Integrated Remote Sensing and GIS Approach for Demarcation of Groundwater Potential Zones in Ambalantota Divisional Secretariat

*Mayadunna BB, Weerasekera WL, Senanayake IP, Dissanayake DMDOK

*Corresponding author - bhagyamayadunna@gmail.com

Abstract: Demand for water in Hambantota district is increasing rapidly due to agricultural activities, massive on-going development projects, industrialization and consequent population growth. Implementation of a proper water management system is essential in facing predicted water stress conditions where groundwater resources can play an important role. Delineation of groundwater potential zones, recharge zones and groundwater quality assessment can be identified as the three main segments of groundwater management. Geospatial technologies can be successfully utilized in such endeavours due to the cost and time effectiveness.

Ambalantota Divisional Secretariat was selected as the study area in this research work. Rainfall, contour, geology, geomorphology, soil and drainage network data along with Landsat 7 ETM+ image were utilized to develop relevant thematic layers in delineating groundwater potential zones and recharging sites through a weighted overlay model on a GIS platform.

Field studies were carried out to collect samples for water quality analysis and to verify the results. Groundwater quality map of the area was generated based on the results of laboratory analysis, depicting suitability level for drinking.

The results indicate that Ambalantota DS has significant groundwater potential and recharge potential, hence can be effectively utilized as a hub for a water management system in Hambantota district.

Keywords: Groundwater recharge, lineament mapping, weighted overlay analysis, water scarcity

1. Introduction

The available surface water resources scarcely fulfil the current water requirement in the world (U.S. Department of the Interior, 2013). Therefore, groundwater exploration has become a vital practice in present day.

D.M.D.O.K. Dissanayake,

B.Sc.Eng. (Hons)(Moratuwa), Ph.D. (Seoul), C.Eng. M.I.E. (S.L.), Senior Lecturer in Department of Earth Resources Engineering, University of Moratuwa I.P. Senanayake, B.Sc.Eng (Hons) (Moratuwa), M.Phil. (Moratuwa), AMIE(SL), Senior Lecturer in Department of Earth Resources Engineering, University of Moratuwa B.B. Mayadunna, W.L. Weerasekera, Final year Undergraduate students in the Department of Farth Resources Engineering Although Sri Lanka receives а considerable amount of average annual rainfall varying from 900 mm 5,500 mm (Department of to Agriculture, Sri Lanka, 2006), it is not distributed evenly over the island. Consequently, the three main climatic zones namely, dry, intermediate and wet zone were defined based on the distribution of rainfall (Rainforest Rescue International, 2005). Sri Lanka has a considerable volume of groundwater stocks that can be utilized in drinking and domestic (Machanayake and purposes Bandara. 1999). Therefore. groundwater can be identified as an invaluable resource, which can contribute in fulfilling the demand for fresh water in the dry zone of Sri Lanka.

Hambatota can be identified as a district affected by severe periodic droughts due to its surface water scarcity caused by less rainfall, high evoporation rates and soil conditions (Senanayake*et al.,* 2012). Agriculture is the main livelihood in the district and is based on proper water supply.

Furthermore, rapid on-going development projects in the area such as, international harbour and airport, conference hall. infrastructure developments, etc. increase the demand for fresh water dramatically Development (Urban Authority, 2011). According to the Comprehensive Assessment of the Freshwater Resources of the World (1997), it can be predicted that two thirds of the world population will face water stress conditions by 2025(Senanayake et al., 2012). Further, UN studies explain that countries with water withdrawal rate of 40% or more will face severe water stress conditions. The withdrawal rate of available water resources in South Asia is 48%. Hence, Sri Lanka should be properly prepared to face this predicted water stress conditions (Senanayake *et al.*, 2012).

Thus, establishing a proper water management system is a necessity, where groundwater management plays an integral role. Remote sensing and Geographic Information System (GIS) techniques can be successfully utilized for demarcation of groundwater potential zones and groundwater recharge zones due to time and cost effectiveness.

Ambalantota Divisional Secretariat (DS) of Hambantota district was selected for this study. The area covers approximately 203 sq. km and bounded by latitudes 80°53' - 81° 02'E and longitudes 6° 04' - 6° 15'N. Walawe River and Ridiyagama Tank provide water-rich conditions in the area. Consequently, Ambalantota can be effectively used as a hub in a water management system designed to face the predicted water stress conditions in Hambantota district.

