a tropical monsoon climate, with scorching summers and moderate to heavy rainfall from June to September. Summer temperatures can reach 38⁰ Celsius, while winters are mild, with temperatures ranging from 15 to 30 degrees Celsius [28]. The perennial River Cauvery flows easterly in the north, while the River Kapila flows easterly in the south [28]. The study area has a mix of urban and rural populations, as well as a diverse range of industries [28]. Nanjangud is the second-highest tax-paying taluk after Bengaluru, collecting more than USD4.6 million in sales tax per year [28] and [29].

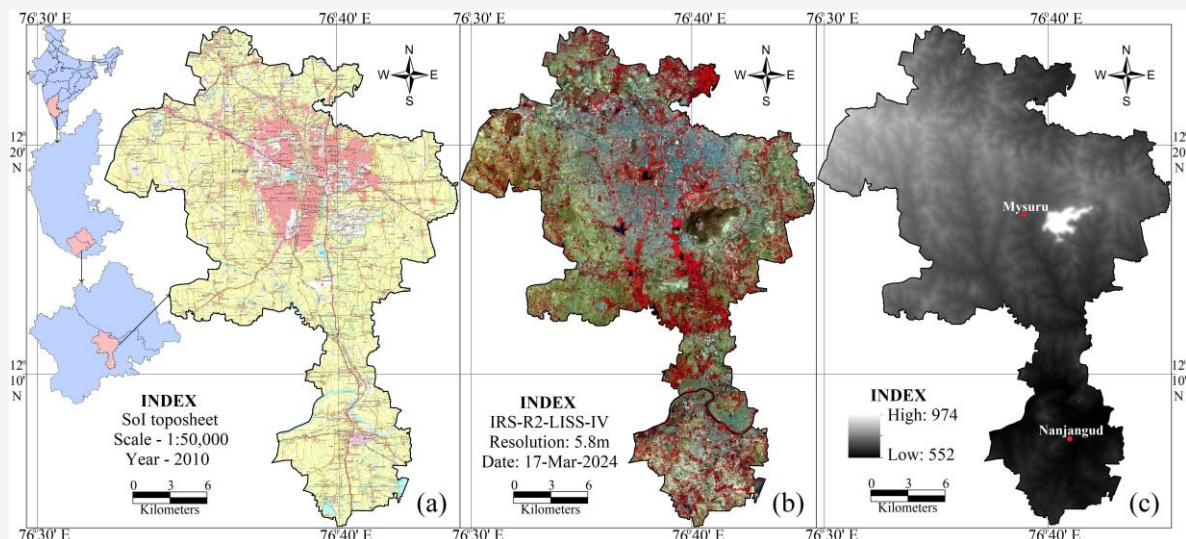


Figure 1: (a) Topographic map, (b) LISS-IV Satellite image, (c) Alos-Palsar DEM image

The lithology map is prepared using a 1:250,000 scale GSI quadrangle map that is overlaid on recent satellite data to update the lithological information [31]. The geomorphology map was prepared using a 1:250,000 scale geomorphological map of Karnataka and updated with LISS-IV imagery [30]. Soil textures were obtained from the National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) and the Karnataka State Remote Sensing Application Centre (KSRSAC), Mysuru [30]. A 5.8-meter spatial resolution LISS-IV image (Figure 1(b)) was (<https://bhoonidhi.nrsc.gov.in/bhoonidhi/index.html>) downloaded to create thematic layers such as lineaments and land use land cover (LULC) patterns [30]. Lineaments were extracted using RockWare software, while LULC was extracted using supervised classification in ArcMap v10.8.2 and verified through limited field visits. Alos-Palsar Digital Elevation Model (DEM) image was collected to study slope categories and drainage patterns [32] (Figure 1(c)). Isohyetal and groundwater depth maps were prepared in ArcMap v10.8.2 using annual average data of rainfall (2000-2020) and groundwater table (2001-2023) collected from District Groundwater Board, Mysuru city. These maps were classified into 4 zones of spatial distribution that influence landfill siting.

