Application of Geospatial and Field Techniques to choose Suitable sites for Construction of Subsurface Dams along Papaghni River Basin Y.S.R District A.P India

M. Ramachandra, K. Raghu Babu*, B. Pradeep Kumar, P. Ravichandra
Department of Geology, Yogi Vemana University, Kadapa, Andhra Pradesh, India.

Abstract: The Papaghni River originates in the Nandi Hills of Chikkaballapur district in Karnataka. It enters the Andhra Pradesh in Anantapur district and flow into YSR district at Koduru village. It is a non-perennial, rain fed, seasonal river with its basin receiving 60-80 cm of rainfall yearly. It traverses through a surrounding granitic terrain by eroding the track and forming valleys. The functionality of cutting-edge mapping technology and geospatial analyses to prepare geology and geomorphology maps has been applied in the present study. Papaghni river is one among the rivers of the world characterized by frequent bank erosion leading to channel pattern with changes and shifting of bank line. This observes interest of earth scientists aimed towards the imminent technology of construction of sub surface dams. The Penna River flows along several mandals of YSR district of Rayalaseema area, Andhra Pradesh India, among which three mandals, Vempalli, Veerapunayinipalli, and Pendlimarri are taken for the present study. YSR District is a semi-arid region with very low average rainfall per annum. Sub surface dam is a facility that stores ground water in pores of strata and use floor water in a sustainble manner. These dams have many intrinsic well worth applications that an ideal surface dam lack. The basics about sub surface dams, the development of unique dams across the river, an important precept is a slim valley containing coarse sand particles in the river course where the water can be trapped and avoid flood. Very coarse sand grains create natural voids in their contact with each other, in which more water can be stored. According to a current evaluation of the construction of surface dams, sedimentation, submergence of villages, fertile lands and forest, fall apart, and salination, will occur, in addition to the immaturity and complexity of geological capabilities. These worst effects can be reduced through building of sub surface dam. Constructing a subsurface dam in the Papaghni river channel will prevent the adverse effects of a subsurface dam and in addition equivalent quantity of groundwater can be stored in the upstream. This technology will have boosted up the groundwater assets of several nearby regions which include the Vempalli, Veerapunayinipalli, and Pendlimarri areas bordered via Papaghni River in YSR District. This tries to make out a case for construction of small subsurface dams on the confluence of the Papaghni River to provide water deliver to the continuous drought prone area further East west side of Pendlimarri Vempalli and Veerapunayuni palli and their vicinity.

Key words: Papaghni River, sub surface dams, surface dams, grain sizes sand, pore Space.

I. Introduction

Subsurface dam is a facility that stores groundwater in the pores spaces between the coarse grains of the sand strata which enable its sustainable use (Raghu babu et al., 2018). It has many deserves, as an example, in contrast to a floor dam, it does not allow submerge of land to keep water, and there may be no chance of breaching disasters. The surface region can be used within the same way before and after the construction of the subsurface dam. A subsurface dam allows the development of water assets in regions in which the development of floor dams is hard because of geological conditions, and groundwater can't be used inside the area It is composed of a reduce-off wall via which the groundwater drift is dammed or intrusion of the seawater is averted, and facilities (wells, intake shaft, and pumps) that draw up the stored groundwater. The minimal hindrance in the subsurface dams is that the usage of stored groundwater requires pumping, running expenditure in contrast to those of floor dams which are being planned and built for irrigation (S. Nagata, 1993). Further it needs a surface runoff i.e., the subsurface dam system works only in the villages where the river surface runoff is bordered. The Penna River flows along the three mandals towards the southwest of YSR district. The river flows along the border of Vempalli, Veerapunayinipalli and Pendlimarri mandals, belongs to the geological sub section area with parallel faults oriented from northwest to southeast in the YSR district. The basement forms numerous underground valley systems between these faults. The geomorphological structure shows cuesta inclined toward west. Such geological and geomorphological situations are suitable for the construction of subsurface dams because Groundwater glide can be easily dammed by way of cut-off walls in these valleys. The irrigation assignment with creation of subsurface dams, to increase the groundwater resource for agriculture is considered one of the biggest systems of engineering application inside the river (Sunagawa et.al, 2003). Subsurface dam is a facility that stores groundwater within the pores of pore spaces of sand strata to permit its sustainable use. These dams have other advantages in contrast to surface dams such as built up land doesn’t always submerged to store water, agriculture land, vegetation, forest land will not be lost to aid the storage of water and there is no risk of breaching due to herbal or manmade disasters. The floor vicinity may be used inside the identical way both earlier than and after creation of the dam. A subsurface dam permits the development of water sources in regions where the construction of surface dams is difficult due to geological situations, and dams are composed of a reduce-off wall to dam the groundwater flow and prevent the intrusion of river water, as well as facilities (wells, consumption shaft, and pumps) that draw up the saved groundwater. Since the utilization of stored groundwater in an underground dam requires pumping, the operating charges are better than those of a surface dam. The subsurface dams also facilitate to store some hundred to numerous million m^3 of groundwater like in the case of surface storage of water in the case of surface dams but the only drawback is that it needs a surface runoff. Recently, the concept of the subsurface dam has spread, and many underground dams have been built. This paper critiques some issues of subsurface dams, including their environmental effect. Basic information approximates dams on the geological traits of the stratum maintaining the groundwater, the depth of the stratum, and the permeability and shape of the basement. Generally, shallower groundwater has a better go with the low price. Subsurface dams constructed below ground level that arrest the drift of a natural aquifer and sand garage. Classification of underground dams Groundwater runs thru a particular hydrologic cycle, so the flow fee varies depending on the geological characteristics of the stratum holding the groundwater, the depth of the stratum, and the permeability and form of the basement. Where groundwater runs at an enormously high discharge, the water can be saved by means of barrier the upstream go with the flow with a water-proof hedge as executed with rivers. (Hanson and Nilsson-1986) divided into subsurface dams built underneath floor stage seize that go with the flow of an herbal sand storage Dams that impound water in sediments gathered by way of the dam itself.

