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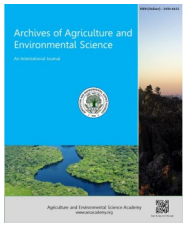

ORIGINAL RESEARCH ARTICLE

Spatial distribution of solid waste disposal sites in Allahabad city, Uttar Pradesh, India using GIS approach

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ABSTRACT

The present investigation was conducted to study the spatial distribution of solid waste disposal sites in Allahabad city, Uttar Pradesh, India using GIS approach. In this investigation site determination for the transfer of strong waste is performed utilizing geographical information system (GIS), the analytical hierarchy process (AHP), and remote detecting strategies for the Allahabad city. In GIS, every single possible prerequisite are at first indicated, spatial information coordinated and overlaid and in view of the last yield got appropriate naturally kindhearted destinations for squander transfer are recognized. Analytical hierarchy process give a deliberate way to deal with evaluating and incorporating the effects of different variables, including a few levels for surveying and coordinating the effects of different components, including a few levels dependent and free, qualitative and quantitative data. Remote Sensing pictures and Survey of India topomaps were utilized to extricate data on badlands and other lands utilize highlights, geography, hydro-geomorphology, seepage, street systems and slant of the region. Various tools and software's were used for the study like Arc GIS 10.1 LIS III image, SRTM DATA, ERDAS imagine etc. The results of the present study indicated that maps of land use cover/land use change/ satellite imageries and GIS tool were benefited for characterizing appropriate plans and methodologies for effective solid waste management plan in metropolitan cities. Therefore, GIS tools, satellite imageries, maps must be considered for the implementation of solid waste management policies.

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INTRODUCTION

India is the world's second greatest populated country after China with population of 1.21 billion (insights 2011) and that infers India contain17.5% of the aggregate people, is a place that is known for physical grouped assortment, climatic assortment, geographic arranged assortment, ecological nice assortment, social grouped assortment, social arranged assortment and etymological grouped assortment (Al-Hanbali *et al.,* 2011; Yadav, 2013). The yearly improvement rate of urban populace in India is 3.35% (Census of India, 2011). The degree of people living in urban zones has extended from 17.35% (1951) to 31.2% (2011) (Karadimas *et al.,* 2004; Census, 2011; Yogeshwar, 2012). The quick and consistent advancement in urban masses prompts an enthusiastic augmentation in urban solid wastage, with a genuine monetary and biological impact. In case this situation isn't dealt with in a proper route inside time then it would be immediate more unfortunate results on an overall level and besides causing biological tainting and have ended up being persevering issues for mankind. In this manner solid waste organization (Solid waste management) is one of the major thing basic organizations to be given by metropolitan specialists in India, the current circumstance gives rather an ungraceful picture the extent that organization movement as affirm by non-appearance of attractive general waste organization instrument (Khajuria *et al.,* 2011). Show level of organization in various urban reaches is low to the point that there is a hazard to the general prosperity particularly and normal quality when all is said in done (Akolkar, 2005; Shahabi, 2012). Strong squanders are the natural and inorganic waste materials, for example, item bundling, grass clippings, furniture, apparel, bottles, kitchen won't, paper, apparatuses, paint jars, batteries, and so forth., created in a general public, which don't for the most part convey any an incentive to the main user(s) (Kamboj and Choudhary, 2013). Strong waste administration has turned into a noteworthy test in urban regions all through the world. Without a successful and productive strong waste administration program, the waste created from different human exercises, both mechanical and local, can bring about wellbeing perils and negatively affect the earth and people. Geographic information system (GIS) may adequately be utilized to choose the best possible site areas arranged by their needs (Sharholy *et al.,* 2007; Nishanth, 2010). The spatial information might be put away as various topical layers and controlled to determine new usable data utilizing the current