3. Results and Analysis

3.1 Lithology

Lithology is a fundamental criterion in landfill siting for leachate containment, site stability, and environmental protection. The Peninsular Gneissic Complex is the major rock type, consisting of granitic gneisses (coarse-grained, banded, and felsic) produced billions of years ago during intense igneous

activity [33] and [34]. Precambrian igneous and metamorphic rocks are exposed at the surface or beneath country rocks [33][35] and [36]. Amphibolites with pelitic/metapelitic schists occur at random, but migmatite, granodiorite, and tonalitic gneisses are extensively distributed (Figure 2(a)). Chamundi granite appears as a batholith at the center; while dykes (fine-grained, mafic, intrusive) are rare, indicating later magmatic intrusions, and tectonic activity [33]. Field studies have shown pink and gray granite in the north, as well as ultramafic bodies in the surrounding area. Hardrock formations such as granite, gneisses, and migmatites are preferred in landfill siting, since they provide better natural containment, stability and long-term environmental protection than other geological settings.

3.2 Geomorphology

It is divided into three geomorphological zones: ridge land, midland plateau, and low plain land, which are separated by conspicuous ridges that run west to east and north to south [37]. The underlying lithology shapes the city's topography, with historic monuments and urban development often aligned along ridgelines [37]. The study area is characterized as channel island, pediment, pediment inselberg complex, pediplain moderate/ shallow, residual hills, river, settlement and valley fill shallow (Figure 2(b)). The most dominating feature mapped was pediplain shallow, which was attributed to very good to moderate recharge zones, while structural hills and valleys had low occurrences [38] and [39]. The geography in the study area ranges from plain to undulating, with the major Cauvery River flowing in the north and the Kapila River in the south [39] and [40].

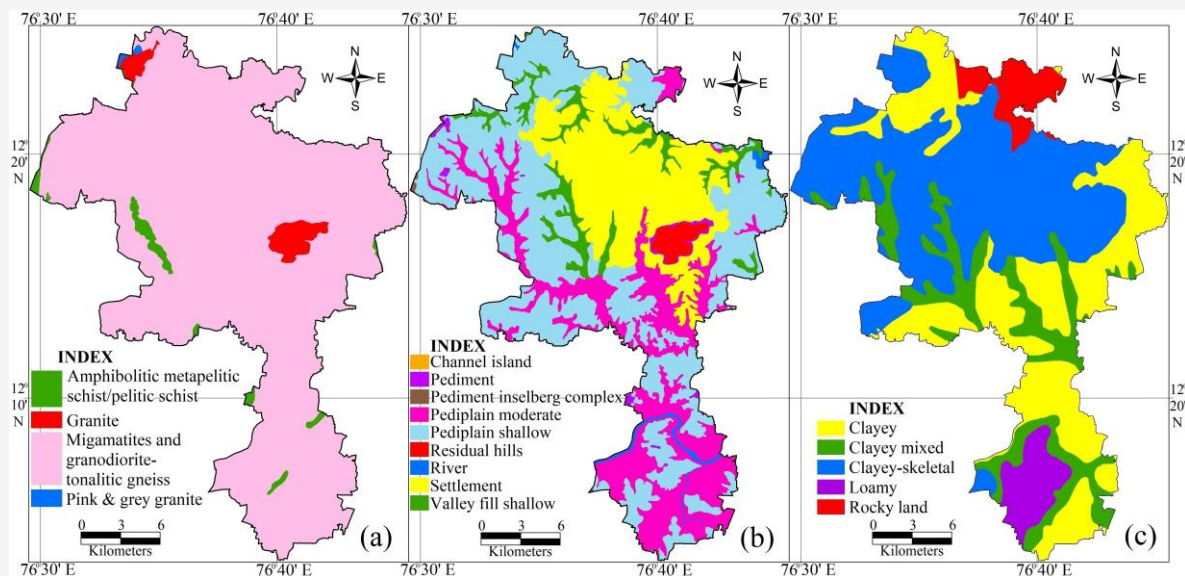


Figure 2: (a) Lithology, (b) Geomorphology, (c) Soil map

Granitic gneisses are geomorphic units that form a continuous range of significant hard surfaces and generally act as runoff [30]. Structural hills are made up of gneiss and schistose rocks, and they serve as a drainage zone with weak recharge conditions, making them excellent for landfill development. Geomorphological formations are prioritized in landfill sites, with a preference for stable, low-permeability, and well-drained landforms over steep, unstable, or flood-prone areas.