The most important production technique for subsurface dams is grouting, but these days' other techniques were used for the construction of subsurface dams. The combination of permeability of river basin and porosity efficient sand bed is enough to gather and store the essential groundwater. The stratum (impermeable base) ought to be the subordinate function in and around the storage layer. There must be a sufficient groundwater recharge to correspond to the quantity of water to be saved. The river total location of 1037 Skm has been studied with the aid of an integrated approach of Remote Sensing and Geographical Information System (GIS). The channel configuration of the Papaghni River has been mapped using IRS-P6 LISS-III satellite screen and same has been adopted for pc photographs eventually. The evaluation of satellite facts has furnished not only the statistics on the channel configuration of the river system on repetitive foundation but also several sizeable additional facts like the changes in river morphology, stable and unstable reaches of the river banks and modifications in the fundamental channel have also been acquired. However, the satellite image provides latest and dependable information on the dynamic geomorphology of the Papaghni River for designing and implementation of subsurface dam improvement programmes and erosion manipulate schemes within the north western region of the Kadapa district. The geomorphological characteristics of Papaghni River Basin, a tributary of Pennar River in south India is derived using IRS P6 LISS III image. Evaluation of a river basin offers a quantitative description of the drainage implement, that's an essential aspect of the characterization of basins. Morphology evaluation using GIS techniques coupled with remote sensing information is appropriate to analyze the drainage basin characteristics because it provides the actual time and accurate data related to distinct geological formations, landforms and help to identify the drainage channels which can be altered with the aid of natural forces or human induced activity.

II. STUDY AREA

The Pendlimarri, Vempalli, and Veerapunayunipalli Mandals are located in the topographical map of 57J07 and 57/J11, of Survey of India. Total area of the mandals is 1037.05sq km The study lies within the area of intersection 77° 45' E and 79° 05' E longitude and 14° 15' N and 15° 40' N Latitude towards the western part of Cuddapah Basin. It covers a place of about 1037 sq.Km. Major district protecting the observe vicinity are YSR district (Fig: 1) the district has a particularly metamorphosed lithology with granitic basement with a profound unconformity. The sediments inside the Kadapa location are due to the upturned edges of gneissic and schistose rocks of Archean age. The bucking impact of the earth produced the concave facet going through the east and the thinning of the crescent alongside the tip. The Western part of the Cuddapah basin has a number of radial factures around the boundary that is due to the release forces (release factures). The western component is comparatively less metamorphosed than the eastern side.

The river borders three mandals flowing along a major fault separating these mandals from each other. There are 11 villages in Vempalle mandal among which 4 villages around one km distance from the river. These villages will be immediately benefited by the construction of subsurface dam while the others will get the benefit in due course of time. There are 26 villages in Pendlimarri mandal. The river flows along Nandimandalam village and 5 more villages are in the vicinity of the river, which are immediately benefited by the construction of subsurface dam. Veerapunayunipalli mandal has a total of 19 villges, among which 6 villages are in the vicinity of the river and immediately benefited by the construction of the subsurface dam.

