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Assessment of Groundwater potential zone using remote sensing and GIS, A case study in Nandhiyar sub basin, Tamilnadu, India

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Abstract: Groundwater is one of the greatest hidden natural resources of the earth's crust. It has ubiquitous occurrence. The deformative forces and different earth processes depending upon the nature and composition of the rocks produces characteristic structural, morphological features, which themselves are responsible for the groundwater accumulation, storage and movement, a detailed understanding of all these pathfinders and appreciation of their relative significance in different hydro geological environment is essential in proper planning and management of the groundwater resources. Assessing the groundwater potential zone is particularly important for the safety of water quality and the management of groundwater systems. A case study was conducted in Nandhiyar sub basin to find out the groundwater potential zone. The thematic maps such as geomorphology, geology, soil, drainage, lineament map were prepared in Arc GIS. All the thematic layers were integrated in to Arc GIS 9.3 software to find a groundwater potential zone map of the study area. Thus, three different groundwater potential zones were identified, namely 'Poor', 'Moderate' and 'Good'.

Key words: Groundwater, Nandhiyar, Geomorphology, Soil, Lineament etc

I. INTRODUCTION

Water is one of the most essential commodities for mankind and the largest available source of fresh water lays underground (Todd,1980). It is one of the most significant natural resources which support both human needs and economic development. Tremendous increase in the agricultural, industrial and domestic activities in recent years has increased the demand for good quality water to meet the growing needs. Groundwater is mostly preferred to meet this growing demand because of its lower level of contamination and wider distribution (Biswas Arkoprovo et.al.,2012).

Groundwater resources are an important natural resource for its use in domestic, agriculture, and industries purposes. There has been a tremendous increase in the demand for groundwater due to increase in population, advanced irrigation practices and industrial usages (Ramamoorthy and Rammohan,2015).

The occurrence of groundwater at any place on the earth is not a matter of chance but a consequence of the interaction of the climatic, geological, hydrological, physiographical and ecological factors. Groundwater exploration operation is essentially a hydrogeological and geophysical inference operation and is dependent on the correct interpretation of the hydrological indicators and evidences (Antony Ravindran,2012).

Several researches have utilized the GIS technology and the remotely sensed derived data for water resources management, groundwater assessment and modeling. This study addresses the strategies for an integrated approach of remote sensing and GIS techniques to delineate groundwater prospective zones. The technique of integrated remote sensing and GIS has proved to be an efficient tool in groundwater studies (Edet et al. 1998; Krishnamurthy et.al 1996 and Murthy 2000). The Remote Sensing and GIS tools have opened new paths in water resources studies. One of the greatest advantages of using remote sensing and GIS techniques for hydrological investigations and monitoring is its ability to generate information in spatial and temporal domain, which is very crucial for successful analysis, prediction and validation (Sarma and Saraf, 2002).

II. STUDY AREA

The study area Nandhiyar Sub basin is located on the western part of Chennai basin group and it spread over parts of Vellore and

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Thiruvallur Districts of Tamil Nadu (Fig:1). The sub basin is bounded on the eastern and southern sides by Kosasthalaiyar sub basin, north by Nagari sub basin and western side by Andhrapradesh State. The areal extent of study area is 622.26 sq.km. It covers in Survey of India toposheets 57 O/7,57 O/8, 57 O/11 and 57 O/12.