3.3 Soil

The soils of the study area are characterized by clay, clay-mixed, clay-skeletal, and loamy types, which are distributed depending on the geomorphology, local geology, and topographical position. Limited field visits are carried out at 15 random locations to ensure the validation of the geospatial thematic map and field observations. Clay type of soils is located on either side of perennial River Cauvery in the northern region and Kapila in the southern region. Clayey-skeletal type is noticed in low-lying areas, mainly in western parts and entire Mysuru settlement zone. Clayey-mixed soils are noticed on pediplains of Kadakola village, whereas loamy types are restricted to industrial-settlement zones of Hullahalli village and Nanjangud town. Clay, clayey-mixed, clayey-skeletal soils are less permeable, have high moisture retention, and are fertile (Figure 2(c)) [33]. Clay and clayey-mixed soils are both deep and moderately well-drained and have a minor salt. These mixed soils are found in discrete areas near the contact of schist and other basic intrusions [23]. Clayey-skeletal soil is associated with deep and moderately gravelly clay

soil on gently sloping and has slightly eroded in particles. Loamy soils are non-expansive (low plasticity) and appropriate for most construction activities [41]. Clayey soils are ideal for landfill siting due to their superior natural containment capabilities and regulatory approval. Clayey-mixed and clayey-skeletal soils are less desirable due to their increased permeability can compromise landfill siting and environmental protection. Clay and other low-permeability soils are recommended, as they act as natural barriers, reducing leachate flow into the underlying ground and groundwater [42].

3.4 Slope

Slope is a critical topographic factor in landfill siting due to its influence on stability, drainage, construction feasibility, and environmental safety [43]. In the plain land areas of Mysuru, the dominant or master slope runs from the central part towards both the north and south [38]. Mysore city lies within the Cauvery River Basin, exhibiting a steeper slope, classified into upper ridge steep slope land, mid steep slope land, and valley land, based on elevation and gradient parameters. The general topographic elevation across the study area ranges from approximately 1021 meters above mean sea level in the central region (atop Chamundi hill) to 681 meters near Nanjangud. The Chamundi hill region features steeper and more dissected slopes than the central plains and lowlands. Large portions of the study area, particularly the southern regions, fall into nearly level (0-3°) range. These lands are generally flat or gently sloping eastward and are best suited for urban development and agriculture.

