CHAPTER 5

SITE SUITABILITY ANALYSIS USING GIS & RIAM

5.1 GENERAL

Solid waste management is a burning problem all over the world. The combination of solid waste management problems like declining disposal site capacity, ever increasing generation of wastes to be disposed, environmental problems at many existing solid waste disposal facilities, and an influx of out-of-state waste create multitude of problems for the administrators.

Waste management cannot be viewed in isolation from other environmental issues including conservation of resources and environmental pollution. In other words, the quantities and types of waste produced are dependent on the products bought, the length of time for which those products are used and the manner in which they are dealt with when there is no further use for them. Sustainable waste management requires the concerted and continuous effort of all of the city’s waste producers, irrespective of the quantities of waste they produce. Each of us thus, has a specific responsibility to introduce an element of sustainability into the way resources are used, as well as into consumption patterns and waste management choices.

The present study deals only with solid waste, liquid and gaseous emissions are not addressed. Information is provided on the current systems in place for the collection, recovery and disposal of waste in the city. Detailed statistics on the quantities of individual waste streams and fractions produced in Hosur town are also provided.
5.1.1 Criteria for selection of Landfill

The criteria for selection of Landfill site as CPCB are carried out by step by step procedure by evaluating the alternatives. The various steps to identify site for landfill are shown in flow chart below as CPCB guides.

STEP 1

Mapping of constraints
Selection of Potential sites

STEP 2

Identification of comparison potential sites
Short listing of Potential sites

STEP 3

Preliminary survey (Walk over survey)
Preliminary Assessment of physical & Environmental conditions of the site and surrounding Area.
Short listing of Potential sites

STEP 4

Site Investigation on preferred sites
Investigation Includes detailed survey of
• Geology of the area
• Hydrology
• Climatologically condition
• Land use
• Social etc.

STEP 5

Ranking of sites
Attribute Ranking

Final decision

Figure 5.1 Site selection for Landfill
The factors considered while selecting a disposal site includes

1. Available land area
2. Impact of processing and resource recovery
3. Haul distance
4. Soil conditions & Topography
5. Climatologically conditions
6. Surface water Hydrology
7. Geologic and Hydrological conditions
8. Local environmental conditions
9. Potential ultimate uses for the completed site

The factors in siting of waste disposal facility includes

1. The accessibility to the site like distance from the highway and distance from the origin of waste etc.
2. Receptor related factors like Human habitation and locality, drinking water sources, Agriculture value, public utility value, Historical or Archeological monuments, public accessibility and land use designation etc.
3. The environmental related factors like, air quality, soil & water quality, safety, hydrological investigations, distance to nearest surface water etc.
4. The socio-economic factors like job opportunity, vision and health.
5. The waste management practices related to waste quality per day and life of site.

The Important goals of siting facility are

- To minimize health risk
- To minimize adverse effect of environmental impact
- To minimize costs of the development, construction and operation and
- To maximize public acceptability of the project

### 5.2 SOLID WASTE MANAGEMENT BY USING GIS

SWM involves managing activities associated with the generation, collection, transportation and disposal of solid waste in an environmentally
compatible manner, adopting principles of economy, aesthetics, energy and conservation.

With our country's population crossing one billion mark (Census of India, 2001) and combined with unplanned development and urbanization, one thing is for certain; an enormous amount of waste is going to be generated. The situation is no better at present, the urban population was 217 million in 1991 and the total quantity of solid waste generated in urban areas was estimated at 20.71 million tones.

5.3 NEED OF MODELING FOR SITING USING GIS

Geographical Information System Technique can be used in giving a better solution by considering all the parameters required. GIS is a digital data base management system designed to manage large volumes of spatially distributed data from a variety of sources and process suitability modeling.

