

SITE SELECTION FOR NEW DESALINATION PLANT AND PLANNING AN OPTIMAL WATER DISTRIBUTION NETWORK IN TUTICORIN TALUK

***Miss.V.Sahana Devi, **Mrs.G.Devi.**

**PG student: Department of Civil Engineering,*

***Assistant Professor: Department of Civil Engineering,
Anna University Regional Campus
Tirunelveli ,India*

ABSTRACT

The project aims to propose a suitable site for a new desalination plant in Tuticorin taluk and to prepare an Optimal pipeline route from the selected desalination site to the existing water distribution network. Data collection and database creation for the study area was made in GIS. Various thematic layers such as Land use/Land cover (LULC) map, Slope map, Drainage map, Soil map and Road network map were prepared. Also, the existing water supply network in the study area is extracted from TWAD Board data and GCP points taken along the pipeline alignment. The created input layers are reclassified, weighted and then overlaid to find the best site. A new optimal pipeline route is selected based on Multi Criteria Evaluation and Least Cost Path Analysis (LCPA).

Keywords: *desalination; overlay; site selection; least cost path; optimal route*

INTRODUCTION

Industrial water demand will be on rise in the coming decades with the pace of industrial development. The main source of water for the industrial sector are surface water and ground water. Choice of source of water depends on the following factors. They are availability of sufficient quantity, quality of water, possibility of regular supply and the cost of extraction of water from the source. Tuticorin is an industrial city located on the South Eastern part of Tamil Nadu. The major industries in the study area are Tuticorin Thermal power Station (TTPS), Southern Petrochemical Industries Corporation (SPIC), Tuticorin Alkali Chemicals (TAC), Heavy Water Plant (HWP), SIPCOT, Sterlite and Zirconium. The current water requirements of those industries are met by 20 MGD Water Supply Scheme of TWAD Board. It earns a revenue of more than Rs.20 Crores per year, contributing to the national infrastructure development. The scheme is in use from 1973. It has served for more than 40 years. The source of this scheme is River Tamirabarani. Water is being pumped from Srivaikundam Anicut through closed conduit system. The total designed capacity is 20 MGD. Design duration of operation is 24 hours per day.

Due to various reasons, now the scheme could produce only a quantity of 10.5 MGD to 12 MGD. Hence supplying the full allotted quantity to the beneficiaries has become very difficult. That is, the existing water supply scheme does not meet the water demand of the industries in Tuticorin

taluk. Any interruption in the performance of this scheme will have its heavy financial impact in the economy of the city. Being in the coastal sector, desalination of seawater can be adopted as an alternative solution. It will increase the production of industries which in turn increase the economy of the city. Additional freshwater demand for industrial needs necessitated the proposal for setting up of a desalination plant at Tuticorin taluk, for which a suitable site has to be selected using Remote Sensing and GIS techniques.

AIM AND OBJECTIVES

The aim of the project is to find a suitable site for a new desalination plant and to plan an optimal pipeline route from selected site to the existing water distribution network using Remote Sensing and GIS.

- N. To gather data and information required.
- O. To prepare database for the study area and create various thematic layers in GIS.
- P. To propose a suitable site for a new desalination plant using Site Suitability Analysis.
- Q. To extract the existing water supply network supplying water to various industries in Tuticorin taluk.
- R. To create cost raster datasets and perform Least Cost Path Analysis to find an optimal pipeline route.

STUDY AREA

The study area is selected as Tuticorin taluk in Tuticorin district, Tamil Nadu. It lies between 8°35'0" N to 8°55'0" N latitude and 77°55'0" E to 78°10'0" E longitude, situated in the extreme South-Eastern corner of Tamil Nadu, India. It has a flat terrain. The soil is mostly clay sandy. The city has loose soil with thorny shrubs in the north and salt pans in the south. A maximum temperature of about 39 °C and a minimum temperature of 32 °C is observed in that area. Being in the coastal sector, it has a very high humidity.