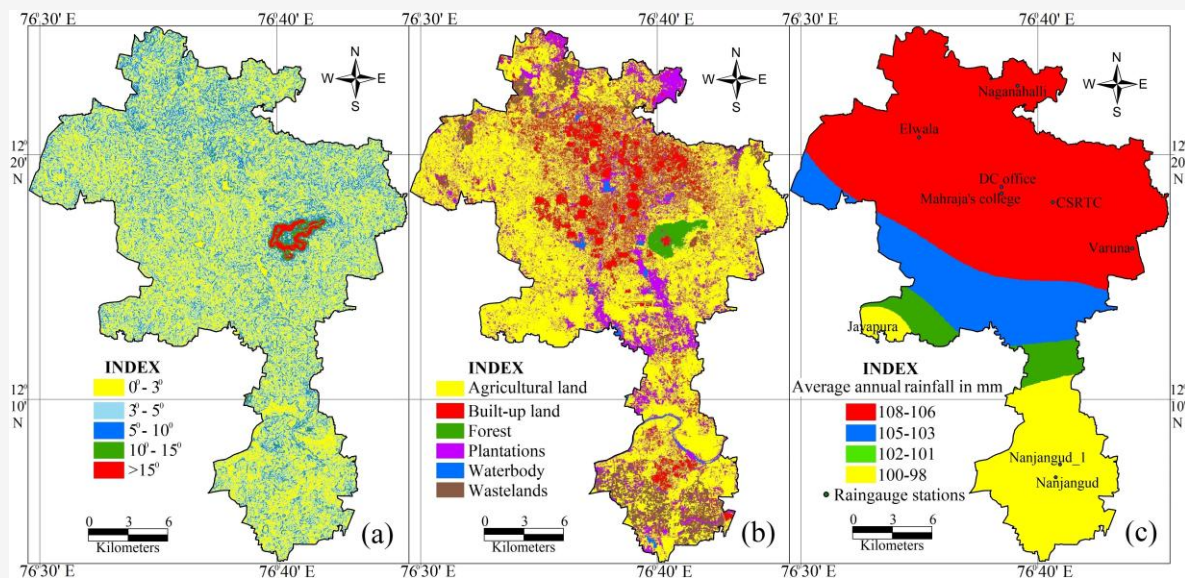


Figure 3: (a) Slope, (b) LULC, (c) Rainfall map

The very gentle slope ($3-5^{\circ}$) class includes gently inclined zones that are often found between northeast and northern regions of the study area. Gentle slopes ($5-10^{\circ}$) can be found in some peripheral zones and at the base of hills. These areas have moderate development potential but may require drainage management. Moderate slopes ($10-15^{\circ}$) are more pronounced slopes, particularly along ridges or the foothills of Chamundi hill, and may pose some obstacles for landfill siting [38]. Strong slope ($>15^{\circ}$) is limited to the steepest sections of Chamundi hills and isolated ridges, making it unsuitable for landfill sites due to overflow and higher intensity of rainwater. The study's slope ranged from 0 to >15 degrees (Figure 3(a)) and the flat terrains with less than 10-degree slope were found to be the most acceptable and highly considered for landfill sites.

3.5 Land Use Land Cover

LULC is one of the most essential factors for landfill sites since it has a direct impact on environmental, social, and operational consequences [44]. Extensive field visits were carried out in Mysuru, which has a complex land use and land cover (LULC) pattern formed by rapid urbanization and historical planning. Vast agricultural areas are dominated greatly in the peripheral and rural parts of Mysuru taluk, notably in the west (Bogadi, Yelwala, Belawadi zones) and east (behind Chamundi hills) [36]. However, this share is gradually reducing as urbanization convert agricultural land into built-up regions containing Govt. buildings, educational institutions, and healthcare facilities (Figure 3(b)). Residential areas of Mysuru city dominate the developed core and planned extensions, with a mix of dense urban

neighborhoods and vacant plots within layouts. Mysuru city is showing increasing built-up land owing to population growth and urban expansion, especially on either side of national, state, and district highways. The industrial zones of Mysuru city and Nanjangud town are in the north-western region and the southern region, respectively. Parks, playgrounds, and green belts contribute to Mysore's planned green spaces observed most in central regions, as do natural forests, notably around Chamundi hill and some protected areas. The forest zones of Chamundi hills have shown a decline associated with the constructions of Malls, Parking areas, and residential layouts at the foot of the hills, which have reduced green cover and disturbed wildlife habitats. Lakes, tanks, and wetlands can be found at random throughout Mysuru city and the northern region along KRS irrigated channels. Productive lands with significant socio-economic values, such as residential, commercial, industrial, agricultural, lakes, tourists/protected monuments, and forest covers, were excluded, while grasslands and barren lands were highly included in landfill site selection to avoid environmental damage, public health, and social risks.

3.6 Rainfall

It plays an important role in landfill site selection due to its influence on leachate generation, flood risk, and environmental pollution [45]. High rainfall increases the quantity of water infiltrating landfill sites, resulting in more leachate formation, which may later migrate into surrounding soil and groundwater [46]. This poses significant environmental and health risks if rainfall is not considered during landfill siting.

