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A GEO-SPATIAL STUDY ON IDENTIFICATION OF SITE SUITABILITY IN THE ANANTHAPUR DISTRICT USING MULTICRITERIA EVALUATION METHOD

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Abstract:

In the present investigation, the Weighted Overlay Tool applies mapping of Ananthapur district in the state of Andhra Pradesh has been carried out using Analytic Hierarchy Process (AHP) based on standard In a Weighted Overlay Analysis, each of the general overlay analysis steps is followed. The computations made by the AHP are always guided by the decision maker's experience, and the AHP can thus be considered as a tool that is able to translate the evaluations (both qualitative and quantitative) made by the decision maker into a multi criteria ranking. In addition, the AHP is simple because there is no need of building a complex expert system with the decision maker's knowledge embedded in it. Thematic map, which are soil,slope,land use/land cover,streams,road and railway network,hydro geomorphology,drainage density,geology,tanks and depth to water table maps were generated and digitized. The digitized maps are edited, Rasterized and reclassified to suit as an input variable in GIS analysis. The whole process has given an output of digital database required for the study.

Keywords: Analytic Hierarchy Process,Weighted Overlay Analysis,Thematic map and GIS analysis

Introduction

The different geological process like weathering, infiltration, leaching, solution and natural contamination are all belong to the natural phenomena and commonly involve a number of complex dynamic and physical factors[1]. These dynamic processes will be further complicated when there is an interference by man into natural phenomena leads to some change, which may sometimes lead to fatal consequences[2]. The resultant complexities are perhaps,very difficult to fully comprehend because of the inherent limitations in the scientific methodologies we use and the deficiencies in knowledge acquired so far in such a situation[3]. Despite these limitations, information can be obtained to a large extent as to how certain natural processes are naturally operated and how they were obliterated by the interference of man by using and interpreting relevant field and analytical data[4].

Hence, in the present investigation, data have been obtained using different standard scientific techniques that range from various field methods to a variety of lab techniques for understanding these processes in the study area i.e. It is observed that the groundwater quality, slope, Land use/Land cover, hydrogeomorphology, drainage density, hydrogeological conditions soil zone are influencing the groundwater quality and there are varying differences in the Rainfall quality at different places[5].

In any area should be properly located and managed to minimize its effects on the environment[6]. The government and the rural should revise the laws regarding the dumpsites location. These laws should include properly managed sites, which are well fenced in and away from the human settlements[7]. The government should annex laws which see to it that the dumpsites are located properly and if it‘s not then actions should be taken according to the law[8]. There should be a follow up in the functioning of the dumpsites to avoid the pollution on the environment and health hazards[9]. Rural areas have to control the litter and monitor their volume[10]. People need to be educated by health motivators about the effects of the dumpsites on their health[11]. This will limit the effect of the dumpsite on the residents. There should be a follow-up to make sure that what they teach the residents is applied. The GIS optimal routing model implementation in the study area will helpful in the minimum cost/distance efficient collection paths for the solid waste transport to the landfill sites. The suggested model was based on the information of the population density, capacity of waste generation, road network and road types, storage bins and collection vehicles etc[12]. The model proposed can be used as the decision support tool by the municipal authorities for the efficient management of the daily operations for the transportation of the solid wastes, load balancing within the vehicles, fuel consumption management and generating work schedules for the vehicles and workers.

GIS technology can be used for the reallocation of the waste bins in the study area based on the waste generation statistics[13]. The model of study uses the location of waste bins, land uses, road network and type of area like residential, market or institutional etc., in examining the municipal bins to be placed along the various routes of the optimum routing network. The model with improvement through the route optimization gives more efficiency in terms of the distance travelled and collection time. The different parameters consideration is helpful in the collection system and managing the man power too in making the cleaner environments. The people in the study area should be educated and make them aware about the wet and dry waste segregation at the source of their household itself would give better results out[14]. The awareness campaigns must be conducted by the municipal authorities at regular time intervals of period about the solid waste and its impacts to the surrounding environment[15]. People should also think about their habitual actions of throwing the waste and other materials onto the roads or nearby surroundings after their consumption. Instead of leaving or throwing them onto the nearby surroundings, they should make it as a responsibility to throw them in the appropriate waste bins provided by the concerned authorities.