MATERIALS AND SOFTWARES USED

Land use/land cover map was prepared with 6 classes such as Waterbody, Built-up land, Agriculture land, Barren land, Scrubland and Saltpan, from Landsat-8 data by performing Supervised Classification in ERDAS IMAGINE 2014. Slope map was prepared with 5 classes from Cartosat-1 DEM data using slope tool in the Spatial Analyst toolbox in Arc GIS 10.1. The Slope tool calculates the maximum rate of change from a cell to its neighbours, which typically indicates the topography of that area. Drainage map was prepared with 2 classes from Cartosat-1 DEM data by using the hydrology tool in ArcGIS 10.1. Class 1 denotes there is flow in that area. Class 0

denotes there is no flow. Soil map of the study area was prepared by georeferencing and digitizing the Tamil Nadu Soil Atlas image. The variety of soils found in the study area are clay soil, loamy soil, sandy soil, periodically flooded lands, gravelly clay soil. Water Supply and Demand data and the Existing network line map was collected from TWAD Board. GCP points were collected at industries, sumps and pumphouses to locate them on the map.

METHODOLOGY

Site selection is a type of analysis performed in GIS softwares to find out a best place for any development.

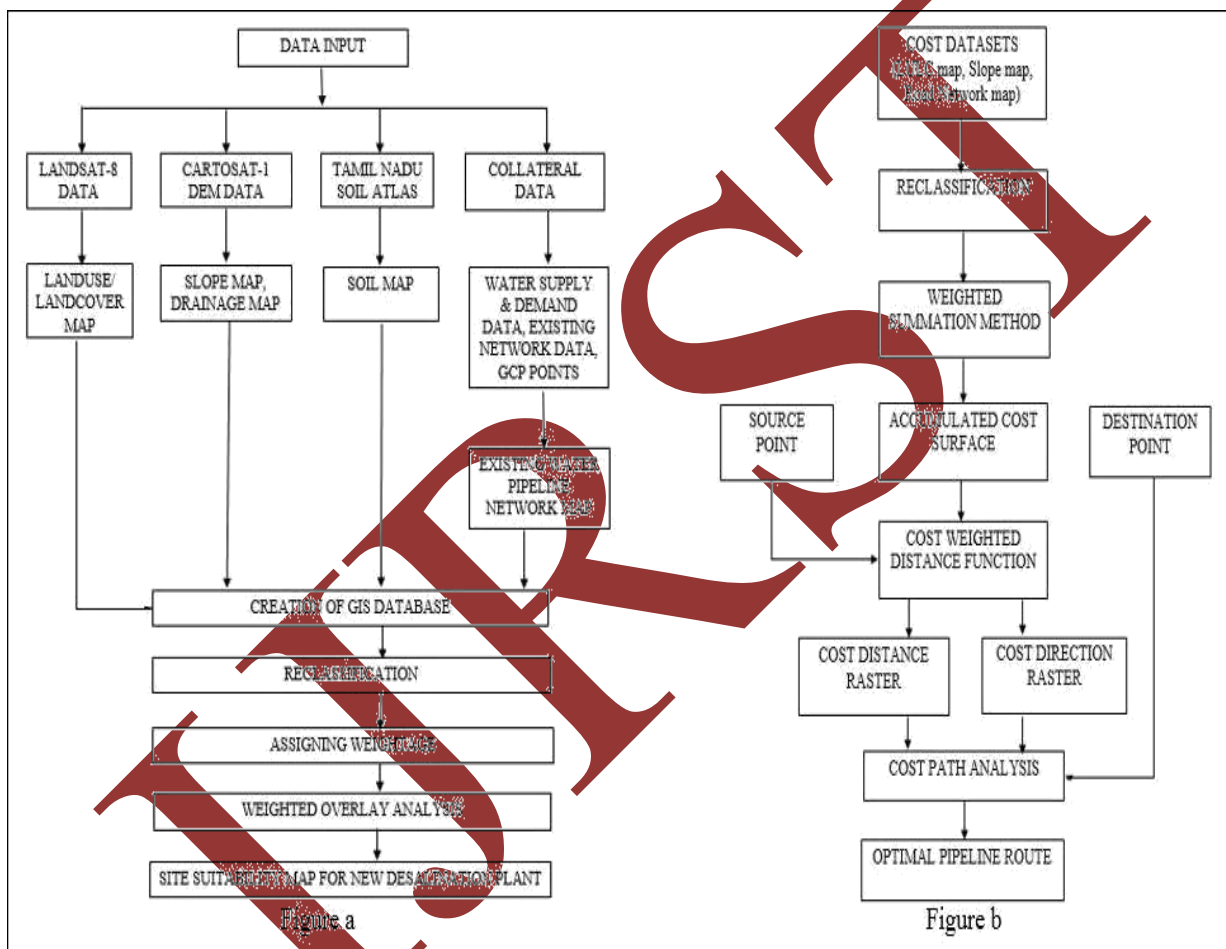


Figure 1. Methodology flowchart (Figure a. Workflow of Site Suitability Analysis, Figure b. Workflow of Cost Path Analysis)