Table 3: Rainfall and Groundwater depth data of the study area

Annual Average Rainfall data from 2000-2020				
Sl. No	Rain gauge stations	Latitude	Longitude	Average
1.	Mysore (DC Office)	12.3097	76.6406	107.514
2.	Mysore (Maharaja's College)	12.3052	76.6406	107.533
3.	CSRTC	12.2990	76.6760	107.514
4.	Elwala	12.3437	76.5834	107.514
5.	Varuna	12.2670	76.7310	107.514
6.	Naganahalli	12.3787	76.6521	107.514
7.	Jayapura	12.2044	76.5538	99.396
8.	Nanjangud	12.1110	76.6770	98.362
9.	Nanjangud 1	12.1199	76.6800	98.43

Annual Average Groundwater Depth from 2001-2023				
Sl. No	Observation well points	Latitude	Longitude	Average
1.	Alanahalli	12.2993	76.7014	16.233
2.	Bhogadi	12.3050	76.5964	16.005
3.	Elwala	12.3562	76.5441	7.892
4.	Jayapura	12.2047	76.5541	25.616
5.	Kadakola	12.1933	76.6653	8.897
6.	Siddalingapura	12.3653	76.6613	3.470
7.	Debur	12.1198	76.6433	4.737
8.	Hullahalli	12.0986	76.5556	8.593
9.	Nanjangud	12.1231	76.5556	3.351

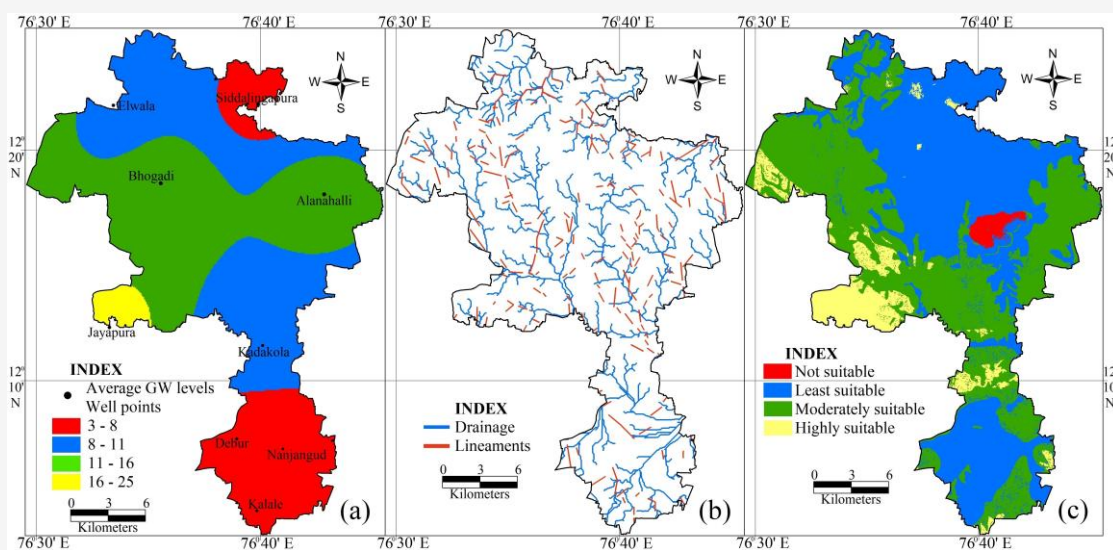


Figure 4: (a) Groundwater Table map, (b) Drainage overlaid on Lineaments, (c) Landfill site suitability map using Weighted Overlay Method (WOM)

About 20 years (2000-2020) rainfall data from 9 representative rain gauge stations were analyzed and mapped for annual average rainfall variations (Figure 3(c) and Table 3). The rainfall data ranged from 98 to 108 mm and were classified into 4 zones from lower to higher rainfall areas. Lower rainfall zones of 98 to 100mm were preferred and assigned higher scoring in the present study to reduce the water infiltration amount [35].

3.7 Groundwater Depth

Groundwater depth is a highly weighted criterion in landfill siting, often scoring among the most

important environmental factors [47]. A 20-year (2001-2023) groundwater depth data from 9 observation well points were collected from the District Groundwater Board, Mysuru city (Figure 4(a) and Table 3).