Study area

The area Ananthapur district under the investigation lies between the 76’-50’’ to 78’-30’’ East Longitude and 13’-40’’to 15’-15’’ North Latitude. The area is located in and around Ananthapur District of Andhra Pradesh(Figure 1). District forms the important part of Rayalaseema region. Its northern and central regions are a high plateau, generally undulating, with large granite rocks or low hill ranges rising occasionally. In the southern parts, surface is more hilly. Four rivers flow within the district. Penna,Chitravathi,Vedavathi,Papagni,warnamukhi and Thadakaleru. The important river in the District is Pennar. It has its origin in the Nandi Hills of Karnataka State where it is called "UTTARA PINAKINI" and enters this District in the extreme South of Hindupur Mandal and flows through Parigi, Roddam, Ramagiri, Kambadur, Kalyandurg, Beluguppa, Uravakonda,Vajrakarur,Pamidi, Peddavadugur, River which has its origin in Karnataka State enters this District in Parigi Mandal and joins Pennar River at Sangameswarampalli of Parigi Mandal. Another significant river in the District is "CHITRAVATHI". Its origin is in Karnataka State. This river enters the District near Kodikonda village of Chilamathur Mandal and flows North over Rocky and Hilly uplands of Gorantla,Puttaparthi, Bukkapatnam, Kothacheruvu, C.K.Palli, Dharmavaram, Bathalapalli, Tadimarri and Yellanur Mandals and falls into Pennar River at Gandikota in Cuddapah District. VEDAVATHI or HAGARI RIVER also an important one in the District has its origin in Karnataka State and flows through Gummagatta, Brahmasamudram, Beluguppa, Kanekal and D.Hirehal Mandals and enters Bellary District of Karnataka State. Bhairavanithippa Project (B.T.Project) constructed on this river.vPeddapappur and Tadipatri Mandals and finally enters Cuddapah District. District has 949 villages. Apart from these streams like KUSHAVATHI in Chilamathur Mandal, SWARNAMUKHI in Agali Mandal, MADDILERU in Nallamada, Kadiri and

Mudigubba Mandals, PANDAMERU in Kanaganipalli, Raptadu, Ananthapuramu B.K.Samudram and Singanamala Mandals, PAPAGNI in Tanakal Mandal are important water supply sources to various large and medium irrigation tanks in the district.The study area covering a total area of around 19130 sq.km. The economy of the district is predominantly agrarian with very few industries. With a very scanty rainfall of 563 mm,district is one of the most backward district of the state. Prominent crops are groundnut, rice, sunflower, chilly, bengalgram, sorghum and cotton. Silk trade, limestone quarrying iron and diamond mining constitute th few industries here. Temple town of Lepakshi with famous Veerabhadra. a wonderful example of Vijayanagara architectural style and art is located in Ananthapur. The total 63 Mandals of Ananthapur district are grouped into three revenue divisions. Ananthapur Division(20 Mandals) Vidapanakal, Vajrakarur, Guntakal,Gooty, Peddavadugur, Yadiki, Tadpatri, Peddapappur, Singanamala, Pamidi, Garladinne, Kudair, Uravakonda, Atmakur, Ananthapur, Bukkarayasamudram, Narpala, Putlur, Yellanur and Raptadu. Dharmavaram Division:(17 Mandals) D.Hirehal, Bommanahal, Beluguppa,Kanekal, Rayadurg, Gummagatta, Brahmasamudram, Settur, Kundurpi, Kalyandurg, Tadimarri, Bathalapalle, Kanaganapalle, Kambadur, Ramagiri, Chennekothapalle and Dharmavaram. Penukonda Division:(26 Mandals)Mudigubba, Nambulipulikunta, Tanakal, Nallacheruvu, Gandlapenta, Kadiri, Amadagur, Obuladevaracheruvu, Nallamada, Gorantla, Puttaparthi, Bukkapatnam, Kothacheruvu, Penukonda, Roddam, Somandepalle, Chilamathur, Lepakshi, Hindupur, Parigi, Madakasira, Gudibanda, Amarapuram, Agali, Talupula and Rolla. The soils in Ananthapuramu District are predominantly red except Kanekal, Bommanahal, Vidapanakal, Uravakonda, Vajrakarur, Guntakal, Gooty, Pamidi, Peddavadugur, Yadiki, Tadipatri, Yellanur, Peddapappur and Putlur mandals. In these Mandals red and black soils occur almost in equal proportion. Thus 76% red soils, 24% are black soils. There are 929 inhabited villages, out of 964 total Revenue villages of the District. The number of villages in size group of 500 to 1999 forms 32.79% of the total inhabited villages . The size group of 2000 to 4999 forms 41.37% and the size group of 5000 to 9999 forms 13.57% only out of total villages, while 81 villages (8.80%) of total inhabited villages are having population less than 500. There are 32 villages with more than 10,000 population excluding Towns(2011 census).