This study was carried out to identify the groundwater potential zones, delineate the suitable sites for artificial recharge and to assess the groundwater quality in Ambalantota DS by employing remote sensing and GIS technologies.

2. Methodology

2.1 Delineation of groundwater potential zones and recharge zones in Ambalantota DS.

Factors such as rainfall, lineament density, slope, drainage density, land use, lithology, geomorphology and soil types were employed in this study to delineate groundwater potential zones and recharge zones.

Average annual rainfall was calculated using the monthly rainfall data of the study area from 1992 to 2012 obtained from the of Sri Meteorological Department average Lanka. Afterwards, the annual rainfall data were interpolated using the "Kriging" technique to the rainfall map of develop Ambalantota DS.

Lineament mapping was carried out using automatic extraction method with the aid of Digital Terrain Model (DTM) of Ambalantota developed by using 5 m interval contour data prepared by the Survey Department of Sri Lanka. Eight shaded relief images were generated using the DTM corresponding to eight contrast illumination directions viz. 0º, 45°, 90°, 135°, 180°, 225°, 270° and 315° and subsequently compressed into 2 distinct images. The two resultant images were subjected to automatic lineament extraction. The resultant lineament layer was masked to remove man made linear features such as roads, dams, etc. and the lineament density map was prepared.

Slope map was generated using the Triangular Irregular Network (TIN) of Ambalantota interpolated using the contour data.

Stream density map of the area was developed utilizing the stream network data prepared by the Survey Department of Sri Lanka.

Supervised classification of the Landsat ETM+ image was conducted to prepare the land use layer of the study area. Lithological map prepared by the Geological Survey and Mines Bureau was scanned, geo-rectified and digitized.

The geomorphological and the soil map of the area were obtained through http://eusoils.jrc.ec.europa.eu/esdb_ archive/eudasm/asia/lists/clk.htm. Subsequently, the maps were georectified and digitized.

Finally, the weighted overlay analysis method was employed to generate the maps depicting groundwater potential and suitable recharging sites by assigning appropriate ranks to different themes (Table 2.1) and weights to classes in each theme (modified from Shahid et al, 2000; Gunawardena and Dissanayake, 2007; 2013; S. Dissanayake, Weerawarnakula, personal communication, March 21, 2014)) on their the basis of relative contributions towards both potential and recharging separately (Table 2.2).

Table 2.1: Ranks assigned for the thematic layers.

Criteria	Ranks Assigned		
	G/W	G/W	
	Potential	Recharging	
Rainfall	25	20	
Lithology	20	15	
Geomorphology	15	15	
Slope	10	15	
Lineaments	10	10	
Landuse	10	10	
Drainage	5	10	
Density			
Soil	5	5	

Table 2.2: Weights assigned for classes of each theme.