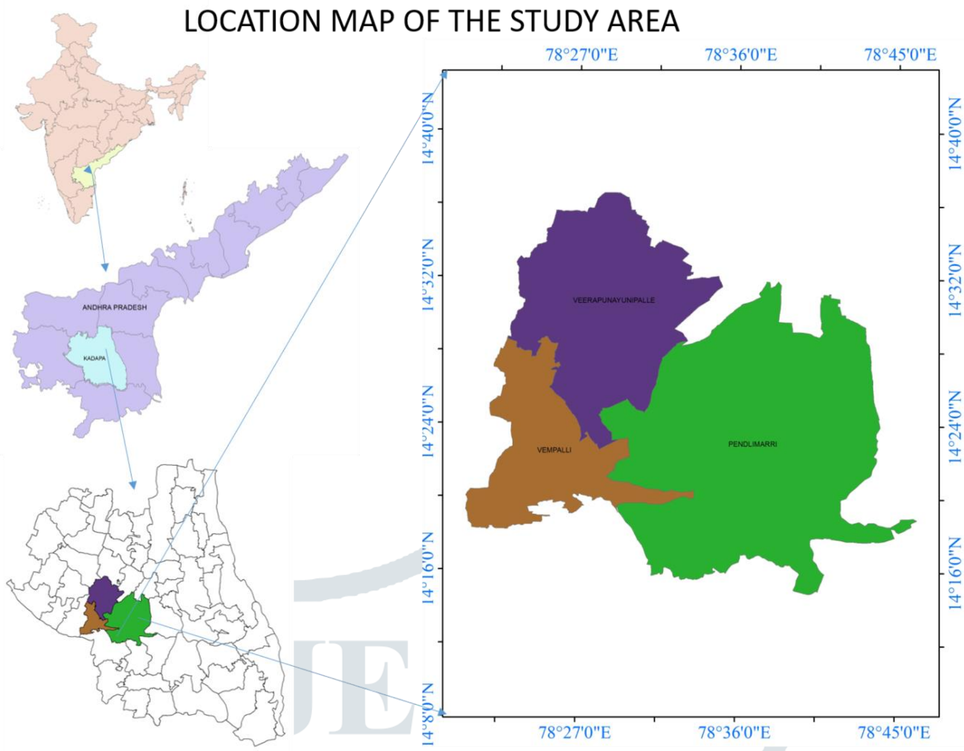

Fig. 1 Location map of the study area.

III. METHODOLOGY

The present look at is an integrated approach by collecting the sand samples from the river bed to measure grain size through field survey, then, IRS P6 LISS III satellite image subjected to image processing is used to delineate the mandal boundaries and river course and then to select a point for the construction of subsurface dam. Also Toposheet no 57J07 and 57J11 prepared by Geological Survey of India is used to put together geological map of the study basin. At the outset the satellite image processed to acquire flow direction and move accumulation the usage of geological device in ArcGIS 10.2. Drainage network became extracted by way of considering pixels approach the river location and mandal boundary was delineated with the aid of giving dispense factor. Sub basins were delineated by taking movement order as threshold the use of sub-basins had been delineated the basin divided into drainage density, flow frequency, relative alleviation, dissection index, and average slope for every network. Various morphometric parameters of entire basin and all sub basins have been calculated based totally on literatures (Horton, 1932, 1945; Strahler, 1952a, b, 1964; Schumm, 1956; Miller, 1953). Geospatial technique became applied for interpolation of put together all corresponding maps.

Google earth is used as records supply for the prevailing observe, 3 fundamental places had been identified with inside the decided on examine location. These places have been marked and have been drawn on Google earth then these polygons have been exported as 500m extenstion record (.Kml) converted from .Kml to layer format the usage of ArcGIS 10 and then exported as shape documents. All exported form documents have been merged in to a new form record containing 3 locations. There after shape files projected to WGS_1984 projection, area of each sample and sum of total sand sample have been separated by different grain sizes (Table 3) as 2000 mtrs area and the most important part of the sand grain sizes was diagnosed at river course VL1, VN2, ND1 (1500m) places of Vempalli, Veerapunayunipalli and Nandimandalam mandals respectively were selected based on the grain size and the river course conveniently narrow down, for the development of dam sites (Fig.7).

IV. RESULT AND DISCUSSION

River locations had been recognized on Google earth imagery, based at the image elements like tone, texture, form, size, sample, and association, and so on. Generally River sand seems in tones of vivid white to dull white (yellow) with coarse medium to great grain sizes due to the presence of minerals. Whereas the sand region identifiable with their slim shape, uneven floor, as proven in (Table 2). The sand excavation depths seems in medium to coarse texture with difficult landscape relying at the depth and moisture content material inside the region. Supplementary photographs were validated with the aid of Google earth historical imagery device to pass test the sand locality regions as subject demarcated in Fig. 5.

4.1. GEOLOGY

The YSR District (Kadapa) is underlain by means of a ramification of rock types belong to Late Archaean or Early Proterozoic era which are succeeded by the rocks of Dharwarian Age and both are traversed via dolerite dykes. The older rocks are overlain by rocks of Cuddapah Supergroup and Kurnool group belonging to Middle and Upper Proterozoic Age. The Cuddapah Sedimentary Basin, that is an good sized, crescent shaped depression over the denuded surfaces of older rocks extending into adjoining districts occupies the foremost a part of the YSR district. The essential rock types are quartzites, shale's, limestones, phyllites, basalts, dolerites, granites, granodiorites, and granite gneiss. The Archaean accommodates the Peninsular Gneissic Complex, represented by granite, granodiorite, granite-gneiss, and migmatite. These rock sorts occur in the south western part of the district. Both the Archaean and Dharwar are traversed by dolerite dykes and quartz Reefs. Alluvium which includes gravel, sand, silt, and clay occur along the river courses in the district.