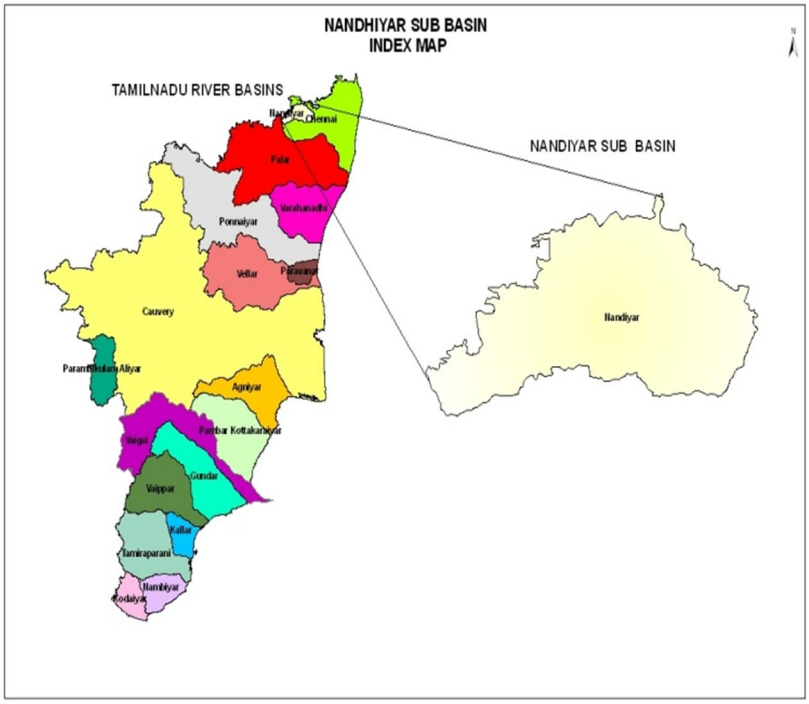

Fig:1 Location Map of study area

A. Materials Used

IRS ID, P6 LISS III &LISS IV satellite data have been used in the present study area and Survey of India toposheets 57 O/7, 57 O/8, 57 O/11 and 57 O/12 at 1:50,000 scales have also been used. Arc GIS 9.3 software have been used for analysis and mapping of the individual layers.

B. Methodology

The base map of study area was prepared from Survey Of India (SOI) toposheets.ARC GIS 9.3 was used to prepare various thematic maps such as Geomorphology, Geology, Soil, Lineament, landuse, etc. The all thematic layers were integrated and prepared ground water potential zone map by weighted overlay analysis method and classified as 'Poor', 'Moderate' and 'Good'.

C. Result and Discussion

1) *Geology:* A geological map of Nandhiyar sub basin (Fig:2) was derived from district geological resource maps of Geological Survey of India. This sub basin is occupied by mostly hard rock formation. Rocks of Archaean and Proterozoic are exposed in this sub basin. Epidote Hornblend gneiss occur in the eastern part of the sub basin whereas charnockite occupies in the southeastern part of the sub basin. Patches of acid intrusive of proterozoic age comprising granite and quartz veins are seen in the study area. The granite occurs as linear bodies in east and southeast of Thiruthani and southwest and north east of Sholingar. It is pink to grey, coarse grained to porphyritic and has a granodioritic composition. Several isolated exposures of the intrusive granite are also seen in the southwest of the study area.

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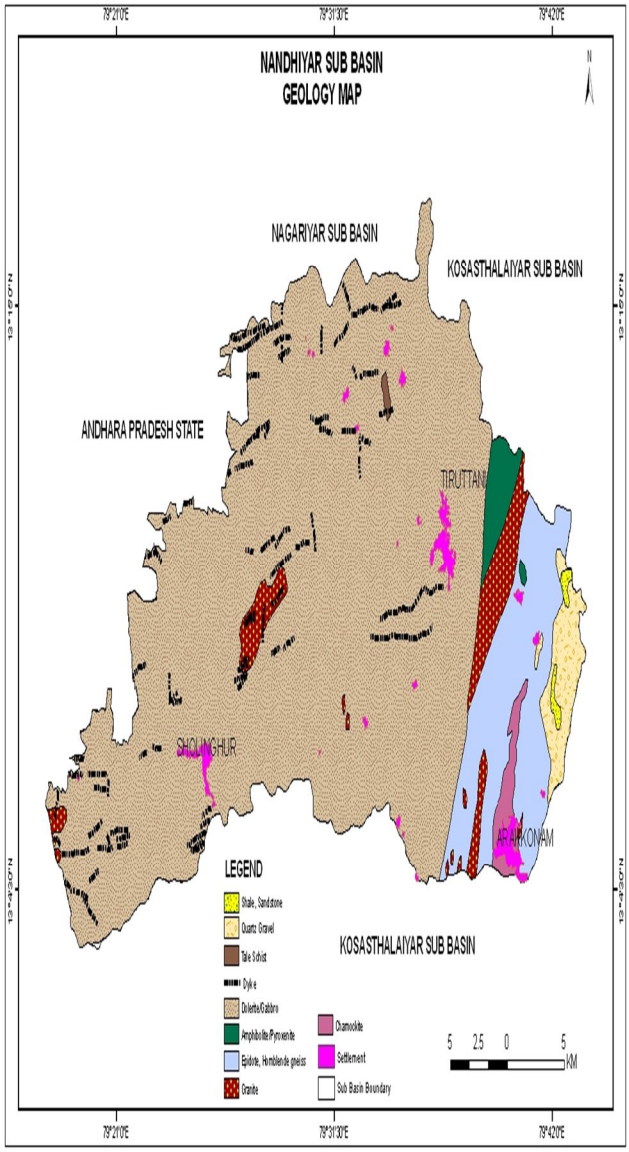