In the first part of the process of data storage, editing, transformations and integration into a GIS is explained. In the second section, the process of retrieving useful information from attribute or geometrical data (querying) is outlined. The third section gives an overview of the spatial functions developed to support spatial analysis. The different steps involved conducting spatial analyses successfully are reviewed in the fourth section. The final section deals with a technique called 'Multi-Criteria Analysis', which can assist in the process of spatial decision-making. A GIS is a powerful and useful tool for spatial analysis. However, the GIS user must remain vigilant. Selecting and using the inappropriate techniques and functions or using inaccurate data may negatively influence the end result of the analysis.
Thus, the purpose of this study is to demonstrate the use of GIS and Remote sensing techniques to identify appropriate areas that are suitable for reasonable, convenient, and administratively transparent waste-disposal sites in Hosur.

5.4 DATA AND SOFTWARE USED

5.4.1 Data used

In the study IRS-P6 LISS-IV, data were used. The area under the study is covered in Survey of India topo sheets. ArcGIS 9.2 software was used for mapping and analysis.

The analysis of the study is to identify the suitable site for solid waste disposal areas in the Hosur Union. Conventional methods require extensive and intensive field survey, and preliminary investigation on various geological parameters. This is a time consuming exercise involving more workforce, energy and cost. The change in the proposals, if any, suggested would require the repetition of the exercise, which would take considerable time. This could be avoided, if Geographical Information System is utilized in identifying the site.

The spatial modeling for siting landfills in GIS has been categorized into Data collection, preliminary analysis and preparation of the decision hierarchy for landfill siting. Identification of potential landfill sites. The methodology adopted involves the preparation of thematic map, like Geomorphology, Land use / Land cover, Slope, Drainage density.
5.5 PREPARATION OF THEMATIC MAPS

Thematic maps like geomorphology map, land use/land cover maps were prepared using IRS-P6 LISS IV data and slope prepared from Arc GIS software.

5.5.1 Geomorphology Map

Geomorphology maps help to identify the various geomorphic units. Shallow pediments and pediments are the results of denudation landforms. The thickness and intensity of these land forms vary depending upon the slope and structural disturbance of the area. The geomorphology map is shown in Figure 5.2.

5.5.1.1 Buried Pediment

These landforms are erosional geomorphic features and have developed by the process of weathering of the hills, having a thin veneer of deposition adjacent to high relief outcrops. If the pediments are covered by alluvium or weathered material, they are termed buried pediments. The rock cut plain erosional surfaces occurs adjoining structural hills / denudation hills / residual hills and are known as pediments when their dimensions are small and as pedi-plain when they extend for larger regions. Sometimes these are covered with thin veneer of alluvium / Aeolian sand and according to their dimensions are identifying as buried pediments or buried pedi-plains. Buried pedi-plains occur on both sides of the streams. Buried pediments are basically the inclined rocky surfaces as extensions of ridges over which the alluvium and Aeolian sand have been deposited.
5.5.1.2 Denudation Hill

Topography is rugged and soil is poorly developed. Most of rainfall goes as surface run-off. Some amount of water retained as temporary storage in filtered through joints and fractures emerges in the form of seasonal springs and seepages. From groundwater point of view, this zone is not of any significance, except for the need for optimal, scientific tapping of the springs on mountain slopes.

5.5.1.3 Pediment- rocky

These landforms are erosional geomorphic features and have developed by the process of weathering of the hills, having a thin veneer of deposition adjacent to high relief outcrops. If the pediments are covered by alluvium or weathered material, they are termed buried pediments. These buried pediments have a medium tone on black and white imagery and a very light gray tone on FCC. The groundwater prospects are good because thickness is more than 20 meters.

5.5.1.4 Structural Hill

This unit in tertiary age sedimentary rocks also forms dissected relief with structural, strike parallel hills, and valleys with hogback ridges, and domination of surface run-off. Part of the rainfall gets intercepted and evapo-transpirated by forest covers. After rains, some of the water in filtered into the dipping Boulder conglomerates and sandstone beds reappear as seepages down dip along bedding planes, and on lower slopes.