Various thematic input layers were prepared based on several criteria from which the GIS software can rate the best sites. Weighted site selection is an important site selection method because it includes options for viewing the next-best sites. LCPA is a powerful tool extensively used in linear route planning features. The cost weighted distance function uses the source and accumulated cost surface to produce cost distance raster and cost direction raster. The final step is finding a new pipeline route between the source and destination using the Cost path tool in ArcGIS 10.1. The

methodology flowchart of the project is shown in Figure 1.

SITE SUITABILITY MAPPING

The created input layers as shown in Figure 2, are reclassified to bring it to the same ranking scheme. When reclassifying and ranking, the scale from 0-10 was used as shown in Table I, where 10 indicates very high suitability and 1 indicates very poor suitability. In LULC map, high values for Barren land and Scrubland. In Slope map, high values for slope < 5. In Drainage map, high value for no flow areas. In Soil map, high values for loamy and sandy soil. Weightage is given to those input layers based on their factor of influence. It must add upto 100%. Overlay the output layers to find the best site for a new desalination plant, meeting the project requirements. The result is a suitability surface with five classes such as very high, high, moderate, low and very low as shown in Figure 3. A suitable site is selected at Mullakaadu village in Tuticorin taluk considering the availability of land close to the sea, source of power supply, proximity to existing water network and proximity to the road.

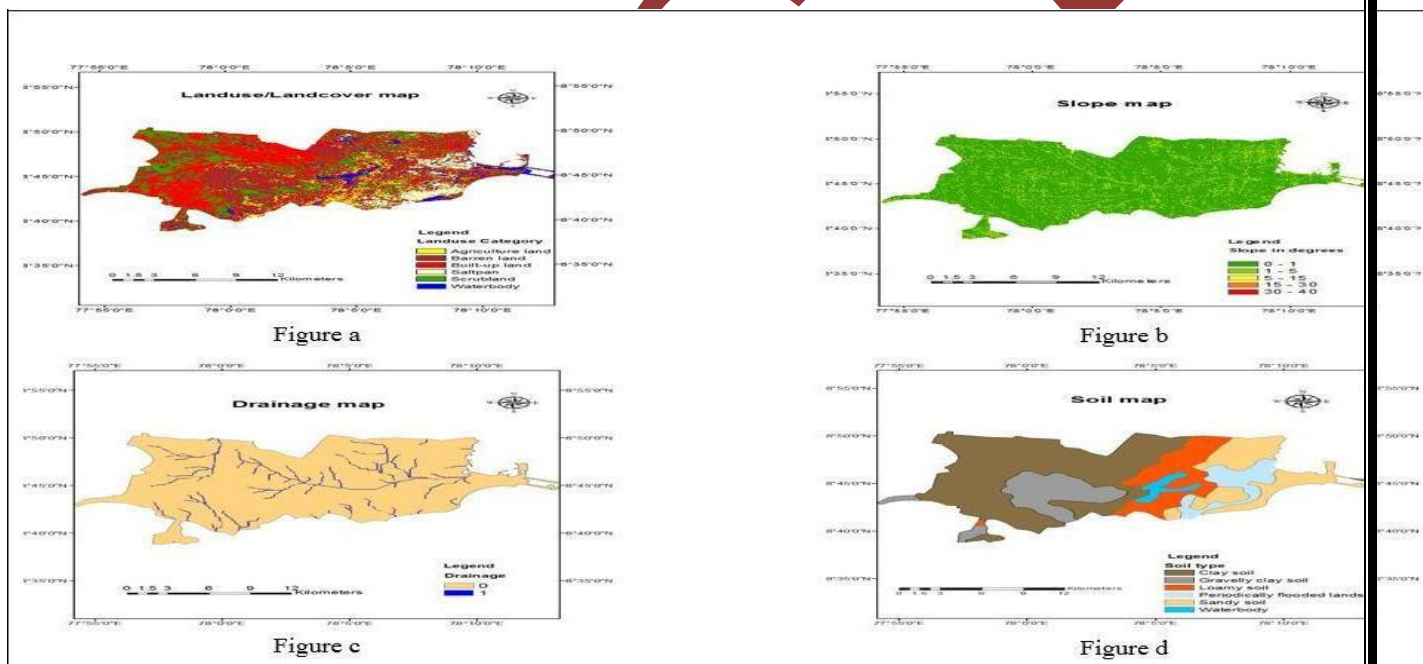


Figure 2. Input layers for Site Suitability Analysis (Figure a. LULC map, Figure b. Slope map, Figure c. Drainage map, Figure d. Soil map of Tuticorin taluk)