Groundwater depths are shallow near perennial surface water bodies and in topographically low areas [48]. The average annual groundwater depth from 2001-2023 was analyzed, which ranged from 3 to 25 mts below mean sea level. The map was classified into 4 zones of unsuitable (3-8mts), least suitable (8-11mts), moderately suitable (11-16mts), and most suitable levels (16-25mts). Sites with deeper

groundwater levels are targeted in the present study to reduce contamination risk. Before selecting a landfill site, detailed subsurface investigations must be conducted to assess groundwater depth, soil permeability, and hydrogeological conditions.

3.8 Drainage Overlaid on Lineaments

The study area is endowed with perennial River Cauvery, which drains major parts with a dendritic type of drainage pattern. Drainage and lineaments are basic geological structures that may be easily identified in satellite imagery and help to understand the nature of lithology. Most of the lineaments are found in the northern and southern directions, acting as a natural recharge structure, infiltration and seepage zones that fills the groundwater table via gentle slope (Figure 4(b)). Overlaying drainage patterns on lineaments demark groundwater circulation, flow direction and recharge/seepage zones, all of which may have an impact on landfill site suitability.

4. Weighted Overlay Method (WOM)

Weighted overlay analysis is a widely used spatial decision-making technique in GIS for determining suitable locations for landfill sites. Analytical Hierarchy Process (AHP) was involved earlier in the present study, but the results could achieve only a 3.29 sq.km area as most suitable, even after many trials and errors. While WOM effectively revealed a nearly 40 sq.km area as most suitable for landfill. All

thematic layers were converted into raster layers, which represent key aspects influencing landfill suitability. Each layer was classed using a common suitability rating of score '4' for highly suitable to '1' for unsuitable based on its influence on landfill suitability [49] (Table 4). The reclassified and weighted layers are combined to produce a composite suitability map that divides the area into different suitability classes, ranging from highly suitable to unsuitable for landfill development. The score for the criteria and sub-criteria has been incorporated into the thematic layers, resulting in the production of a landfill suitability map in GIS utilizing the Weighted Overlay Method (WOM) [27].

The proposed landfill sites were located further away from densely populated/urban areas to prevent air, soil, and water pollution, noise, communicable diseases, and fires, all of which could pose public health issues [50]. Wastelands/bare lands in the outskirts of the ring road were regarded as the most important among the other LULC classes, since landfill sites should ideally be positioned away from built-up regions, natural vegetation, water bodies, and agricultural land, all of which are prevalent in the study area. Lineament, slope, highways, and rivers are other important considerations when establishing ratings. The final composite map identified 39.25 sq.km as most suitable region, 222.28 sq.km as moderately acceptable areas, 239.29 sq.km as least suitable, and 6.419 sq.km as unsuitable areas for landfill zoning in our study (Figure 4(c) and Table 5).

Table 4: Assigned weights for each factor using Weighted Overlay Method

Sl. No	Influencing Factors	Class features	Score	Justification
1	Lithology	Pink & grey granite	4	Hard, less permeable rocks which minimize leachate infiltration
2		Migmatites and granodiorite-tonalitic gneiss	4	
3		Amphibolitic metapelitic schist/pelitic schist, calc-silicate rock	3	Moderately permeable and moderate risk for groundwater
4		Chamundi granite	1	Contain fractures and weathered zones, which later may show higher leachate risks
5	Geomorphology	Pediment	4	Stable and gently sloping terrains, which are ideal for landfill construction
6		Pediment inselberg complex	4	
7		Pediplain shallow	4	
8		Pediplain moderate	3	
9		Channel island	1	Proximity to water or habitation is environmentally hazardous and socially unacceptable
10		Reservoir	1	
11		Residual hills	1	
12		Rever/stream	1	
13		Settlement	1	
14		Pediplain moderate under canal command	1	Proximity to water or habitation is environmentally hazardous and socially unacceptable
15		Pediplain shallow under canal command	1	