ones in GIS. When all is said in done, GIS is intended to acknowledge extensive volumes of spatial information got from various sources and to effectively store, recover, control, examine them. Different fields including remote detecting, cadastral mapping, cartography, structural designing, geology, soil science, studying and photogrammetry can be utilized as a contribution to GIS (Idris *et al.,* 2004; Sharholy *et al.,* 2007; Suchitra, 2007; Sener, 2010). Aside from managing various given essential spatial substances and measures of their area in the earth space, it likewise manages a large group of non-spatial component of these elements (Nas *et al.,* 2010; Nishanth, 2010). Subsequently, a GIS speaks to a personal computer based data framework for dealing with both spatial information and non-spatial information got from an assortment of sources. Further, GIS licenses not just the mechanized mapping or show of areas of highlights yet in addition give a social database ability to recording and breaking down expressive trademark about highlights. Information from the GIS might be recovered by determining either area or trait recovery criteria. Accordingly GIS can fill in as a proving ground for contemplating, arranging, ecological procedures, breaking down the after effects of patterns' expecting the conceivable consequences of arranging choices and administration of assets. The GIS may likewise be utilized for formative arranging in an area (Khajuria *et al.,* 2011; Kumar, 2011; Chaudhary and Das, 2012; Mohammedshum, 2014). The use of present day strategy like GIS will help the organizers and leaders in accomplishing an adjusted advancement in Allahabad city. Squander administration is one of the most concerning issues confronted around the world. This is a direct result of the fast development in the populace and urbanization, which comes about into the decline of the non-inexhaustible assets and transfer of emanating and dangerous waste aimlessly posturing dangers to the presence of people. The adequacy of strong waste transfer relies on the choice of appropriate site and there are a few issues that have affect for site choice. Site choice is hence a standout amongst the most basic zones of metropolitan arranging including a multidisciplinary approach and an expansive range of thought (Chaudhary and Das, 2012; Mohammedshum, 2014). The after effect of the investigation can be exceptionally useful amid the acquisition procedure of transfer locales; that is, the concerned specialists can spare time and expenses related with assessment and assessment for bidders whose destinations are situated far outside the scope of conceivably distinguished territories. Keeping in view, the present investigation was carried out to study the spatial distribution of solid waste dumping sites in Allahabad city, Uttar Pradesh, India for the effective solid waste management policies using GIS approach.

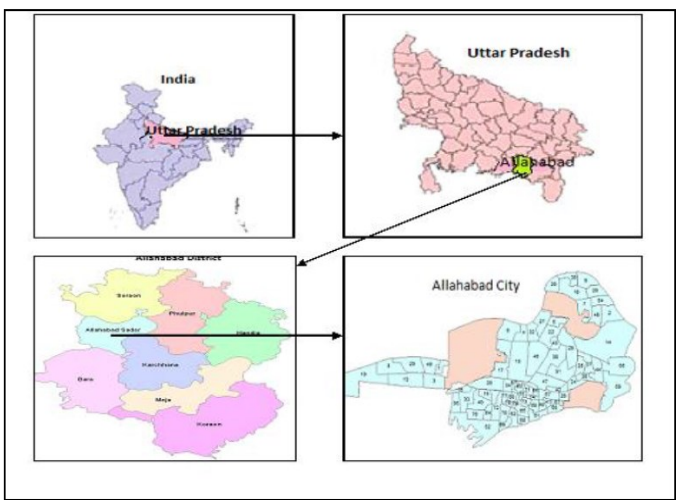

Figure 1. *Geographical location of the study area.*

MATERIALS AND METHODS

Study area description: Allahabad is a major city of Uttar Pradesh falls in the administrative headquarters of the Allahabad district (Figure 1). It is considered holy because the sacred rivers Ganga-Yamuna-Saraswati unite here. It is situated at 25.25° North latitude and 81.58° East longitude. It is the seventh most populous city of Uttar Pradesh and was ranked 130th fastest-growing city in the world in 2011. The metropolitan city covers an area of 63.07sq km and the population of the city as per census 2011 is 11,12,544. The topography of Allahabad city is flat and the temperature varies between 47.8°C in summer to lowest 4.1°C in winter. The city receives on an average annual rainfall of 930mm.

Collection of data: For present study, LISS-III of year 2005 has been used. Resolution of image is 30 meter that obtained from NRSC, SRTM (DEM) of year 2005 has been used, resolution of which is 3 arc second (90 m), Esri's ArcGIS a geographical information system (GIS) for working with maps and geographic information, ERDAS IMAGINE is a remote sensing application with raster graphics editor abilities designed by ERDAS for geospatial applications, Land-use / land-cover map, road map, topographic map, drainage map, and other relevant maps were obtained from relevant agencies including Nagar Nigam Allahabad, Survey of India (Figure 2).

Data used: A number of digital data were used for the analysis. Most of the layers were available for the whole of Allahabad. Therefore, the layers had first to be clipped in the GIS to the extent of the Allahabad city. The projection of all layers had to be set to WGS_84 Map Grid to ensure consistency and enable the overlay of several layers.