Groundwater prospects are extremely poor. Locally, dug-wells having shallow water levels, tap limited groundwater held along wide, braided channel deposits, many of which deplete in summer months. Some of the
water infiltrated into wide channel beds move as under flow and eventually recharge the alluvial fan zone. In this zone structure is identifiable and denudation activity is still playing a major role. Numerous joints and lineaments are present as result erosion is taking place along these lines and narrow valleys have been formed. Valleys in this area are V-shaped to round. Steep slope is very common in this unit.

5.5.1.5 Residual Hills

A number of isolated hills of different dimensions varying from a couple of kilometers to a few hundred meters across occur all along the foot slopes of hills. There is also an isolated residual hill forming the hills. These hills are mostly of Pre Cambrian origin. The residual hills and the adjoining pediment zones provide the necessary forest green cover to an otherwise predominantly agricultural land use in the valley. Since these hills occupy a considerable area, they spatially provide a good source of groundwater recharge because of interception of rain by thick vegetation, stream bed infiltration and the slow recharge into the piedmont deposits.
Source: IRS-P6 LISS IV Satellite data

**Figure 5.2 Geomorphology**

Source: IRS-P6 LISS IV Satellite data

**Figure 5.3 Land Use / Land cover map**
5.5.2 Land use / Land cover

The land use / land cover pattern of a region is an outcome of both natural and socio-economic factors and their utilization by man in time and space. Land is becoming a scarce commodity due to immense agricultural and demographic pressure. Hence, information on land use / land cover and possibilities for their optimal use is essential for the selection, planning and implementation of land uses schemes to meet the increasing demands for basic human needs and welfare. Figure 5.3 shows the land use and land cover map.

Increasing human interventions and unfavorable bio-climatic environment has led to transformation of large tracts of land into wastelands. Satellite remote sensing play an important role in generating information about the latest land use-land cover pattern in an area and its temporal changes through times. The information being in digital form can be brought under Geographical Information System (GIS) to provide a suitable platform for data analysis, update and retrieval.

5.5.3 Slope

Slope map was generated using elevation information derived from SOI topographic sheets on 1: 50,000 scale using GIS techniques and it is classified into different categories like very high, high, medium, gentle slope, in that gentle slope preferred for suitable site for solid waste dumping site and more weight age assigned to gentle slope. Slope map shown in Figure 5.4.
5.5.4 Drainage Density

In the study area all the streams are digitized finally the density is calculated using the ARC GIS software. The drainage density shown in Figure 5.5

\[ D_d = \frac{\text{Total stream length}}{\text{Total area}} \]
5.6 WEIGHTED OVERLAY ANALYSIS

Weighted overlay is a technique for applying a common measurement scale of values to diverse and dissimilar inputs in order to create an integrated analysis.

Weighted overlay only accepts integer raster as input, such as a raster of land use or soil types. Continuous (floating point) raster must be reclassified to integer before they can be used. Generally, the values of continuous raster are grouped into ranges, such as for slope, or Euclidean distance outputs. Each range must be assigned a single value before it can be used in the weighted overlay tool. One can either not worry about the value
assigned to each range (but note the range of values the new value corresponds to), and assign weights to the cell values in the weighted overlay dialog box later, or we can assign weights at the time of reclassifying, then with the correct evaluation scale chosen, simply add the raster to the weighted overlay dialog box. The cells in the raster will already be set according to suitability (or preference, or risk, or some similarly unifying scale). The output raster can be weighed by importance and added to produce an output raster.

5.7 THE ROLE OF RS AND GIS IN SWM

In the present study it was tried to find out the potential waste disposal sites using remote sensing and GIS techniques for Hosur municipality. Selection of suitable sites for waste disposal is based on several factors. GIS technology using weighted overlay analysis help to select the possible suitable solid waste disposal sites and are categorized in to very high, high, medium and gentle slope. And more weightage assigned to gentle slope and gentle slope preferred for suitable site for solid waste dumping site.

On the basis of integration of various parameters IRS-P6, LISS IV imagery and GIS as a tool have been found to be very useful for the interpretation and identification of solid waste disposal site. Thus with the use of these technologies management of municipal waste will no longer be a problem for city administrators.