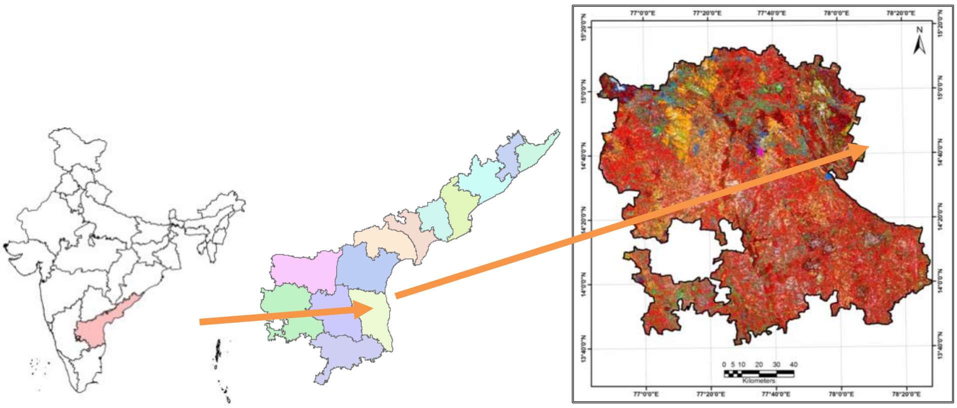

Figure 1. Location map of the study area (Resourcesat-1, LISS IV satellite imagery, 2015)

Materials and Methods

The investigation zone covers 2 sequences of the Survey of India (SOI) toposheets, they are 57 G/10,57 G/6,57 G/2,57 C/14,57 K/5,57 K/1,57 G/13,57 G/9,57 G/5,57 G/1,57 C/13 57 J/8,57 J/4,57 F/16,57 F/12,57 F/8,57 F/4,57 B/16,57 J/7,57 J/3,57 F/15,57 F/11,57 F/7,57 F/3,57 B/15,57 J/2,57 F/14,57 F/10,57 F/6,57 F/2,57 B/14,57 J/1,57 F/13,57 F/9,57 F/5,57 F/1,57 B/13,57 I/4,57 E/16,57 E/12,57 E/8,57 E/4,57 A/6 scale 1:50,000. These toposheets are geo-rectified and projected to polyconic projection (the Metric system units – meters are used as in the present study). These toposheets are geo-rectified and projected to polyconic projection (the Metric system units – meters are used as in the present study). The Ananthapur toposheet map has been scanned and saved in .jpg format and then it is imported into image format which is then referenced to polyconic projection using ArcGIS software.

Results and Discussions

Assigning Percentage Influence and Scale Values of the Maps

The scale value for the individual classes within 10 input maps for the suitable sites map is selected the same as satty scale(1, 3, 5, 7 and 9) by setting evaluation scale from 1 to 9 by the range of 2. These scale values and percentage influence values are based on the calculation performed in chapter 5 (Analytical Hierarchy Process). The tables from Table 1 to 10 show the assigned input given into weighted overlay tool.

Soil

Table 1: Input of Soil Map into Weighted Overlay Tool

Raster	% Influence	Field	Scale Value
Soil	23	Soil	
		Brown Gravel Clay Soil	4
		Brown Clay Soil	5
		Clay Soil	4
		Brown Gravel Loamy Soil	2
		Sandy Soil	1
		Red Clay Soil	5
		Red Clay Soil	1
		Red Loamy Soil	3

LULC

Table.2: Input of LULC Map into Weighted Overlay Tool

Raster	% Influence	Field	Scale Value
LULC	23	LULC	
		Forest	3
		Tanks & Reservoirs	1
		Roads	1
		Plantations	1
		Kharif	1
		Kharif+Rabi(double-cropped)	4
		Wastelands, hills with scrub	3
		Barren & Fallow Lands	5
		Built up Land	2
		Industrial Area	2