Table I. Reclassified values for performing Weighted Overlay Analysis

S.No	Input layers	Classes	Reclassified values
1)	Landuse/Landcover	Agriculture land	5
		Barren land	8
		Built-up land	2
		Saltpan	3
		Scrubland	7
		Waterbody	1
2)	Slope	0-1 degree	8
		1-5 degree	7
		5-15 degree	6
		15-30 degree	5
		30-40 degree	1
3)	Drainage	0	8
		1	2
4)	Soil	Clay soil	3
		Gravelly clay soil	5
		Loamy soil	7
		Periodically flooded lands	2
		Sandy soil	6
		Waterbody	1

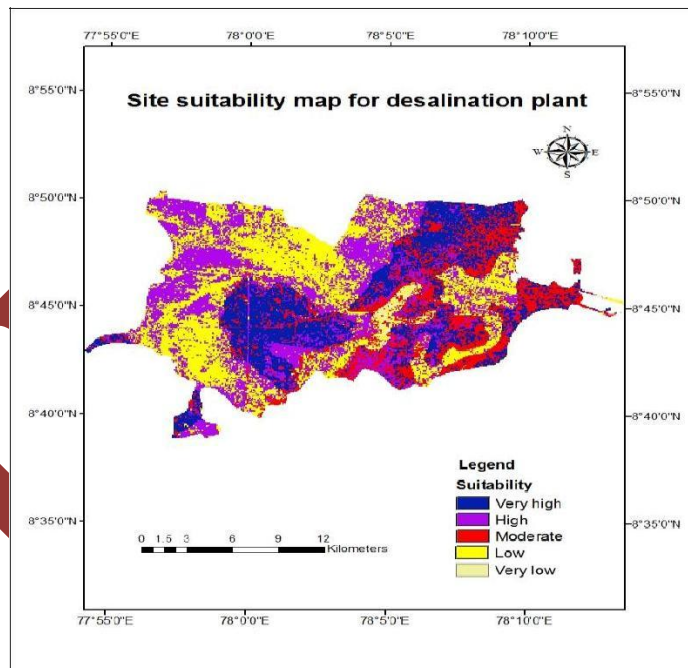


Figure 3. Output layer showing the suitable areas for a new desalination plant in Tuticorin taluk

OPTIMAL ROUTE PLANNING

Cost datasets such as LULC map, Slope map and Buffer road network map were reclassified to a common scale as shown in Table II. Add the reclassified datasets together by multiplying the given weights according to the importance using Weighted Summation tool in ArcGIS 10.1, to produce the accumulated cost surface as shown in Figure 4. When reclassifying the scale from 0-10 was used, where 10 indicates higher cost and 1 indicates lower cost. This scale was used to easily recognize high/low cost areas visually on the cost accumulated surface. In LULC map, higher cost for waterbody and built-up land (settlement). Routing the pipeline through waterbody is dangerous

and it cost huge amount for construction. In Slope map, higher cost for steeper slopes. Steeper slopes are much hazardous and difficult to construct. An optimal route map is prepared using the cost path tool as shown in Figure 5, by inputting the cost distance and direction rasters along with a destination point in ArcGIS 10.1.