Urban solid waste management needs careful considerations. This problem has become as one of the most serious environmental problems in municipal authorities in developing countries like India. In the present work an attempt is also made to identify most suitable sites for municipal solid waste land filling, using inputs from Remote Sensing & Global positioning system (GPS) and analysis using GIS tools.
Remote sensing is one of the excellent tools for inventory and analysis of environment and its resources, owing to its unique ability of providing the synoptic view of a large area of the earth’s surfaces and its capacity of repetitive coverage. Its multispectral capability provides appropriate contrast between various natural features where as its repetitive coverage provides information on the dynamic changes taking place over the earth surface and the natural environment (Navalgund and Kasturirangan, 1983). Technological development in computer science has introduced geographic information system (GIS) as an innovative tool in landfill process (Kontos et al., 2003). GIS combines spatial data (maps, aerial photographs, satellite images) with the other quantitative, qualitative and descriptive information databases. When remotely sensed data are combined with other landscape variables organized with in a GIS environment provide an excellent frame work for data capture, storage, synthesis, measurement and analysis. For assessing a site as a possible location for solid waste land filling, several environmental and political factors and legislations should be considered (Savage et al., 1998).

The role of Geographic Information Systems (GIS) in solid waste management is very large as many aspects of its planning and operations are highly dependent on spatial data. GIS is a tool that not only reduces time and cost of the site selection but also provides a digital data bank for future monitoring program of the site (Miles and Ho, 1999). The methodology utilizes that GIS to evaluate the entire region for the analysis of landfill site suitability is based on certain evaluation criteria and are selected according to study area’s local characteristics (Ozeair and Mohesn, 2009).
5.7.1 Preparation of thematic maps and weightage assignment

Selection of suitable sites for waste disposal is based on several factors. It involves preparation of weighted spatial maps and overlaying analysis in GIS environment (Nishant et al., 2010). In the present study, thematic layers have been generated from different primary sources like SOI Topographical maps and satellite images. Various spatial parameters involved in the selection of SW (solid waste) disposal site like geomorphology, landuse, drainage and slope have been prepared. These maps have been projected using UTM WGS 84 projection system. Each map is verified with the sufficient field collected through GPS measurements for achieving better accuracy. Later each thematic map is reclassified by assigning weightage values to different classes.

5.7.2 Weighted overlay analysis

The overlaying of weighted thematic maps has helped to identify the possible suitable solid waste disposal sites. The thematic layers have been subjected into overlay analysis using simple Boolean operation and the suitable classes have been superimposed for deriving three types of land suitability classes. They are highly suitable, moderately suitable and less suitable. Among these categories, the sites which are within highly suitable buffer zones are selected for the disposal of solid wastes.

5.7.3 Theme wise suitability of different classes in the study area

The land suitability for solid waste dumping is as follows:

**Geomorphology**

Highly suitable - Denudational hill, structural hill  
Moderate - Denudational slope, shallow pediment  
Not suitable - Flood plain
Land use/Land cover
Highly suitable - Barren land and rocky waste
Moderate - Scrub land
Not suitable - All other categories

Drainage Density
Highly suitable - low density
Moderate - Moderate density
Not suitable - High density

Distance from the drainage
Highly suitable - 2000-3000 m 1000-2000 m
Moderate - 500-1000 m
Not suitable - 0-500 m

Slope
Highly suitable - 0-10°
Moderate - 10-20°
Not suitable - above 20°

South-west and northern parts of the study area is characterized by the low drainage density (0-0.4) and slope (< 10°) values. The barren and rocky wastes of these parts with landforms like denudational hills, structural hills and shallow pediments are suggested for solid waste disposal. Such sites having areal extent more than 5 square kilometers are available in Nagaondapalli, Belagondapalli, Achattipalli regions. Since both drainage density and slope are low, the possibility of transport and spread of solid waste to the surrounding and distant regions during rainy season is very less.
Further this may help in reducing the clogging of natural drains thereby significantly minimizing the chances of storm-water flooding. The above areas contain non porous sedimentary rocks and igneous granitic rocks. The terrain topography is very hard with compact soils. This reduces the draining of solid waste into sub surface layers. The vegetation cover is very low in these areas and restricted sparsely distributed thorny bushes and patches of grasses. The above suggested areas are completely devoid of settlements.