Table – 1 Lithostratigraphic Succession of study area part

Group	Formation	Thickness (m)	Lithology
Chitravati Group	Gandikota Quartzite	300	Quartzite and Shale
	Tadipatri formation	4600	Shale, Ashfall tuffs Quartzite, Dolomite with igneous intrusives
	Pulivendla quartzite	1-75	Conglomerate, Quartzite
------------ Disconformity -----------			
Papaghni Group	Vempalle Formation	1900	Stromatolitic dolomite, Dolomite, Dolomite mudstone, Chert breccias Quartzite with basic flows and intrusives.
	Gulcheru Quartzite	28-210	Conglomerate and Quartzite
------------ Non-conformity -----------			
Archaean and Dharwar			

In above study area mostly occupied geological succession of Papaghni group and Chitravati group, main lithology being dolomite and quartzite. The river bed is flowing through quartzites of Gulcheru formation which are highly suitable for subsurface dam construction because of their porosity structural disturbances like faults, folds joints and lineaments and with inclinations varying from 5° - >35°. In the present study the sand particles were classified during field investigationo where river width and sand grade are suitable for subsurface dam construction within the latitude and longitudes as shown in Fig. 2.

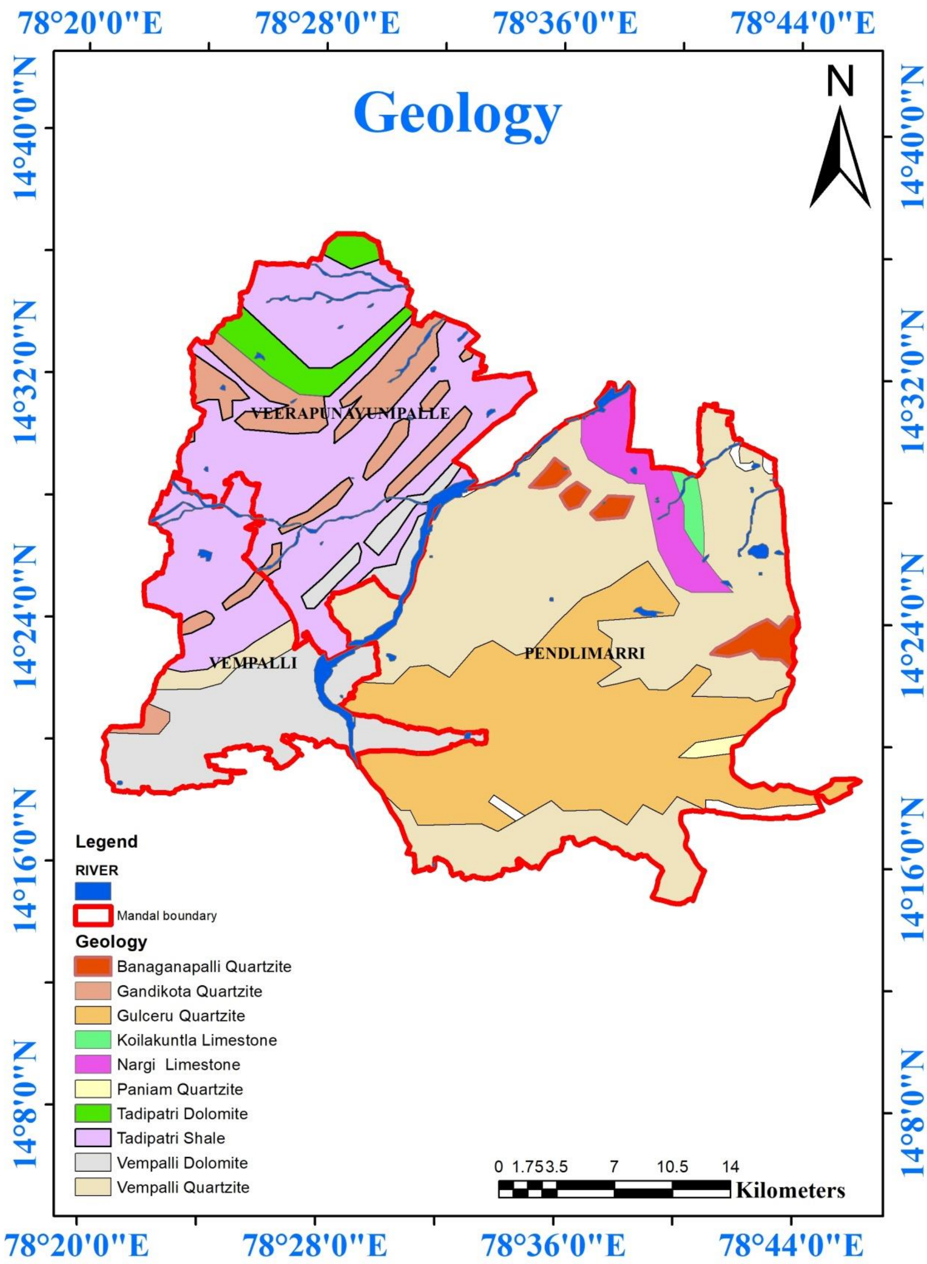

Fig: 2 Geology map of the study area

4.2. GEOMORPHOLOGY

Geomorphologically, YSR District (Kadapa) has been categorised into three units based totally on geomorphological features, slope component, and soil. The 4 groups are

I. Structural land forms ii. Denudational land forms iii. Fluvial land forms and iv. Denudational origin pediment and Pedi plain. Geomorphologically, YSR District (Kadapa) has been categorized into three devices based totally on improvement, slope aspect, and soil.