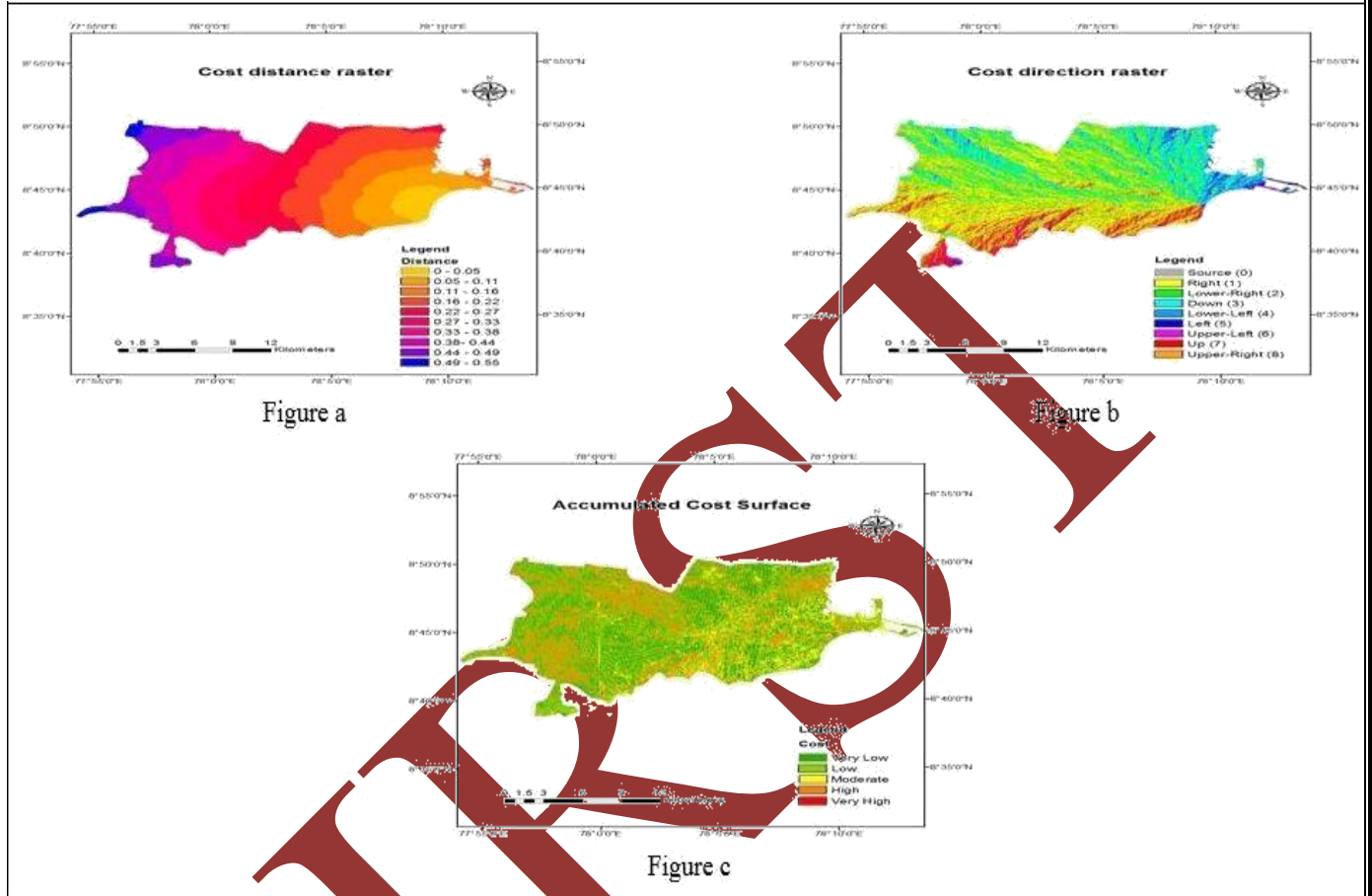


Figure 4. Input layers for Cost Path Analysis (Figure a. Cost distance raster, Figure b. Cost direction raster, Figure c. Accumulated Cost Surface)

Table II. Reclassified values for performing Weighted Summation

S.No	Input layers	Classes	Reclassified values
1)	Landuse/Landcover	Agriculture land	5
		Barren land	2
		Built-up land	8
		Saltpan	4
		Scrubland	3
		Waterbody	6
2)	Slope	0-1 degree	1
		1-5 degree	3
		5-15 degree	4
		15-30 degree	6
		30-40 degree	8
3)	Road buffer	5 m	2
		10 m	3
		15 m	6
		20 m	7