Thus geoinformatics tools have offered sophisticated spatial analyses by the use of vector and raster based data for an overall evaluation of the study region. GIS has helped for integrating spatial information from different sources and supporting strategic planning and decision making. Multi criteria analyses have helped to make a more realistic representation of the real world, allowing a more rational approach to problems and cost efficient decision making.

5.8 RAPID IMPACT ASSESSMENT MATRIX

The Rapid Impact Assessment Matrix (RIAM) is based on the standard important assessment criteria, as well as the semi-quantitative values. For each of these criteria are collected to provide an accurate and independent score for each condition. The impact of project activities is evaluated against the environmental components and individual scores are arrived based on the site condition which provides a measure of the impact expected from the component.

Four stages of environmental impact assessment are:

- Brain storm (Cognitive condition: Collection of information by observation / interview / photos)
- Prioritize positive and negative potential impacts (based on the environmental components designed in RIAM)
• Evaluate against the environmental components (based on standard definition of the important assessment criteria as well as the means by which semi-quantitative values for each of these criteria can be collected to provide independent score for each condition)
• Environmental Assessment (charts and results)

5.8.1 Physical / Chemical (PC)

Includes all physical and chemical aspects of the environment, including non-renewable natural resources (no-biological) and the degradation of the physical environment through pollution.

5.8.2 Biological / Ecological (BE)

Includes all biological aspects of the environment, including renewable natural resources, conservation of the biodiversity, interaction between species and pollution of the biosphere.

5.8.3 Sociological / Cultural (SC)

Includes all human aspects of the environment, including social subjects that affect the individuals and the communities; with cultural aspects, it is included the inheritance conservation and human development.

5.8.4 Economical / Operational (EO)

To identify qualitatively the economical consequences of environmental change, temporary and permanent, as well as the complexities of administration of the projects inside the context of the activity project.
5.8.5 Assessment Criteria

The important assessment criteria are discussed as below.

**Group A**: Criteria that are of importance to the condition, and which can individually change the score obtained. A measure of the importance of the relevance condition (A1) is evaluated according to the space borders or interest of the man that will be affected. The magnitude (A2) is defined as a measure of the scale of benefit / damage of an impact or condition.

**Group B**: Criteria that are of value to the situation, but should not be individually capable of changing the score obtained. This permanent criterion (B1) defines if a condition is temporary or permanent, and if it should only be seen as a measure of the temporary state of the condition.

The reversibility criterion (B2) defines if a condition can be changed and if it can be seen as a measure of control on effect of the condition. This cumulative criterion (B3), where the effect of a condition will have a single direct impact or there will be a cumulative effect during the course of time, or, on the other hand, a synergetic effect with other conditions. Theoretically, the cumulative criterion is the mean used to judge the sustainability of a condition, and it should not be confused with a permanent situation or reversible condition. After necessary calculations, the RIAM classifies the degree of the damage or benefit according following classifications and assessment criteria.
Table 5.1 Description of class on RIAM