CriteriaWeights Assigned G/W Potentialand / or granulite Massive rockand / or granulite domes soldand / or granulite biotite greissand / or granulite biotite greissand / or granulite domes and / and				Calc-gneiss	2	2
G/W Potential $G/WRechargin8granuliteMassive rock12Geomorphology(River plane77Genocktifc22ySurface withInselbergs andthin soil33biotite gneiss34Low plantation33biotite gneiss34Low plantation33biotite gneiss34Inselbergs andthin soilGneissic rock23Land use-Highly34Chena56weathered-5Paddy67coarse and-5Scrub26dolomiticWater bodies88dolomitic-5SoilAlluvial soils oftetrrain66Quarzite andquarz rich22Reddish brown66Nighamountof gravel insub soildich sondit-1-266Jundulationterrain$	Criteria Weights Assigned		and/ or			
Massive rock12Potential RecharginMassive rock12gChanockitic22geness andChanockitic23Low plantation333biotite graissSurface withDune sand26Inselbergs andChanockitic23Land useHighly34Chena56weatheredCrub26messade7Paddy67ccarse and5Soril26dominat5Alluvial soils of66Quartzite and/2VariableSolpeguartzitchSerpentines22drainage and terrainSolpe1266Reddish brown663.533Soloized0.5.1888Soloized0.5.188Soloized0.5.188Soloized0.5.188Soloized0.5.181Iterrain2.335Reddish brown663.53Iterrain2.335Reddish brown663.51Iterrain2.335Reddish brown663.51Iterrain2.43.533Reddish brown663.52		CAN	GW	granulite		
Geomorphologinteractionwith less fracturesGeomorphologChanockitic22River plane77greisis and chanockitic23Low plantation33biotite gneiss6Inselbergs and thin soilDune sand26Inselbergs and thin soil6Gneissic rock23Land useHighly34Chena56weatheredHome Garden22Marble usually45Paddy67coarse and56Scrub26dolonitic56Water bodies88dominant56Mineal sand/2555Alluvial soils of66Quartz ite and22drainage and terrainScrup0.5-1888solonetz: undulating terrain1-2666undulating terrain2.3444Reddish brown663-5333earths with high amount of gravel in sub soil0-5-1811gley soils; undulation1-25331gley soils; undulation263-526and dune sands; flat terrain2263-533Regosols on and dune sands; flat terrain22 <td></td> <td>Potential</td> <td>Rechargin</td> <td>Massive rock</td> <td>1</td> <td>2</td>		Potential	Rechargin	Massive rock	1	2
GeomorphologGhanockitic2y River plane77Chanockitic22Biver plane77chanockitic23Low plantation33bioite gneiss34Surface with Inselbergs and thin soilDune sand26Inselbergs and thin soil767coarse34Chena56weathered \cdot \cdot 777<		i otentiai	g	with less		
rrr <th< td=""><td>Geomorpholog</td><td></td><td>0</td><td>fractures</td><td></td><td></td></th<>	Geomorpholog		0	fractures		
River plane77gness and chanocktitLow plantation33biotite gnessSurface withDune sand26Inselbergs and thin soilGnesisci cock23Land useHighly34Chena56weathered7Chena56rocks7Home Garden22Marbel usually45Paddy67coarse and75Scrub26dolomitic76Water bodies88locally calcite75Alluvial soils of66Quartzite and25Variableguartz richSiope757drainage and terrainSolodizedSiope778Reddish brown663-5333earths and solodized0.5-18886odized soloidized0.5-18111high amount of gravel in sub soil dow humic gley solis;0.5-16226and dune terrain1-25333	y v			Chanockitic	2	2