Geomorphology

Table.3: Input of Geomorphology Map into Weighted Overlay Tool

Raster	% Influence	Field	Scale Value
Geomorphology	10	CLASSIFICATION	
		Moderately Weathered Pedi plain	5
		Shallow Weathered Pedi plain	5
		Structural Hill	1
		Inter Mountain Valley	2
		Valley Fills	3
		Water Body	1
		Denudation Hills	2
		Pediment Slope	3
		Deeply Weathered Pedi plain	4
		Beach Sand	1
		Dissected Slope	2
		Marine Clay	1
		Isenberg	1
		Marshy Land	1
		Residual Hill	1
		Pediment	3

Geology

Table 4: Input of Geology into the Weighted Overlay Tool

Raster	% Influence	Field	Scale Value
Geology	10	CLASSIFICATION	
		Tidal Flat	1
		Laterite	2
		Granite Gneiss	3
		Quartzite	3
		Charnockite	4
		Khondalite	5

Slope

Table 5: Input of Slope Map into Weighted Overlay Tool

Raster	% Influence	Field	Scale Value
Slope	3	DISTANCE	
		0-250mts	1
		250-500mts	2
		500-750mts	3
		750-1000mts	4
		> 1000mts	5

Groundwater Level

Table 6: Input of Groundwater Level Map into Weighted Overlay Tool

Raster	% Influence	Field	Scale Value
Groundwater Level	10	Groundwater Level	
		< 15 meters	1
		15 to 30 meters	2
		30 to 50 meters	3
		50 to 70 meters	4
		70 to 100 meters (> 70 meters)	5

Drainage Density

Table 7: Input of Drainage Density Map into Weighted Overlay Tool

Raster	% Influence	Field	Scale Value
Drainage Density	5	Drainage Density	
		Very Low Density	5
		Low Density	4
		Moderate Density	3
		High Density	2
		Very High Density	1

Distance to Tanks and Streams

Table 8: Input of Distance to Tanks and Streams Map into Weighted Overlay Tool

Raster	% Influence	Field	Scale Value
Distance to Tanks and Streams	10	Distance to Tanks and Streams	
		< 15 meters	1
		15 to 30 meters	2
		30 to 50 meters	3
		50 to 70 meters	4
		70 to 100 meters (> 70 meters)	5

NDVI

Table 9: Input of Tanks Buffered Distance into the Weighted Overlay Tool

Raster	% Influence	Field	Scale Value
NDVI	3	NDVI	
		Very Low	1
		Low	2
		Moderate	3
		High	4
		Very High	5

Rainfall

Table 10: Input of Rainfall into the Weighted Overlay Tool

Raster	% Influence	Field	Scale Value
Rainfall	10	Rainfall(mm)	
		320-420	1
		420-520	2
		520-670	3
		670-770	3
		770-870	4
		870-950	5

7.7 SITE SUITABILITY MAP

The Final Suitable Sites Map is shown below in Fig.2.