I) The structural landforms: These encompass structural hills, structural valleys, and cuesta Hills, Mesa/Buttee, linear ridges, intermontane valleys etc. These landforms occupy inConsiderable part and are by and large developed in eastern part.

ii) Denudational landforms: These consist of pediplain, pediment- inselberg complicated, Piedmont region and residual hills. The ground water prospects are constrained in shallow Weathered pedipline and pediment in selberg complex, whereas floor water Prospects are mild in reasonably weathered pediplain.

iii) Fluvial land forms: These consist of alluvial plains alongside essential rivers zones. Flood plains shape highly effective zones, while river bureaucracy alongside foot hills and shape shallow aquifers with top yields. Papaghni eighty four Nandi Hills, Chikbullapur, Karnataka 914m.
iv) Denudational originated pediment – pediplain complex indicates the river is subjected to variace structural and erosional activity in the study area showes fig: 3

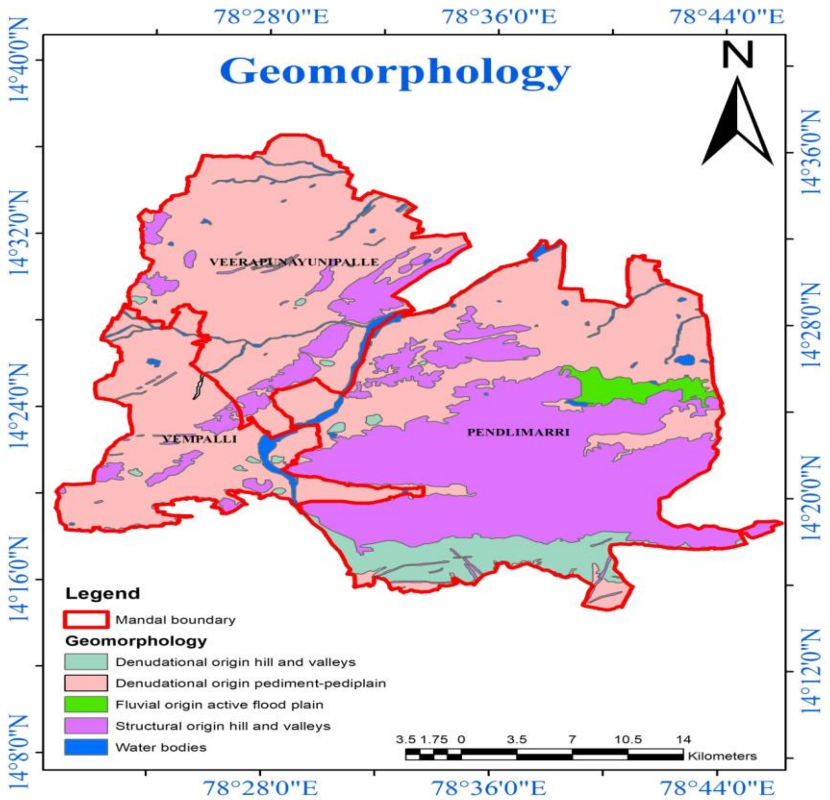

Fig: 3 Geomorphology map of the study area

4.3. SLOPE

The direction of slope map and development of water assent depends particularly on proper understanding and evaluation of physical conditions of the river basin. An integrated method is necessary amongst earth scientists and engineers for proper usage of land and water sources. The development of land and water assets in the Papaghni basin has been proposed, based totally on research from land capability, surface and sub-surface water sources, importance of factors of water balance. The studies of the land functionality of the basin consist of fluvial plains. The slope could be very gentle. It is much less than 5°. The soil fertility is outstanding. The ground water assets are brilliant. The erosion susceptibility may be very low. Land consists of hilly terrain with much less than 35° slope. These are placed in northern, principal, and southern elements of the basin. The land development that might be taken up are land leveling and land grading, terrace bunding and creation of rock fill dams and sub surface dams for conservation of sand sources as shown in fig: 4