Low plantation33Chandektic biotite greissSurface with Inselbergs and thin soilDune sand26Inselbergs and thin soilGneissic rock23Land useHighly34Chena56weathered7Paddy67coarse and5Paddy67coarse and7Scrub26dolomitic7Vater bodies88dorinant7SoilMineral sand/25Variablequartz rich oquartz richSoipe7drainage and texture; flat terrainSibope72Reddish brown663-59of gravel in solodized0.5-188solontez; undulating terrain1-266negsols on earths with high amount of gravel in sands; flat terrain1-253Regosols on a addune263-533Regosols on and dune sands; flat terrain262-718Rock knob (Sand/Silf/C iay)22263-533Geology1050-110044444Mineral sand; (Sand/Silf/C iay)1150-1200999	River plane	7	7	gneiss and		
Surface with Inselbergs and thin soil Land useDune sand Gneissic rock23Chena56weathered rocks777Home Garden22Marble usually45Paddy67coarse and dominitic777Yater bodies88dominant dominant777Soil66Quartzite and quartz rich drainage and solodized255Reddish brown66Quartzite and quartz rich222Reddish brown660.551888solodized0.5518888solodized0.511888solodized0.511888solodized0.551811high amount of gravel in sub soil0.551622undulation der sands; flat terrain1-2533recent beach and dune sands; flat terrain226622Redish brown663-533562266and dune sands; flat terrain77188111high amount of gravel in sands; flat terrain77183333333333333 </td <td>Low plantation</td> <td>3</td> <td>3</td> <td>chanockitic</td> <td></td> <td></td>	Low plantation	3	3	chanockitic		
Inselbergs and thin sollInselbergs and Gneissic rockImage	Surface with			Dune cand	2	6
thin solGneissic rock23Land useHighly34Chena56weatheredrocksHome Garden22Marble usually45Paddy67coarse and5Scrub26dolomitic5Water bodies88dominant5Soil26Quartzite and25Water bodies66Quartzite and25VariableGneissic rock999earths and66Quartzite and22Variable8Sloperectrine22terrain88888solodized0.5.1888solodized is brown663-533solodized is brown663-5333gerys oils;0.5.16226undulating1-25333terrain77100011Regosols on222993recent beach33333and dune229933and dune229910010gesols on222910022and dune22299 <th< td=""><td>Inselbergs and</td><td></td><td></td><td>Dune sand</td><td>-</td><td>0</td></th<>	Inselbergs and			Dune sand	-	0
Land use Highly 3 4 Chena 5 6 weathered rocks Home Garden 2 2 Marble usually 4 5 Paddy 6 7 coarse and rocks rocks Strub 2 6 dolomitic dolomitic rocarse and	thin soil			Gneissic rock	2	3
Chena56weathered rocks Marble usually45Home Garden22Marble usually45Paddy67coarse and5Scrub26dolomitic locally calcite5Water bodies88dolomitic locally calcite5Water bodies88Mineral sand/25Soilbeach sand25Alluvial soils of66Quartz rich und tainage andSerpentines22Keddish brown660.5-1188solodized0.5-11888solontez; undulating terrain1-266undulating terrain2.344Reddish brown663-533earths with high amount of gravel in sub soil5-1011high amount gley soils; undulation terrain1-2533Regsols on sands; flat terrain263-5526and dune sands; flat terrain3-57183Reock knob22950-1000222plain1000-10503333Geology1000-10503333Alluvium771050-110044(Sand/Silt/C Lay)1000-1150666	Land use			Highly	3	4
Home Garden22Marble usually45Paddy67coarse and5Scrub26dolomitic6Water bodies88dominant5Water bodies88dominant5SoilImage and25variablequartz rich9drainage andSolpe99terrain660uartzite and2Reddish brown660.5-188solodized0.5-1888solodized2.3444terrain2.3444terrain663-533earths and5-10111solodized5.10111high amount663-533earths with5-10111high amount7712.335gley solis;0.5-1622undulation1-2533terrain771000-105033Reok hoob22950-100022plain771050-110044Goad/Silt/C100-11506666lay1001-11506666lay1001-11506666lay	Chena	5	6	weathered		