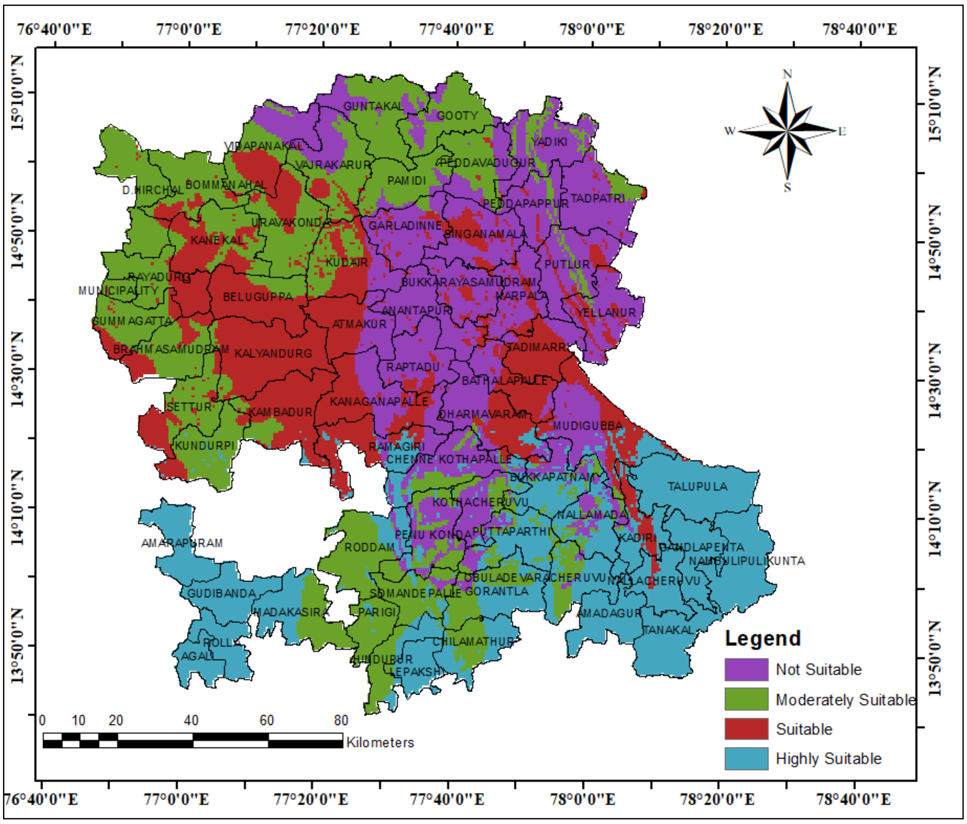

Fig.2: Suitable Sites Map for the Overlay of Suitable Sites Map

Conclusion

In this paper, the scale of 1 to 5 with satisfactory suitability ratings has been chosen shown in Table. 11.

Table.7.11. Suitability Ratings Scale

Scale	Suitability Rating
1	Poor
2	Fair
3	Good
4	Very Good
5	Excellent

The final output map has produced only four classes by the end of overlay analysis because of the Raster calculation explained in illustration section above. The scale values of the output are seen in the attribute table of the map in the "Value" column. The attribute table is shown below in Table 12; the pictorial representation of areas covered under different suitability sites is shown in Fig.7.3.

Table.12. Attribute Table of Suitable Sites Map

Rowid	VALUE	COUNT	SUITABILITY	AREA_SQKM
1	2	17047	Very low	1704.6459
2	3	21111	Low	6083.4691
3	4	29441	Moderate	8418.4607
4	5	10012	High	2001.1201
5	6	9002	Very high	802.8698

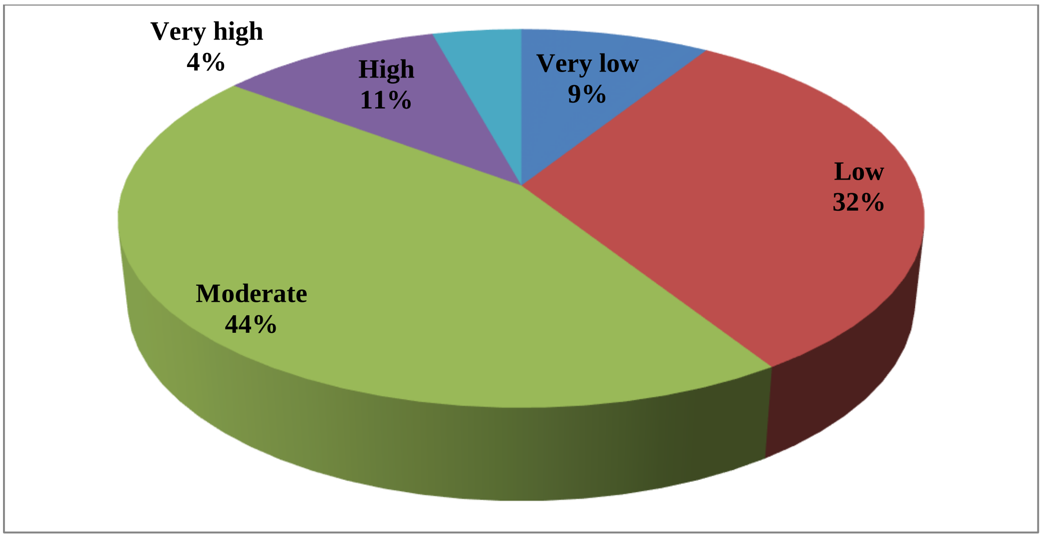

Fig.3: Pictorial representation of Suitability in terms of area

In this analysis, slope, geology, geomorphology has been considered to divide the area into high, moderate and very low site suitability zones. The restoration of ecological balance and the productivity of various land based activities which can indirectly generate gainful employment to the rural poor can be achieved through the effective use of this reliable decision support system. This model provides a holistic picture to enable to share the natural resources and protect them for the betterment of the watershed community. This will also help to plan the infra-structural development needed such as connecting market with local produce. Geo-technical appraisal of all the surface water irrigation projects necessary to avoid unfavourable natural conditions will be easier to develop through participatory methods.