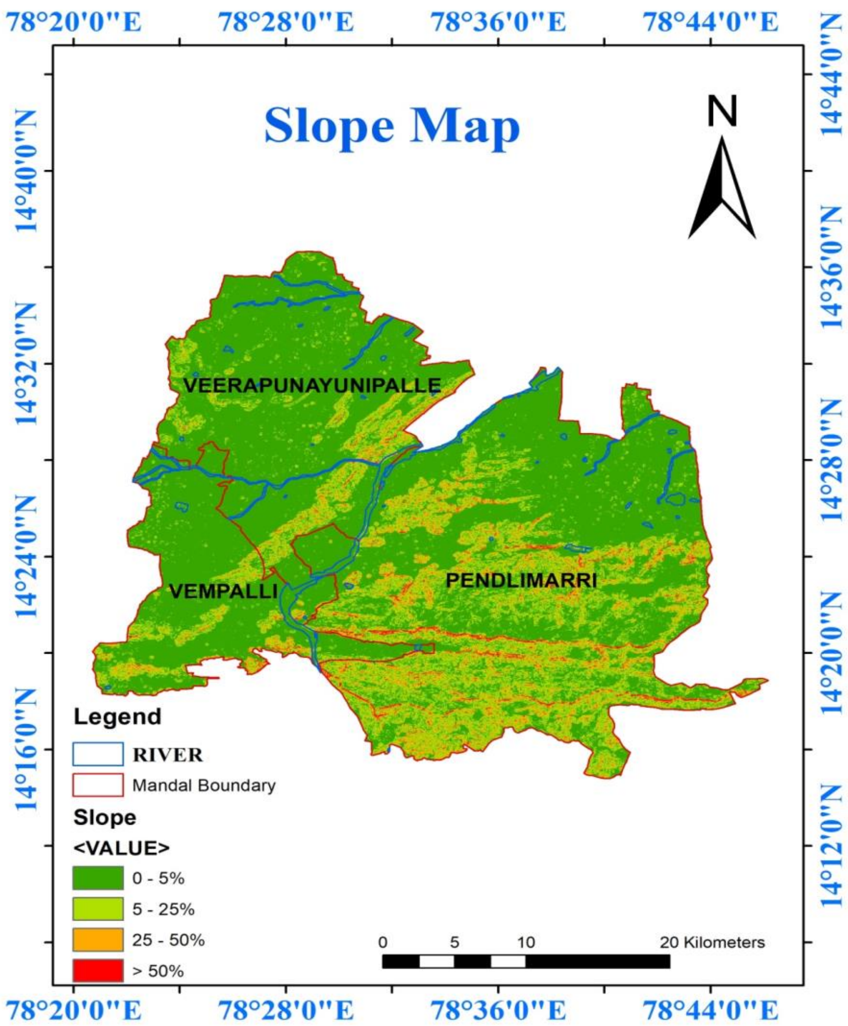

Fig: 4 Slope map of the study area

4.4. DRAINAGE AND DRAINAGE PATTERN

The observed location situated in the south western a part of Kadapa district, accommodates the Papaghni river valleys bordering the three mandals of west to east with a place of 1037.05 square kilometres, vicinity representing mountains and thick woodland areas. Drainage patterns are the design shaped by the combination of drainage methods in a place irrespective of whether they are occupied with the aid of everlasting streams (Howard, 1967) reflecting the surface and subsurface situations. Fig 6 Shows the Drainage model of the proposed location and suggests the Superimpose of drainage map on DEM. The important river that drains through the mandals is Papaghni which is perennial and flows in NW-SE direction. Papaghni river is one of the major the tributaries of Penner River and its other tributaries are Chitravathi, Kundair, and Sagileru are intermittent in nature. The drainage pattern in general is dendritic to sub-dendritic and The drainage is often parallelto sub parallel indicating structural control, which indicates the lithological structural and geomorphic control and physiographic setting of the study area.