Notice Carterial267coarse and45Paddy67coarse and \cdot	Home Garden	2	2	rocks		-
Paddy67coarse and dolomiticScrub26dolomiticWater bodies88dolomiticSoilImage andMineral sand/25variableGuartzite and25variableGuartz richGuartz rich1drainage andSerpentines22texture; flatSlope11terrain0.5-188solodized0.5-188solodized2.344terrain2.344retrain2.344retrain5-1011night amount5-1011of gravel in sub soil0.5-162undulation terrain0.5-162gley soils;0.5-162undulation terrain1-253recent beach and dune sands; flat terrain2.335Regosols on sands; flat terrain2626Alluvium7718Alluvium77100033Alluvium77100-115066(Sand/Silt/C (Sand/Silt/C1150-1200999	Tionic Garden	-	- 7	Marble usually	4	5
Scrub 2 6 dotomite locally calcite dominant Water bodies 8 8 locally calcite dominant Soil Mineral sand/ 2 5 Soil beach sand 2 5 Alluvial soils of 6 6 Quartzite and 2 5 drainage and guartz rich guartz rich <thguartz rich<="" th=""> guartz rich</thguartz>	Paddy	6	/	coarse and		
Water bodies 8 8 100 any Cuttrie Soil Mineral sand/ 2 5 Alluvial soils of 6 6 Quartzi te and 2 5 variable guartz rich guartz rich 7 7 7 9 9 texture; flat Slope 12 6 6 6 9 9 9 terrain 0.5-1 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 10 10	Scrub	2	6	dolomitic		
Soil Mineral sand/ 2 5 Alluvial soils of 6 6 Quartzite and 2 5 variable quartz rich guartz rich 1 1 1 drainage and Serpentines 2 2 2 2 texture; flat Siope 1	Water bodies	8	8	dominant		
SoilInterval and a solid y beach sandAlluvial soils of variable66Quartz ite and quartz rich25drainage and terrainSerpentines22ketture; flat terrainSlope (Degrees)Reddish brown660.5-188solodized solodized0.5-1888solodized undulating terrain1-266undulating 				Mineral sand /	2	5
Alluvial soils of variable66Quartz ite and quartz rich25drainage and texture; flatSerpentines22texture; flat terrainSlope (Degrees)11Reddish brown66 $0-0.5$ 99earths and solodized0.5-188solonetz; undulating terrain1-266undulating terrain2.344Reddish brown663-533earths with high amount of gravel in sub soil &low humic gley soils;0.5-1011ndulation terrain0.5-11622undulation terrain0.5-1162gley soils; undulation0.5-1162undulation terrain1-253recent beach sands; flat terrain3-526and dune sands; flat terrain2950-100022plain Geology22950-110044Alluvium (Sand/Silt/C lay)771050-1100441150-120099999	Soil			beach sand		
variable drainage and texture; flat terrainquartz rich Serpentines22Reddish brown66 $0 - 0.5$ 99earths and solodized0.5-188solonetz; undulating terrain1-266undulating terrain2-344Reddish brown663-533earths with high amount of gravel in sub soil & clow humic gley soils;0.5-1111.253310.5-16221and dune sands; flat terrain0.5-162neck knob22950-100022plain (Sand/Silt/C22950-100033Alluvium771050-110044(Sand/Silt/C1150-12009999	Alluvial soils of	6	6	Ouartzite and	2	5
drainage and texture; flat Serpentines 2 2 texture; flat Slope (Degrees) (Degrees) 9 Reddish brown 6 6 0-0.5 9 9 earths and solodized 0.5-1 8 8 8 solonetz; 1-2 6 6 undulating terrain 2.3 4 4 Reddish brown 6 6 3-5 3 3 earths with high amount of gravel in sub soil &low humic gley soils; 0-10 1 1 1 Regosols on recent beach and dune sands; flat terrain 2 6 2-3 3 5 Regosols on ceols y 2 2 950-1000 2 2 Alluvium 7 7 1050-1100 4 4 (Sand/Silt/C lay) 1150-1200 9 9 9	variable			quartz rich		