Table. 13. Remedial measures suggested for suitability

Sl. No	Soil loss	Mandals	Weightage Overlay	Sub- Mandals	Suitability	Remedial measures
1	Very low	6,8,9,10,19,20,21,25,26,28, 37,42,43,50,51,52, 53,54	Very Low	48,49,50,51	Very low	Afforestation
2	Low	3,5,7,16,18,22,23,24,31,32, 38,45,47,55, 56	Low	9,52,53,54,55,56, 57	Low	Afforestation
3	Moderate	1,2,4,17,33,36,44,46,48,57	Moderate	1,3,5,6,31,32,33, 36,37,38	Moderate	Check-dams and Contour trench, Contour bunds
4	High	11,12,13,15, 27, 29,30,39,49	High	2,4,7,8,10,11,12, 18,20,21, 22,35,39,40,41,42,43,44,45, 46,47	High	Check-dams and Contour trench, Contour bunds
5	Very high	14,34,35,40, 41	Very high	13,14,15,16, 17,19,23,25, 26,27,28,29,30,34	Very high	Check-dams and Contour trench, Contour bunds

GIS analysis AHP model weighted overlay analysis on the Ananthapur District and RULSE model is also calculated for the study area. Both are categorized into five, namely very low, low, moderate, high and very high. Observed, the natural resource data, thus generated will be useful to conserve and manage sub-basin properly to achieve sustainable development, particularly in ecologically fragile areas in order to meet the living standards of the rural communities. By the comparative study it is concluded that moderate, high and very high soil loss basins with field check the check dam, contour trench and contour bunds are suggested to curb soil loss and conversation structure of mandals. In this analysis, Soil, slope, land use / land cover, geology, geomorphology, drainage density, mean the bifurcation ratio, stream frequency, circulatory ratio, elongation ratio, form factor, texture ratio, compactness coefficient, shape factor, and soil loss maps has been considered to divide the area into very high, high, moderate, low and very low site suitability zones. The restoration of ecological balance and the productivity of various land based activities which can indirectly generate gainful employment to the rural poor can be achieved through the effective use of this reliable decision support system. This model provides a holistic picture to enable to share the natural resources and protect them for the betterment of the watershed community. This will also help to plan the infra-structural development needed such as connecting market with local produce. Geo-technical appraisal of all the surface water irrigation projects necessary to avoid unfavorable natural conditions will be easier to develop through participatory method. GIS analysis AHP model weighted overlay analysis on the madals and RULSE model is also calculated for the study area. Both are categorized into five, namely very low, low, moderate, high and very high. Observed, the natural resource data, thus generated will be useful to conserve and manage watershed properly to achieve sustainable development, particularly in ecologically fragile areas in order to meet the living standards of the rural communities. By the comparative study it is concluded that moderate, high and very high soil loss basins with field check the check dam, contour trench and contour bunds are suggested to curb soil loss and conversation structure.

The Cuddapah and Kurnool developments happening in the north eastern piece of the region include quartzites, shales, and limestones, over a restricted territory in Tadipatri, Yadiki, Yellanur, Putlur, Peddapappur, Peddavaduguru and Gooty mandals (Fig.3). The Cuddapah silt have gone through compaction, transformation during post Cuddapah distortion. Subsequently, the stones have created breaking, blaming and collapsing. Arrangement pits likewise happen in limestone territories. Enduring in shales, limestones and essential nosy shakes by and large shifts from 5.0 to 15.0 mbgl. The profundity of burrowed wells fluctuates from 8.0 to 18.0 m bgl. The profundity to water level changes
from 3 to 15 m bgl. The yield of burrowed wells fluctuates from 50 to 250 cu.m/day for siphoning time of 4 to 6 hrs in a day. Bore wells have been bored by APSIDC for water system 10 a long time back, in the limestone plot. The yields of bore wells are accounted for to be more than 6.0 lps and frequently upto 12 lps. Yet, when all is said in done, it fluctuates from 1 to 5 lps for shifting siphoning times of 6 to 8 hrs day by day. Nonetheless, yields of these drag wells diminished during mid year months and support siphoning for 3-5 hours every day. The greater part of these wells are being utilized for agriculture.

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