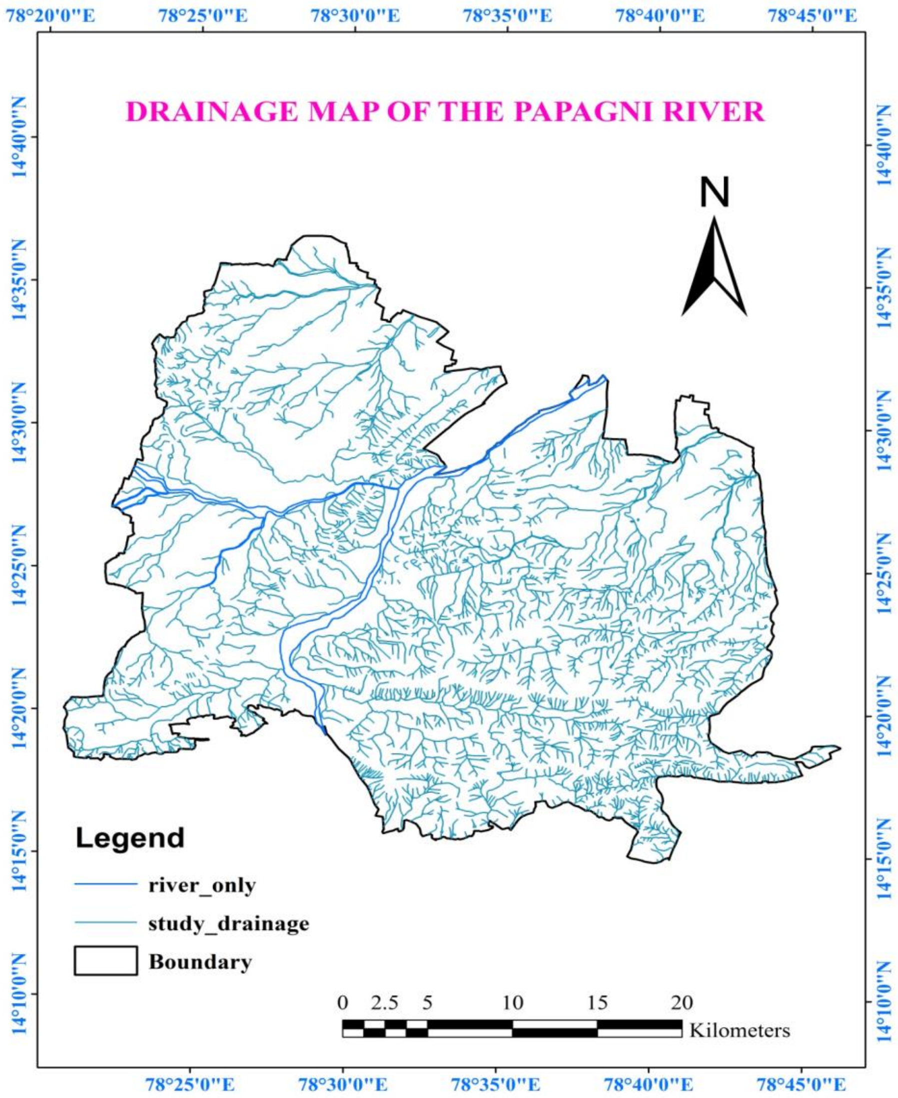

Fig: 6 Drainage and River map of the study area

4.5. SITE SUITABILITY FOR SUBSURFACE DAM

In majority, three factors are considered in the present study for the selection of site for subsurface dam. The foremost is that the host rocks underlying the river basin. The rocks should be harder and weather resistant and should allow the water content stay for a longer duration. The second factor is regarding the grain size of the sand particles in the river bed. The sand in the river bed around the study area has been collected in not less than three in one station (mandal/village) for grain size analysis of the sand particles. The point where very coarse grains or even coarse grains obtained is considered for the subsurface dam site. The farthest consideration is to look for the point where the river course gets narrow down in the flow along. In the present study five locations have been identified using google earth satellite data for the construction of dam site based on the factor that the river course gets narrow down (Fig. 7a, b, c). But finally three locations have been demarcated based on the fact of fulfilling the other two principles mentioned earlier (Table-5).

Table: 2 Sand size analyses in different points of river course

Sample	Sample No.	Name of the village/mandal	Coordinates	Size Range approx. inches	Class
1	VL1	Vempalli/ Vempalli	14°21'32.8"N 78°27'57.4"E	>0.039	Very Coarse
2	VL2	Vempalli/ Vempalli	14°21'33.9"N 78°27'57.2"E	0.020–0.039	Coarse
3	VL3	Vempalli/ Vempalli	14°21'57.3"N 78°27'57.2"E	0.010–0.020	Medium
4	VN1	U Rajupalem/ VN Palli	14°26'02.5"N 78°31'11.7"E	>0.039	Very Coarse

5	VN2	U Rajupalem/ VN Palli	14°26'00.6"N 78°31'09.7"E	0.020–0.039	Coarse
6	VN2	U Rajupalem/ VN Palli	14°26'05.3"N 78°31'14.1"E	0.010–0.020	Medium
7	ND1	Nandimandalam/ Pendlimarri	14°24'45.5"N 78°30'42.4"E	0.020–0.039	Coarse
8	ND2	Nandimandalam/ Pendlimarri	14°24'46.8"N 78°30'42.4"E	0.0049–0.010	Fine to silt
9	ND3	Nandimandalam/ Pendlimarri	14°24'48.5"N 78°30'43.3"E	0.0049–0.010	Fine to silt

Table: 3 Grain size analyses (Wentworth Classification)

Aggregate name	φ scale	Size range (metric)	Size range (approx. inches)
Coarse	1-10	½–1 mm	0.020–0.039 in
Medium	2-1	¼–½ mm	0.010–0.020 in
Fine	3-2	125–250 µm	0.0049–0.010 in

Fig. 7a, b, c – Selected locations for Subsurface dam site

(a)

(b)

(c)

Table 4 Proposed dam sites.

Sample	Name of the mandal	Name of the village	Coordinates
1	Vempalli	Vempalli	14°21'32.8"N 78°27'57.4"E
2	Vempalli	Vempalli	14°21'33.9"N 78°27'57.2"E
3	VN Palli	U Rajupalem	14°26'02.5"N 78°31'11.7
4	VN Palli	U Rajupalem	14°26'00.6"N 78°31'09.7
5	Pendlimarri	Nandimandalam	14°24'45.5"N 78°30'42.4"E

Table 5 Finalized points of subsurface dam site

Sample	Name of the mandal	Name of the village	Coordinates	Size Range (inc	Class
1	Vempalli	Vempalli	14°21'32.8"N 78°27'57.4"E	>0.039	Very Coarse
2	VN Palli	U Rajupalem	14°26'02.5"N 78°31'11.7"E	>0.039	Very Coarse
3	Pendlimarri	Nandimandalam	14°24'45.5"N 78°30'42.4"E	0.020 -0.039	Coarse