texture; flat Slope terrain (Degrees) Reddish brown 6 6 o-0.5 9 9 earths and 0.5-1 8 8 solodized 1-2 6 6 undulating 2.3 4 4 terrain 3.5 3 3 readdish brown 6 6 3.5 3 3 earths with 5-10 1 1 1 high amount 5-10 1 1 1 high amount 0-0.5 8 1 gley soils; 0.5-1 6 2 undulation 1-2 5 3 kclow humic 0.5-1 6 2 gley soils; 1-2 5 3 terrain 2.3 3 5 Regosols on 2 6 3-5 2 6 and dune 5-7 1 8 3 3 3 sands; flat 1000-1050 3 3 3	drainage and			Serpentines	2	2
terrain (Degrees)	texture; flat			Slope		
Reddish brown 6 6 0-0.5 9 9 earths and solodized 0.5-1 8 8 solonetz; undulating terrain 1-2 6 6 2.3 4 4 Reddish brown 6 6 3-5 3 3 earths with 5-10 1 1 1 high amount of gravel in gley soils; Drainage 0-0.5 8 1 with winnic gley soils; 0.5-1 6 2 undulation 1-2 5 3 terrain 0.5-1 6 2 Regosols on 2 6 3-5 3 recent beach and dune sands; flat terrain 1-2 5 3 Reifall (num) 7 7 1000-1050 3 3 Alluvium 7 7 1050-1100 4 4 (Sand/Silt/C 1150-1200 9 9 9	terrain			(Degrees)		
earths and solodized 0.5-1 8 8 solonetz; 1-2 6 6 undulating terrain 2.3 4 4 Reddish brown 6 6 3-5 3 3 earths with high amount of gravel in sub soil & low humic gley soils; 5-10 1 1 1 with high amount of gravel in sub soil 0-0.5 8 1 % clow humic gley soils; 0.5-1 6 2 undulation 1-2 5 3 terrain sands; flat terrain 2 6 3-5 2 6 and dune sands; flat terrain 5-77 1 8 8 Reck knob 2 2 950-1000 2 2 plain 1000-1050 3 3 3 Geology 1050-1100 4 4 Alluvium 7 7 1000-1150 6 6 iay) 1150-1200 9 9 9	Reddish brown	6	6	0-0.5	9	9
solodized 1-2 6 6 undulating 2-3 4 4 Reddish brown 6 6 3-5 3 3 earths with 5-10 1 1 1 high amount 5-10 1 1 1 of gravel in Drainage Density (m/m²) 5 3 1 sub soil 0-0.5 8 1 1 1 1 klow humic 0-0.5 8 1 <t< td=""><td>earths and</td><td></td><td></td><td>0.5-1</td><td>8</td><td>8</td></t<>	earths and			0.5-1	8	8
solohetz; 1-2 6 6 undulating 2-3 4 4 Reddish brown 6 6 3-5 3 3 earths with 5-10 1 1 1 high amount 5-10 1 1 1 high amount 0f gravel in Drainage 0-0.5 8 1 gley soils; 0.5-1 6 2 2 0.5-1 6 2 undulation 1-2 5 3 3 5 5 3 5 5 3 5 5 5 3 5 5 5 5 5 5 5 5 5 5 5	solodized			1.0	(6
terrain 2-3 4 4 Reddish brown 6 6 3-5 3 3 earths with 5-10 1 1 1 high amount 5-10 1 1 1 high amount Drainage Density (m/m²) 0-0.5 8 1 sub soil 0-0.5 8 1 0-0.5 8 1 gley soils; 0.5-1 6 2 2 0.5-1 6 2 undulation 1-2 5 3 5 3 5 3 5 recent beach 3-5 2 6 3-5 2 6 6 6 3 5 3 5 3 5 5 3 5 5 3 5 5 3 5 5 3 5 5 5 3 5 5 5 5 3 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 <td>solonetz;</td> <td></td> <td></td> <td>1-2</td> <td>0</td> <td>0</td>	solonetz;			1-2	0	0
Reddish brown 6 6 3-5 3 3 earths with 5-10 1 1 high amount 5-10 1 1 of gravel in Drainage Density (m/m²) 0-0.5 8 1 sub soil 0-0.5 8 1 0-0.5 8 1 & alow humic 0.5-1 6 2 0 2 2 3 5 undulation 1-2 5 3 5 3 5 3 5 recent beach 3-5 2 6 3-5 2 6 6 6 3 5 3 5 3 5 3 5 3 5 3 5 3 5 3 5 3 5 3 5 3 5 3 5 3 5 3 5 3 5 3 5 3 5 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	terrain			2-3	4	4
earths with 5-10 1 1 high amount Drainage Density (m/m²) sub soil 0-0.5 8 1 & low humic 0-0.5 8 1 gley soils; 0.5-1 6 2 undulation 1-2 5 3 terrain 2 6 3-5 2 6 and dune 5-7 1 8 8 sands; flat Errain 5-7 1 8 sands; flat Errain 8 3 5 Regosols on 2 2 950-1000 2 2 gley soils; 1000-1050 3 3 3 sands; flat 1000-1050 3 3 3 Geology 1050-1100 4 4 Alluvium 7 7 100-1150 6 6 iay) 150-1200 9 9 9	Reddish brown	6	6	3-5	3	3