Fig:2 Geology Map

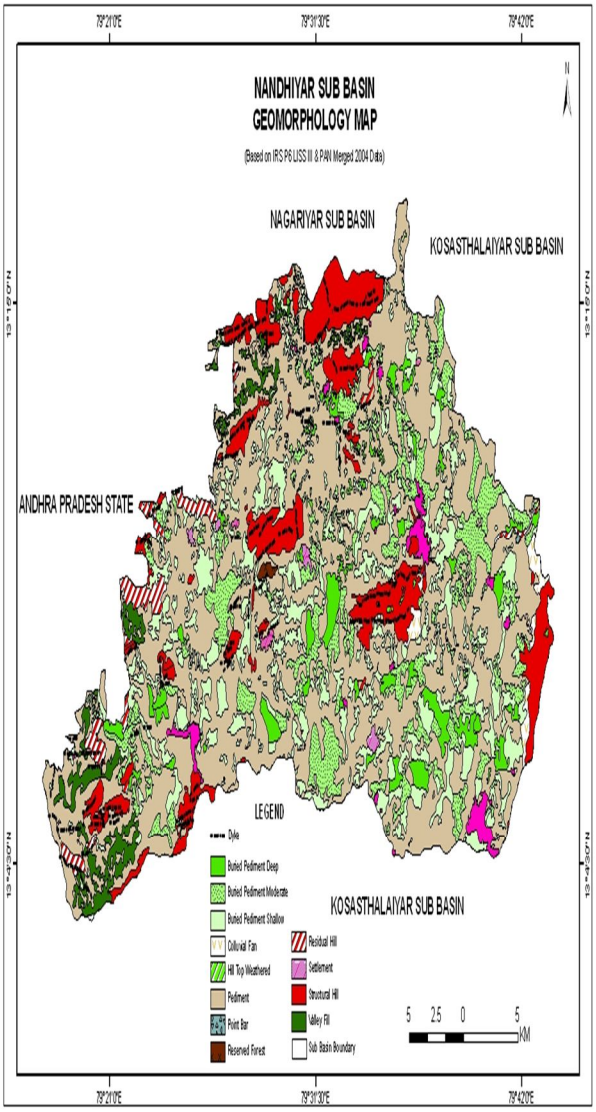

Fig:3 Geomorphology Map

2) *Geomorphology:* Geomorphic features play a vital role in the evaluation of surface and ground water resources. The hydro geomorphic units such as flood plain, valley fill, buried pediment is good sources of groundwater where as structural hills, pediment zone and gullied land are poor recharge zones (Subagunasekar et al.2012).

The following geomorphological features are identified from the study area, Pediment, Buried Pediment (Shallow), Buried Pediment(Medium), Buried Pediment(deep),Structural hill, dyke etc.

The north west portion of the sub basin covered by vast pediment zone.Some portion in the northeast and northwest part of study area covered by Buried pediment (shallow), Buried Pediment (Moderate) is found in the upper central portion of the sub basin(Fig:3).

3) *Soil:* Soil map (Fig:4) of Nandhiyar sub basin was prepared based on soil classification National Bureau of Soil Survey and Land use Planning, Bangalore (NBSS) in co-operation with the Department of Agriculture, Tamil Nadu. The predominant soil types found in this sub basin is Alfisols, and Inceptisols. Due to different stages of weathering of parent material, the above soil types are met with in mixture.