Toposheet (Survey of India): For the present study Survey of India (SOI) topographical map G44P15 at the scale 1:50,000 have been used (Figure 2). From the Toposheet creates the shape file of road, river and railway network using the Arc GIS 10.1 software.

LISS-III Satellite image: For present study, LISS-III of year 2005 has been used. Resolution of image is 30 meter that obtained from NRSC (Figure 2).

Digital elevation model (SRTM data): For present study, SRTM (DEM) of year 2005 has been used. Resolution of this image is 3 arc second (90 m). SRTM data in 3 arc sec (90m) resolution can be found in either 'research' or 'finished' grade (http://srtm.usgs.gov).

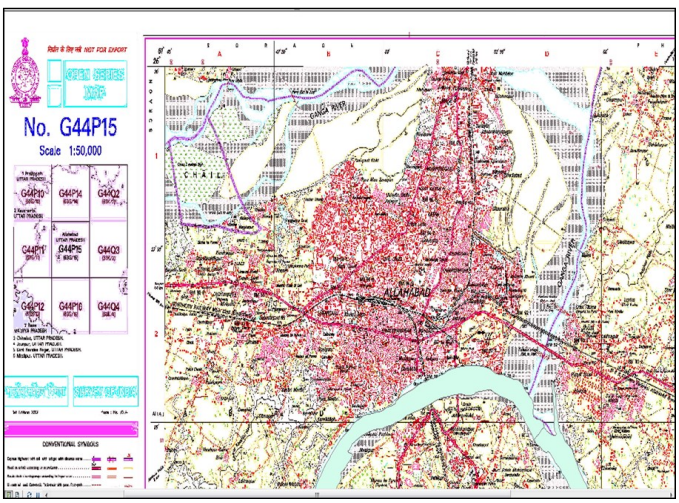

Figure 2. *Toposheet of the Allahabad city (Source: Nagar Nigam Allahabad).*

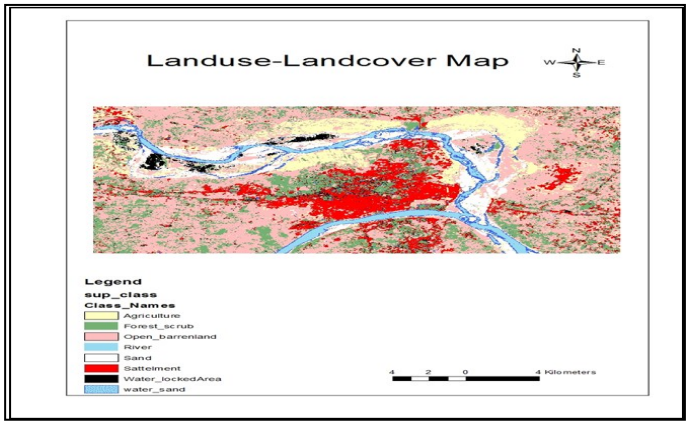

Figure 3. *Land use-Land cover map of Allahabad city.*

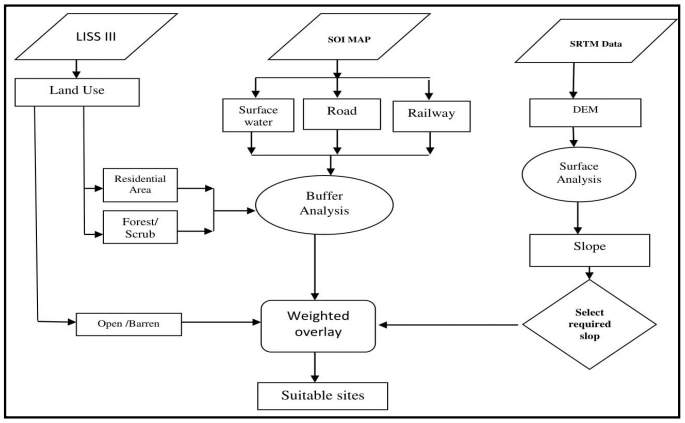

Figure 4. *Flow chart for selection of suitable dumping site.*

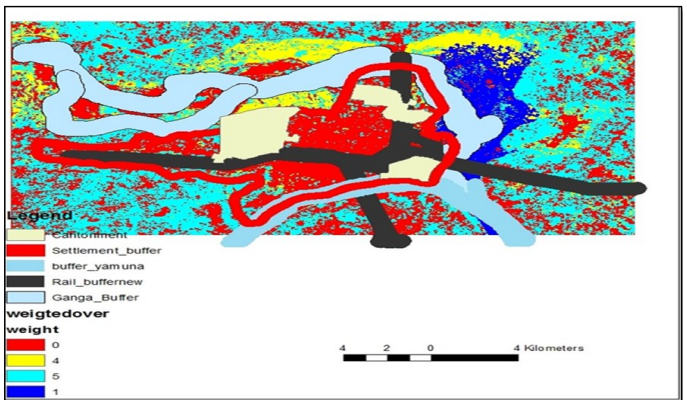

Figure 5. *Site suitability map for waste disposal.*

RESULTS AND DISCUSSION

The table 1 and figure 3, 4 and 5 describes various land use pattern and land cover scheme classification. It clearly indicated that open or barren land can only be used for the waste disposal using scientific measures. Most importantly the solid waste disposal sites must be far away from the water sources like rivers and lakes, agricultural land, forest land and residential areas. Akolkar (2005) also suggested the importance of land use cover for the effective management of solid waste. The present examination was intended to consider the criteria's impacting the propriety of a site for misuse organization, arrive use/arrive cover examination of study zone, develop an appropriate GIS show for site decision for dumping goals, dismember the diverse maps delivered using GIS show for site decision for brief exchange regions. In light of these objectives the basic conclusions are drawn from the present examination and are shown as the parts that can impact the sensibility of a site for dumping solid waste has been pondered are: site constrain, arrive cover, isolate from Airports, expel from surface water, adjacent geography, soils, climate, dubious zones, neighborhood generally differed vegetation, expel from normally delicate or protected regions expel from urban zones and people. The eventual outcomes of land use and arrive cover examination exhibit that ebb and flow arrive classes in the examination domain are: created arrive (Settlement), agribusiness arrive, sand, water, and timberland/spotless and open/ destroy arrive. Nas *et al.* (2010) also suggested the importance of GIS and multi-criteria evaluation for the selection of municipal solid waste (MSW) landfill site for Konya, Turkey.