high amount Drainage Density (m/m²) sub soil 0-0.5 8 1 & dow humic 0-0.5 8 1 gley soils; 0.5-1 6 2 undulation 1-2 5 3 terrain 2 6 3-5 2 6 recent beach 3-5 2 6 6 2 and dune 5-77 1 8 8 8 8 1 kerrain 8 3-5 2 6	earths with			5-10	1	1
of gravel in sub soil Density (m/m²) sub soil 0-0.5 8 1 &low humic gley soils; 0.5-1 6 2 undulation 1-2 5 3 terrain 2-3 3 5 Regosols on 2 6 3-5 2 6 and dune 5-7 1 8 sands; flat terrain 5-7 1 8 sands; flat terrain 1000-1050 3 3 Rock knob 2 2 950-1000 2 2 plain 1000-1050 3 3 3 Geology 1050-1100 4 4 Alluvium 7 7 1100-1150 6 6 iay) 1150-1200 9 9 9	high amount		•	Drainago		
sub soil 0-0.5 8 1 &low humic 0-0.5 8 1 gley soils; 0.5-1 6 2 undulation 1-2 5 3 terrain 2 6 2-3 3 5 Regosols on 2 6 3-5 2 6 and dune 5-7 1 8 8 1 sands; flat 5-7 1 8 8 1 terrain 5-7 1 8 8 1 8 1	of gravel in			Density (m/m ²)		
&low humic 0.5-1 6 2 gley soils; 1-2 5 3 undulation 1-2 5 3 terrain 2-3 3 5 Regosols on 2 6 3-5 2 6 and dune 5-7 1 8 sands; flat 5-77 1 8 terrain 5-77 1 8 Rock knob 2 2 950-1000 2 2 plain 1000-1050 3 3 3 Geology 1050-1100 4 4 Alluvium 7 7 1000-1150 6 6 jay) 1150-1200 9 9 9	sub soil			0-0.5	8	1
gley soils; 1-2 5 3 undulation 1-2 5 3 terrain 2-3 3 5 Regosols on 2 6 3-5 2 6 and dune 5-7 1 8 sands; flat 5-7 1 8 terrain Rainfall (nm) Rock knob 2 2 950-1000 2 2 plain 1000-1050 3 3 Geology 1050-1100 4 4 Alluvium 7 7 1100-1150 6 6 iay) 1150-1200 9 9	&low humic			0 5 1		2
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	gley soils;			0.5-1	b	2
terrain 2 6 2-3 3 5 Regosols on 2 6 3-5 2 6 and dune 5-7 1 8 sands; flat 5-7 1 8 terrain Rainfall (mm) 2 2 Rock knob 2 2 950-1000 2 2 plain 1000-1050 3 3 3 Geology 1050-1100 4 4 (Sand/Silt/C 1100-1150 6 6 iay) 1150-1200 9 9	undulation			1-2	5	3
Regosols on 2 6 recent beach 3-5 2 6 and dune 5-7 1 8 sands; flat Fainfall (mm) 8 terrain Rainfall (mm) 2 2 Rock knob 2 2 950-1000 2 2 plain 1000-1050 3 3 Geology 1050-1100 4 4 Alluvium 7 7 1100-1150 6 6 iay) 1150-1200 9 9 9	terrain	0	,	2-3	3	5
recent beach 50 2 6 and dune 5-7 1 8 sands; flat Rainfall (mm) terrain Rainfall (mm) Rock knob 2 2 950-1000 2 2 plain 1000-1050 3 3 Geology 1050-1100 4 4 Alluvium 7 7 1100-1150 6 6 iay) 1150-1200 9 9 9	kegosols on	2	0	3-5	2	6
and duite 5-7 1 8 sands; flat terrain Rainfall (mm) 8 Rock knob 2 2 950-1000 2 2 plain 1000-1050 3 3 Geology 1050-1100 4 4 Alluvium 7 7 1100-1150 6 6 iay) 1150-1200 9 9	and dune			5 7		0
terrain Rainfall (mm) Rock knob 2 2 950-1000 2 2 plain 1000-1050 3 3 Geology 1050-1100 4 4 Alluvium 7 7 1100-1150 6 6 jay) 1150-1200 9 9 9	sands: flat			3-7		8
Rock knob 2 2 950-1000 2 2 plain 1000-1050 3 3 Geology 1050-1100 4 4 Alluvium 7 7 1100-1150 6 6 iay) 1150-1200 9 9 9	terrain			Rainfall (mm)		
plain 1000-1050 3 3 Geology 1050-1100 4 4 Alluvium 7 7 1100-1150 6 6 (Sand/Silt/C 1150-1200 9 9	Rock knob	2	2	950-1000	2	2
Geology 1050-1000 5 5 Alluvium 7 7 1050-1100 4 4 (Sand/Silt/C 1100-1150 6 6 6 lay) 1150-1200 9 9 9	plain			1000-1050	2	2
Alluvium 7 7 1050-1100 4 4 (Sand/Silt/C 1100-1150 6 6 lay) 1150-1200 9 9	Geology			1050 1000	5	5
(Sand/Silt/C 1100-1150 6 6 lay) 1150-1200 9 9	Alluvium	7	7	1050-1100	4	4
lay) 1150-1200 9 9	(Sand/Silt/C			1100-1150	6	6
	lay)			1150-1200	9	9