<table>
<thead>
<tr>
<th>Environmental classification (ES)</th>
<th>Value of the class</th>
<th>Value of the class (Numerical)</th>
<th>Description of the class</th>
</tr>
</thead>
<tbody>
<tr>
<td>72 – 108</td>
<td>E</td>
<td>5</td>
<td>Extremely Positive Impact</td>
</tr>
<tr>
<td>36 – 71</td>
<td>D</td>
<td>4</td>
<td>Significantly Positive Impact</td>
</tr>
<tr>
<td>19 – 35</td>
<td>C</td>
<td>3</td>
<td>Moderately Positive Impact</td>
</tr>
<tr>
<td>10 – 18</td>
<td>B</td>
<td>2</td>
<td>Less Positive Impact</td>
</tr>
<tr>
<td>1 – 9</td>
<td>A</td>
<td>1</td>
<td>Reduced Positive Impact</td>
</tr>
<tr>
<td>0</td>
<td>N</td>
<td>0</td>
<td>No alteration</td>
</tr>
<tr>
<td>1 – 9</td>
<td>-A</td>
<td>-1</td>
<td>Reduced Negative Impact</td>
</tr>
<tr>
<td>10 – 18</td>
<td>-B</td>
<td>-2</td>
<td>Less Negative Impact</td>
</tr>
<tr>
<td>19 – 35</td>
<td>-C</td>
<td>-3</td>
<td>Moderately Negative Impact</td>
</tr>
<tr>
<td>36 – 71</td>
<td>-D</td>
<td>-4</td>
<td>Significantly Negative Impact</td>
</tr>
<tr>
<td>72 – 108</td>
<td>-E</td>
<td>-5</td>
<td>Extremely Negative Impact</td>
</tr>
</tbody>
</table>
Table 5.2 Assessment criteria (Pastakia & Jensen, 1998)

<table>
<thead>
<tr>
<th>Group</th>
<th>Category</th>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td></td>
<td>4</td>
<td>International importance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>National importance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Outside of local condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Local condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>Not important</td>
</tr>
<tr>
<td>A2</td>
<td></td>
<td>+3</td>
<td>Major positive benefits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+2</td>
<td>Significant improvement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+1</td>
<td>Improvement in “Status Quo”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>No change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-1</td>
<td>Negative change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-2</td>
<td>Significant negative effect</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-3</td>
<td>Major negative effect</td>
</tr>
<tr>
<td>B1</td>
<td></td>
<td>1</td>
<td>No change / not applicable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Temporary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Permanent</td>
</tr>
<tr>
<td>B2</td>
<td></td>
<td>1</td>
<td>No change / not applicable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Reversible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Irreversible</td>
</tr>
<tr>
<td>B3</td>
<td></td>
<td>1</td>
<td>No change / not applicable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Single / Non-Cumulative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Cumulative / Synergistic</td>
</tr>
</tbody>
</table>

The value allotted to each of these groups of criteria is determined by the use of a series of simple formulae. The process can be expressed (Pastakia, 1998):
If \((a1) * (a2) = aT\) and \((b1) + (b2) + (b3) = bT\) (5.1)

then, \((aT) * (bT) = ES\) (1) \hspace{1cm} (5.2)

Where,

- \((a1)\) and \((a2)\) are the individual criteria scores for group \((A)\)
- \((b1)\) to \((b3)\) are the individual criteria scores for group \((B)\)
- \(aT\) is the result of multiplication of all \((A)\) scores
- \(bT\) is the result of summation of all \((B)\) scores
- \(ES\) is the Environmental Score for the condition.

5.8.6 RIAM Input

![RIAM Input](image)

Figure 5.6 Description of Environmental Impact Assessment
Figure 5.7 Description of option list of impact assessment

Figure 5.8 Component list under landfill option
Figure 5.9 Weight age of components for RIAM analysis

5.8.7 RIAM Output

Table 5.3 RIAM output related to all components and Score summary

<table>
<thead>
<tr>
<th>Physical and chemical components (PC)</th>
<th>ES</th>
<th>RE</th>
<th>A1</th>
<th>A2</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC1 geophysical</td>
<td>-16</td>
<td>A1</td>
<td>4</td>
<td>-1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>PC2 soil</td>
<td>16</td>
<td>B</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>PC3 water quality</td>
<td>40</td>
<td>D</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>PC4 climate</td>
<td>0</td>
<td>N</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PC5 air quality</td>
<td>-40</td>
<td>D</td>
<td>4</td>
<td>-2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>PC6 environmental noise</td>
<td>24</td>
<td>C</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PC7 rainfall</td>
<td>12</td>
<td>B</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PC8 loss of forest</td>
<td>36</td>
<td>D</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>PC9 solid waste</td>
<td>72</td>
<td>E</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
### Biological and ecological components (EE)