Moreover, site suitability map for waste disposal (Figure 5) also benefited the municipal corporations and local governance for the effective utilization of resources. Khajuria *et al.* (2011) and Shahabi (2012) reported that site suitability map and GIS application were found helpful for estimating the current status of municipal solid waste management system. These results may be profitable for characterizing appropriate plans and methodologies with a specific end goal to achieve a balanced and reasonable progression in the zone. The site assurance is a critical propel when masterminding solid waste land application contrive. By using the support examination and weighted overlay technique a fitting site for dumping districts has been perceived and showed up in diagram. Khajuria *et al.* (2011) reported the current status of municipal solid waste management system in Chandigarh City, India using GIS tools. Yogeshwar (2012) and Yadav (2013) are also in favoured the use of GIS techniques and remote sensing in the effective solid waste management.

Table 1. Land use/ land cover classification scheme (Anderson *et al.*, 1976).

Land use/land cover	Description
Built-up land (Settlement)	Areas that have been populated with residential, commercial, industrial, transportation and facilities.
Agriculture land	Area covered with crop fields, pasture, nurseries, horticulture area and bare fields.
Sand	Area covered by silica
Water	Area covered with water such as rivers and lakes ,reservoirs, streams
Forest or scrub land	Area covered with mature trees, shrubby plants and other plants growing close together.
Open / Barren land	Area covered with Dry salt flats, Beaches, Bare exposed rock, gravel pits

Table 2. Result of accuracy generated in supervised classification.

Class Name	Reference totals	Classified totals	Number correct	Producers accuracy	Users accuracy
Water sand	0	0	0	--	--
Water logged area	0	0	0	---	---
Agriculture	3	2	2	66.67%	100.00%
Forest scrub	7	6	5	71.43%	83.33%
Forest scrub	7	6	5	71.43%	83.33%
Sand	3	3	3	100.00%	100.00%
Open barren land	19	21	19	100.00%	90.48%
Settlement	3	4	3	100.00%	75.00%
River	1	1	1	100.00%	100.00%
Totals	36	37	33		
Overall classification accuracy =	**89.19%**				

Conclusions

The present study concluded that GIS tools are very important for the selection of suitable sites for solid waste disposal. The results of the present study benefited for characterizing appropriate plans and methodologies for effective solid waste management plan in metropolitan cities. Therefore, GIS tools, satellite imageries, maps must be considered for the implementation of solid waste management policies.

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