Lineament		
Density (m/m ²)		
0 - 0.0005	1	1
0.0005 - 0.001	4	4
.001003	6	6

2.2 Preparing groundwater quality maps of Ambalantota DS

Five major water quality parameters, pH, turbidity, dissolve oxygen (DO), total dissolve solids (TDS) and conductivity electrical were considered in this study to assess the groundwater quality in Ambalantota. Water samples of the study area were collected in a grid pattern and, analyzed subsequently in the laboratory. Thematic layers of the measured groundwater parameters generated using were Inverse Distance Weighted (IDW) interpolation technique by combining with the data obtained from the Water Resource and Drainage Board. The final groundwater quality map was prepared to depict the combined result of the analysis of water quality parameters using a weighted overlay analysis by assigning equal weights.

3. Results and Discussion

Developed groundwater potential and recharge zone maps were classified into three classes as low, moderate and high, assigning appropriate break values (Figure 3.1). Further, the groundwater quality map was classified as low, moderate and high based on the level of suitability for drinking (Figure 3.2).

The results illustrate approximately 89% of the DS falls under high to moderate groundwater potential zones and nearly94% of the area under high to moderate groundwater recharge zones. Hardness, turbidity and electrical conductivity of the groundwater in the coastal region of the DS have higher values due to saline water intrusion resulting low suitability for drinking in the Southern region of the study area. The quality of groundwater improves from Southern region towards North.

Groundwater table can be artificially recharged by pebble bed method, percolation pits, recharge wells, ridges and furrows check dams, gully control/stone wall structures, contour bunding, trenching and land flooding.

Further studies employing time series data, geophysical surveys, etc. are suggested to verify the results and to improve the accuracy of the model.

The methodology adopted in this study can be generalized to whole Hambantota. Further, it can be employed for the whole dry zone in Sri Lanka using appropriate regional parameters.

4. Conclusion

This study was carried out to demarcate groundwater potential zones, suitable sites for artificial groundwater recharge and to assess the groundwater quality of Ambalantota DS.

The results of the study explain that Ambalantota DS has a considerable groundwater potential and a high groundwater recharging capacity; hence can be utilized as a hub in a future water management system designed for the Hambantota district. Groundwater in the Northern part of Ambalantota is suitable for drinking, while groundwater in Southern part can be utilized with purification.

5. Acknowledgements

The authors would like to thank Dr. A.K.M.B. Abeysinghe, Head, Department of Earth Resources Engineering, Dr. H.M.R. Premasiri, Coordinator-Final Year Research Projects, Department of Earth Resources Engineering, academic staff and non-academic staff members of Department of Earth Resources Engineering for their kind assistance during the research. We owe our deepest gratitude to Mr. Preethi Liyanage, Librarian, Arthur C Clarke Institute for Modern Technologies for his kind assistance. Further, we extend our sincere gratitude to the Department of Meteorology and Water Resource and Drainage Board providing for necessary data.

6. References

- Department of Agriculture, Sri Lanka(2006) "Crop Remediation".http://www.agridept. gov.lk/index.php/en/croprecomm endations/903
- Dissanayake, D.M.D.O.K. (2013) "Application of remote sensing and GIS for demarcation of Groundwater potential zones", Seminar on GIS for Water Distribution Infrastructure Network in NWS&DB Sabaragamuwa Region.
- Gunawardena. G.M.W.L. and Dissanayake, D.M.D.O.K. (2007)"Evaluation of Water Scarcity in the Selected Area of Hambantota District Using RS and GIS Technology",11th International Conference on Sri Lanka Studies.
- Machanayake, P. and Bandara, C. M. M. (1999) "Water resources of Sri Lanka". 1stedition, National Science Foundation, Sri Lanka.
- Rainforest Rescue International (2005) "Sri Lanka's Climatic Zones",

http://www.rainforestrescueintern ational.org/

- Kumar, P.K.D., Gopinath, G. and Seralathan, P. (2007) " Application of remote sensing and GIS for the demarcation of groundwater potential zones of a river basin in Kerala, southwest coast of India", *International Journal of Remote Sensing, vol. 28, pp. 5583 - 5601.*
- Senanayake, I. P., Dissanayake, D. M. D. O. K. and Puswewala, U. G. A. (2012) "Site suitability analysis for reservoirs in suriyawewa by using GIS techniques", Journal of Remote Sensing & GIS, vol. 3, pp 60-78.
- Senanayake, I. P., Dissanayake, D. M. D. O. K. and Puswewala, U. G. A. (2012) "Analysis of the abundance of abandoned tanks in Hambantota District, Sri Lanka using GIS techniques", The Egyptian Journal of Remote Sensing and Space Science, vol. 15, pp. 143-150.
- Shahid, S., Nath, S.K. and Roy J. (2000) "Groundwater potential modelling in a soft rock area using a GIS", International Journal of Remote Sensing, vol. 21, pp. 1919 -1924.
- Urban Development Authority, Sri Lanka- (2011) "Greater Hambantota Development Plan".http://www.uda.lk/projects hambantota.html
- U.S. Department of the Interior, U.S.G.S. (2013) "The World's Water". http://ga.water.usgs.gov/edu/eart hwherewater.html



Figure 3.1: Groundwater potential and recharge zone maps of Ambalantota



Figure 3.2: Groundwater quality map of Ambalantota DS.