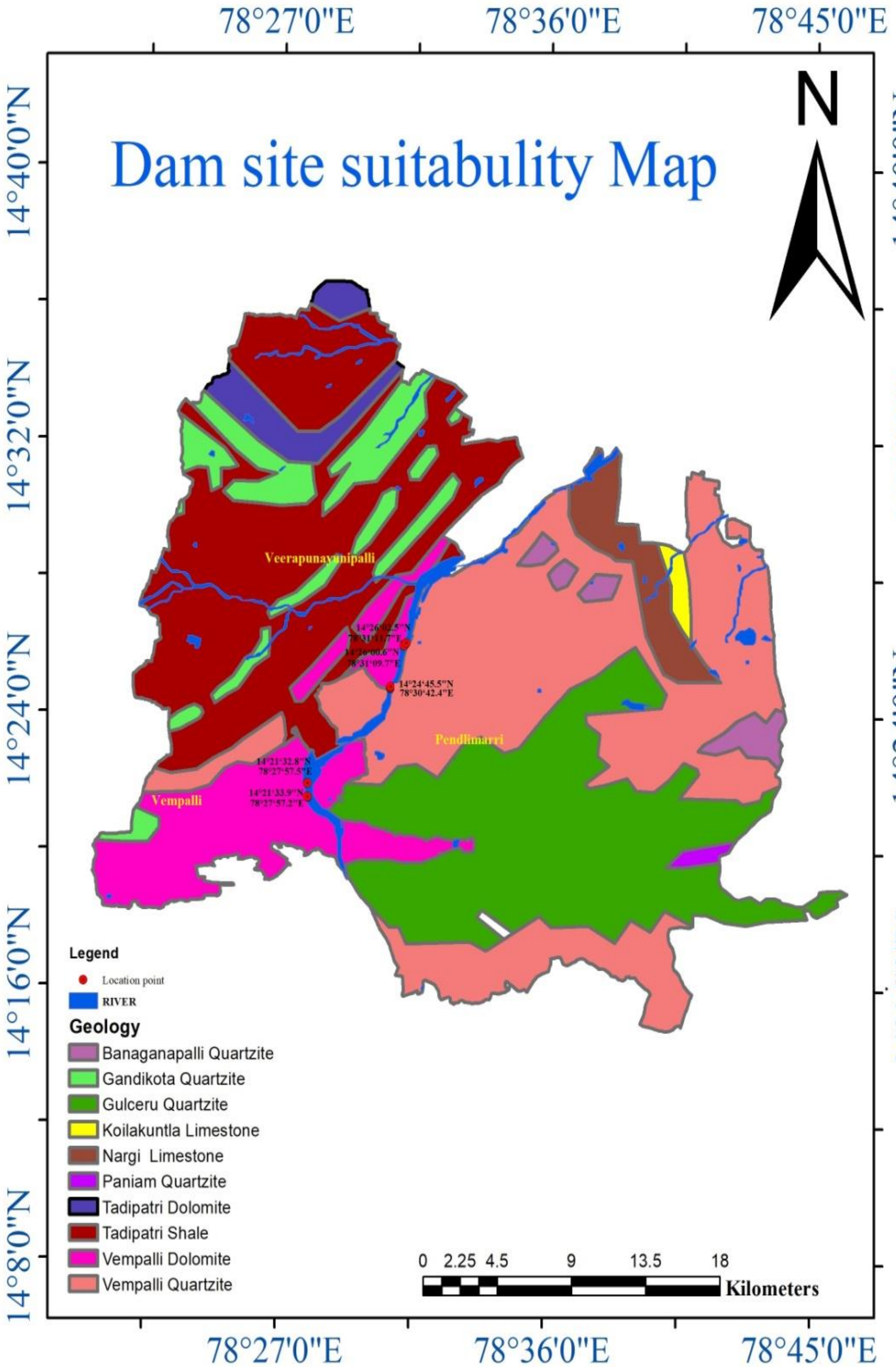

Fig: 7 Finalization map of the study area

Plate 1: - Sand sample collection from papagni river for dam site suitability.

Plate 2: - Sand grain Analysis of Grading in sedimetology laboratory A) Sand collected from Papagni River; B) sand grading by seive analysiss by using various seive sizes. C&D) coarse medium fine and very fine grade sand from two sites.

5. CONCLUSION

The geotechanical methods were recognized on the proposed sub surface dam site; they have been widely examined in sand grain sizes and within the laboratory. Rock solubility under in river circumstance became investigated. Geological and geomorphological variation tests were executed on sand specimens received from river region inside the dam site foundation. The major drawback of the subsurface dam system is that it needs a surface runoff. Further the requirement will not be fulfilled in the situation and in the preferred regions suitable for multipurpose dam construction where the subsurface dams cannot be recommended. Papaghni River was identified by using various thematic maps by using Geospatial technologies. In order to improve or increase the rate of infiltration of the inflow of Papaghni river by analysing various thematic maps like geology, geomorphology, slope, drainage pattern and sand sieve analysis the following locations identified three location latitude and longitudes (14°21'32.8"N 78°27'57.4"E, 14°21'33.9"N 78°27'57.2"E,14°26'02.5"N 78°31'11.7"E, 14°26'00.6"N 78°31'09.7"E, 14°24'45.5"N 78°30'42.4"E) for the construction of sub surface dams.

Based on the studies carried out in three locations along the Papaghni river basin three points have been identified finally suitable for the construction of the subsurface dam. These locations are satisfying all three principle factors for the construction of the subsurface dam (Table-5). Further, it is concluded that the application of geospatial techniques for mapping or identifying are suitable sites for construction of subsurface dams in the study area played a vital role. By integrating various geospatial technologies are RS, (GIS), and Global positioning system (GPS).

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