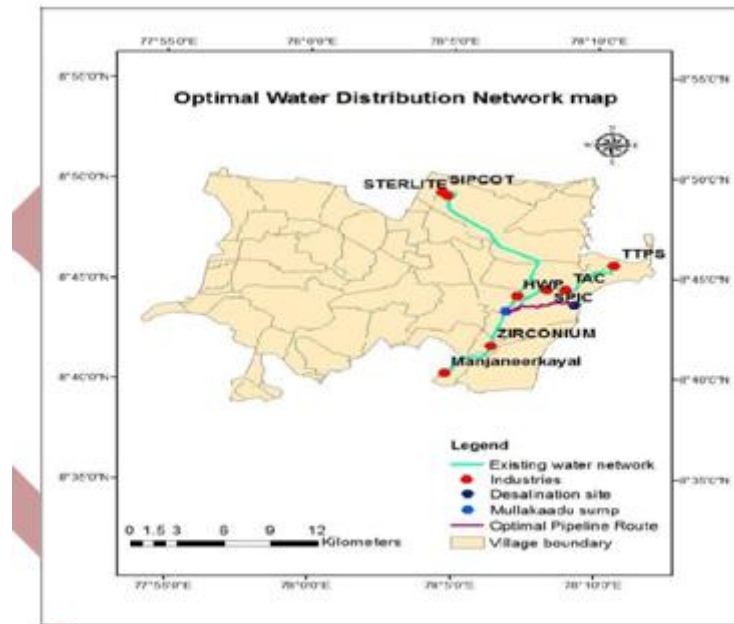


Figure 5. Output layer showing the optimal route for a new proposed pipeline

CONCLUSION

Remote sensing satellites provides continuous data products that are helpful in producing various informative layers with the help of GIS softwares. The optimal path focuses on minimizing the number of road and stream crossings. Usually the linear feature projects are laid parallel to the property boundaries and existing infrastructures (roads). This will reduce the land acquisition thereby minimizing the impact on the environment. This study outlines the efficient use of different GIS tools and remote sensing data products in site selection and pipeline routing. Thus a suitable site is selected close to the sea at Mullakaadu village in Tuticorin taluk using Weighted Overlay Analysis. Also an optimal route of about 5km parallel to the saltpan road alignment, is obtained using Least Cost Path Analysis from the desalination site to the Mullakaadu sump.

REFERENCES

- NN. Bagli, Geneletti and Orsi.F (2011), 'Routing of powerlines through least cost path analysis and multicriteria evaluation to minimise environmental impacts', *Env.Impact Assess.Rev*, 31:234-239.
- OO. Bathrellos.G, Skilodimou.H, Soulakellis.N, Panagopoulos.G and Tataris.G (2007), 'Mapping Urban Water Demands using Multicriteria Analysis and Geoinformation methods', *Journal of Water Resources Planning and Management*, Vol.31, pp.4-14.
- PP.Cohon.J, ReVelle.C, Current.J, Eagles.T, Eberhart.R and Church.R (1980), 'Application of multi-objectives facility location model to power plant siting in a six-state region of the U.S',

- QQ. Dan Abudu and Meredith Williams (2015), 'GIS based Optimal Route Selection for Oil and Gas pipelines in Uganda', *Advances in Computer Science:an International Journal*, Vol.4,pp.93-104.
- RR. Dinesh Kumar P.K, Naveen Kumar K.R and Muraleedharanan K.R (2014), 'Identification of Optimum outfall location for desalination plant in the Coastal waters of Tuticorin, India', *International Journal of Environmental Research*, Vol.8(1), pp.69-78.
- SS. Khadri, S.F.R and Chaitanya Pande (2014), 'Urban Water Supply System – A Case study on Water Network Distribution in Chalisgaon City in Dhule district, Maharashtra using Remote Sensing and GIS Techniques', *IOSR Journal of Mechanical and Civil Engineering*, pp.01-12.
- TT. Mohamed Rami Mahmoud, Hussam Fahmy, John W. Labadie and M. Asce (2002), 'Multicriteria siting and sizing of desalination facilities with Geographic information system', *Journal of Water Resource Planning and Management*, pp.113-120.
- UU. Muhsen S. Alhrari, Khairy Agha and Samah K. Alghoul (2014), 'Development of Decision Support System for optimal site selection of desalination plants', *IOSR Journal of Mechanical and Civil Engineering*, Vol.11, pp.84-90.
- VV. Saha, A.K., Arora M.K, Gupta.R.P, Viridi.M.L and Esaplovics.E (2005), 'GIS based route planning in landslide prone areas', *Int.J.Geograph.Inform.Sci*, 19(10):1149-1175.
- WW. Vasan.A and Slobodan P.Simonovic (2010), 'Optimization of Water Distribution Network Design using Differential Evolution', *Journal of Water Resources Planning and Management*, pp.279-287.