16	Soil types	Clayey	4	High absorption and low permeability, which are excellent for isolating landfill contaminants
17		Clayey-skeletal	4	
18		Rocky land	4	
19		Loamy	3	
20		Clayey mixed	2	Provide better natural barriers, but require supplementation with engineered solutions for full leachate contamination
21	Slope categories	Gentle slope (0 – 3 degrees)	4	Easy to manage with preferable lower erosion risks
22		Moderate slope (3 - 5 degrees)	4	
23		Nearly level (5 - 10 degrees)	3	
24		Strong slope (10 – 15 degrees)	2	
25		Very strong slope (>15 degrees)	1	
26	LULC	Wasteland	4	Ideal for landfill with minimal social opposition
27		Agricultural land	1	
28		Built-up land	1	
29		Forest	1	
30		Plantations	1	
31		Waterbody	1	
32	Rainfall (mm)	98-100	4	Less leachate generation
33		101-102	3	
34		103-105	2	
35		106-108	1	
36	Groundwater depth (m)	16-25	4	Low contamination risks
37		11-16	3	
38		8-11	2	
39		3-8	1	
				Poses a grave threat to groundwater quality and public health likely by leachate contamination

Table 5: Area coverage of each Prospective Landfill site for Mysuru-Nanjangud Master Plan (2031)

Sl. No	Suitable class	Score	Area Coverage (sq.km.)
1.	Highly suitable	4	39.25
2.	Moderately suitable	3	222.28
3.	Least suitable	2	239.29
4.	Unsuitable	1	6.419

5. Discussions

Globally, solid waste generation rates are increasing, with a footprint of 0.75 kg/person/day estimated in 2016 [51]. Annual solid waste generation is expected to increase by 70% between 2016 and 2050 due to rapid population growth and urbanization [52] and [53]. Even countries with a high percentage of reuse and recycling face a challenge in disposing of leftover waste, as a final disposal site is always rare and debated. Only 22–28% of wastes in India are treated and recycled, and the rest of these are thrown as waste dumps in dumping yards [54]. In India, various-sized cities are forced to dump their solid waste without a recycling plant, which urges the need for greater landfill space [47].

In most cases, solid waste from the cities was dumped in the low-lying wetland area and burned in an unprofessional manner [47]. Unscientific disposal of solid wastes can result in a variety of aesthetic and environmental challenges, including the spread of illness and major health issues due to burning. Recent research has also shown that open dumping sites are a significant source of greenhouse gas emissions.

In Mysuru, improper solid waste management has historically led to localized air and water pollution, especially near the now-defunct Vidyananya Puram landfill, which had been a source of public complaints due to odour, mosquito breeding, and groundwater contamination concerns. Communities

living near these areas, often from lower socio-economic groups, bear the brunt of health risks like respiratory problems from open burning, gastrointestinal diseases from contaminated water, and psychological stress due to foul odour and visual air pollution [48]. In Nanjangud, the industrial estates and adjacent residential clusters add another layer of complexity. The lack of proper separation between industrial and municipal waste streams is posing chronic health risks to surrounding communities, especially in zones without sufficient healthcare infrastructure. The municipal solid waste collected in Mysuru is transferred to the existing landfill site (Excel compost plant) located in Sewage Farm in Vidyaranya Puram, near Chamundi hills, as there is no treatment unit located in Nanjangud.

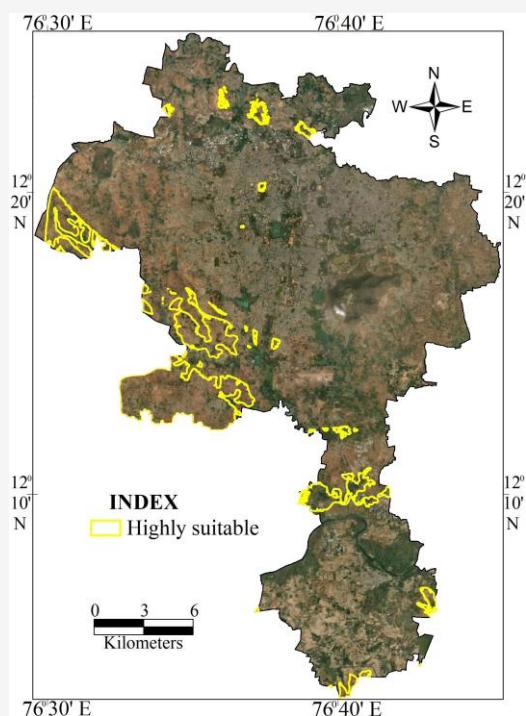


Figure 5: Landfill site suitability map overlaid on Google Earth Imagery

The existing compost has a maximum capacity of 200 tons per day and is located on a major lineament that has caused groundwater pollution [23]. The non-degradable waste that remains after composting is then thrown on surrounding open land. For the sake of determining the adequacy of the composting facility and the engineering of a sanitary landfill site, per capita municipal solid waste generation is assumed to be 300g/capita/day [21].