<table>
<thead>
<tr>
<th>Components</th>
<th>ES</th>
<th>RB</th>
<th>A1</th>
<th>A2</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE1 vegetation</td>
<td>42</td>
<td>D</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>BE2 habitat lose</td>
<td>-20</td>
<td>-C</td>
<td>2</td>
<td>-2</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>BE3 house sanitation</td>
<td>8</td>
<td>A</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>BE4 sewage</td>
<td>0</td>
<td>N</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>BE5 foul smell</td>
<td>-7</td>
<td>-A</td>
<td>1</td>
<td>-1</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

### Sociological and cultural components (SC)

<table>
<thead>
<tr>
<th>Components</th>
<th>ES</th>
<th>RB</th>
<th>A1</th>
<th>A2</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC1 culture</td>
<td>6</td>
<td>A</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>SC2 education</td>
<td>42</td>
<td>D</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>SC3 science</td>
<td>28</td>
<td>C</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>SC4 mosquitoes</td>
<td>-28</td>
<td>-C</td>
<td>2</td>
<td>-2</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>SC5 house flies</td>
<td>-28</td>
<td>-C</td>
<td>2</td>
<td>-2</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

### Economical and operational components (EO)

<table>
<thead>
<tr>
<th>Components</th>
<th>ES</th>
<th>RB</th>
<th>A1</th>
<th>A2</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>EO1 job</td>
<td>16</td>
<td>B</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>EO2 route</td>
<td>8</td>
<td>A</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>EO3 tourism</td>
<td>12</td>
<td>B</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

### Summary of scores

<table>
<thead>
<tr>
<th>Range</th>
<th>-108</th>
<th>-71</th>
<th>-35</th>
<th>-18</th>
<th>-9</th>
<th>0</th>
<th>1</th>
<th>10</th>
<th>19</th>
<th>36</th>
<th>72</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>-E</td>
<td>-D</td>
<td>-C</td>
<td>-B</td>
<td>-A</td>
<td>N</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
</tr>
<tr>
<td>PC</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>BE</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>SC</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>EO</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>
5.8.8 Analysis and results from RIAM

Major impacts by physical and chemical components in land filling, plays a primary role. The physical components involved under this category are detailed as PC1, PC2, PC3…..etc. assessment criteria are assigned by groups and scale effect according to national and local importance. From the result, air quality need to be considered up to medium scale. Major direct impacts like biological and ecological components are detailed by suitable scale for the assessment of site suitability. Form the result, foul smell play a considerable role while site selection. Assessment criteria related to sociological and cultural components are semi-direct approach, in which houseflies and mosquito’s components play a vital role. Economical & operational components are indirect approach in national importance in which not much affects our results. The overall summary arrived for all the collected PC, BE, SC and EO are stated, in which the majority shows, the present proposed study will provide a positive impact in the levels B&D category.

**Landfill**

![Cumulative environmental score for identified components](image)

*Figure 5.10 Cumulative environmental score for identified components*
Figure 5.11  Impact of physical /chemical components and biological / ecological components

Figure 5.12  Impact of Social & cultural components and Environmental & Operational components
From the RIAM analysis, the cumulative environmental score for all the components for landfill is arrived in graphical form. It is clear that B&D category of impact is being generated by all the components. Therefore, the cumulative impact score represent the present solid waste disposed form is significantly positive impact (D). Physical and chemical components play a role at the level of B&D category. The biological and ecological components under medium scale an average impact either positive or negative. Therefore biological components like foul smell, sewage are considerable impact in negative side which needs to be taking into consideration, while designing the landfill. In sociological, housefly and other insects need to take care while design the optimum layout for the landfill consideration. All in average value but in negative category where observed. Negative impact to negative activity which shows best for the present condition. The Environmental & operational components play a positive impact under the class of A&B on whole, The present study have the dominant class of B&D in which the positive impacts are clearly superimposed.
By RIAM analysis, cumulatively positive impact where observed from analysis. The present site selection is well suitable for the proposed land fill. The overall class observed from RIAM software is under B to D moderately positive (Significantly).