The predicted population in the study area is 23,77,000 (23.77 lakhs) in 2031, with an estimated 630 tons of wastes/day due to the rapid expansion of new residential, commercial, and industrial zones

[21]. The Mysuru-Nanjangud Master Plan 2031 is designed to handle strong urban growth and investment in areas such as IT-BT, services, tourism, commercial centers, and satellite townships, all of which result in increasing Municipal Solid Waste (MSW) generation [21].

Sites with impermeable lithology are considered to reduce the risk of leachate migration and groundwater contamination. Areas with stable, gently sloping topography are preferred, as they reduce erosion and slope instability while facilitating construction and operation. Clayey soils with limited permeability are more desirable, since they act as natural barriers, lowering the risk of groundwater contamination. Slope stability is also crucial for the safe functioning and long-term integrity of the landfill; hence, gentler slopes typically of 0-10 degrees are most considered in this study. LULC data ensures that landfill sites are compatible with nearby land uses and avoid sensitive regions such as residential zones, agricultural land, and protected natural ecosystems (Chamundi hill).

To reduce health, social, and ecological consequences, new landfill sites are chosen distant from densely populated or environmentally sensitive locations. Lower rainfall areas are chosen for erosion prevention and the construction of drainage and leachate management systems. The depth of groundwater is an important factor; thus, zones with deeper groundwater levels are evaluated to reduce the risk of pollution. Drainage systems and lineaments (faults) hamper proper landfill siting, increasing the risk of groundwater contamination. Drainage and lineaments are also kept away from the newly proposed landfill sites to preserve groundwater, surface water, and public health by reducing the possibility of leachate escape and environmental contamination.

The environmental characteristics of a landfill site are more critical than simply its distance from populated or sensitive areas. The suitable landfill sites identified in the south-western parts are located between 1 km and 8 km from Mysuru ring road and running on the National Highway (NH), which eases the transportation. The large volumes of waste can be transported easily on NH, especially over long distances to major landfills due to their all-weather accessibility, connectivity, speed, and year-round reliability. The best landfill sites were found at lower elevations, gentle slopes, low-taxable fields, and significant distances from roads, rivers, and residential areas. These identified areas are judged most suited when meteorological, geological, and environmental parameters are considered. Finally, this study emphasizes the scientific selection of landfill sites to replace existing landfill sites for smart

solid waste management, considering public health and environmental concerns.

6. Conclusions

With rapid urbanization in Mysuru and the industrial expansion of Nanjangud, there is an urgent need to transition from conventional, unscientific waste disposal practices to a more systematic and sustainable approach. The selection of suitable landfill sites is a critical component of integrated solid waste management, requiring a comprehensive evaluation of environmental, social, and regulatory factors to mitigate ecological risks and ensure long-term viability.

In this context, the application of GIS-based WOM emerges as a robust, flexible, and transparent decision-support tool. Unlike pairwise AHP models, the GIS-WOM enables multi-criteria spatial analysis that integrates diverse datasets, allowing for the identification of optimal landfill locations within the Mysuru-Nanjangud Master Plan for the year 2031. Additionally, the establishment of decentralized composting facilities on the periphery of the study area provides a cost-effective solution by reducing waste transportation distances and associated operational costs. Implementing alternate-day collection schedules for dry and wet waste can significantly enhance resource recovery efficiency by maintaining material purity and reducing contamination at the source. Together, these strategies represent a shift toward sustainable and spatially informed waste management, reinforcing the value of geospatial technologies in urban planning and environmental protection.

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