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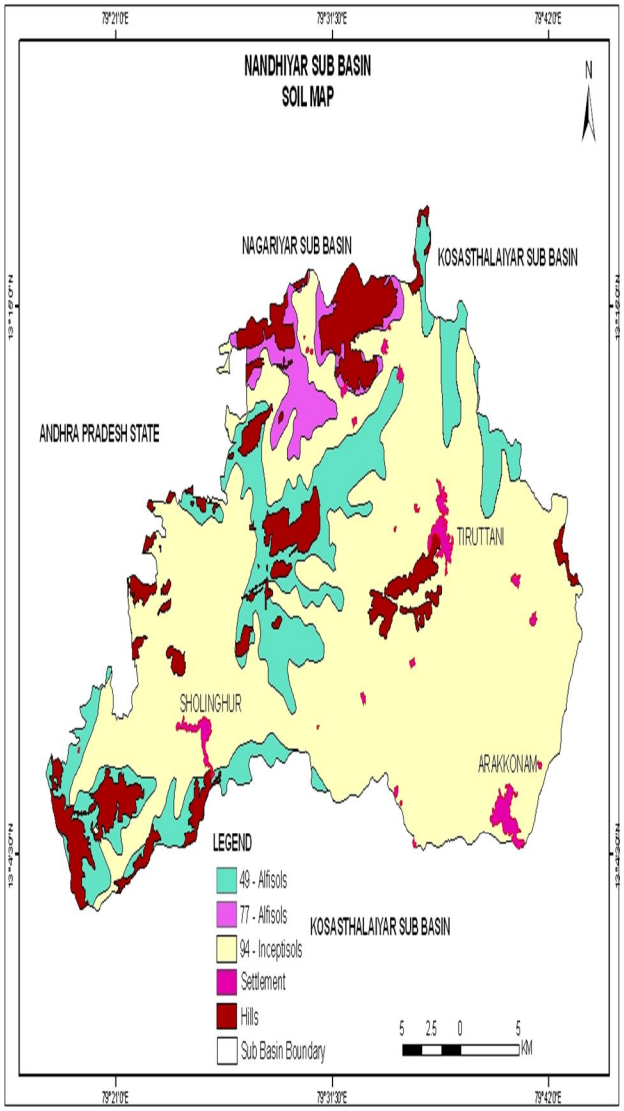

Fig: 4 Soil Map

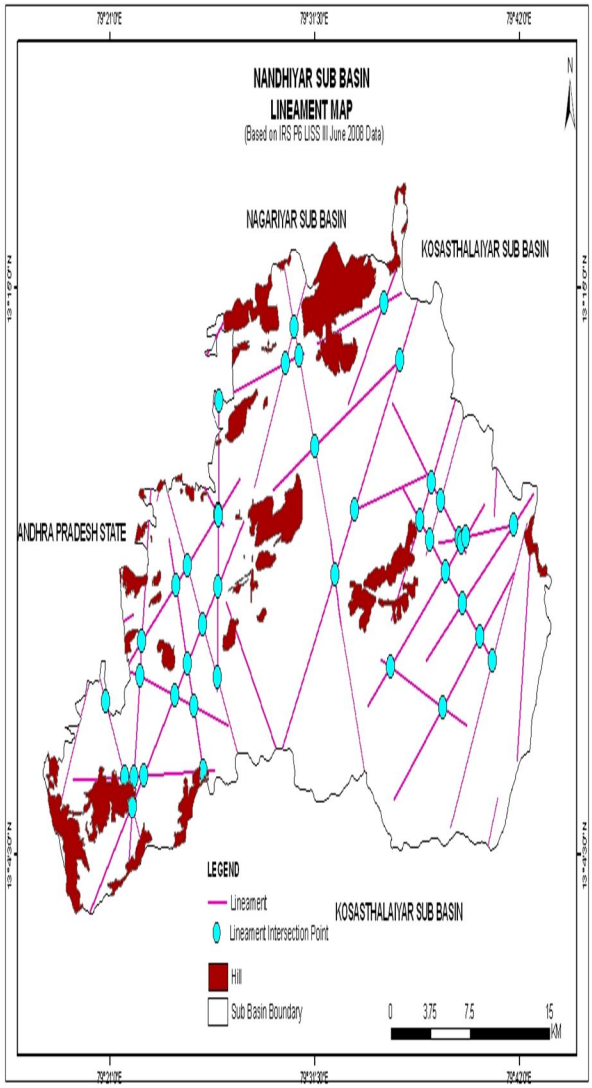

Fig:5 Lineament Map

4) *Lineament:* Lineaments are surface manifestation of the linear fractures like faults, joints and fractures, groundwater potential of high order is indicated where lineament run along and across the weathering rock deposit are intersect on another(Radhakrishnan and Ramamoorthy,2014). Lineament features indirectly reveals the groundwater potential zones,areas with high lineament density are good for groundwater potential zones (Haridas et al., 1998). The lineament intersection areas are considered to be good groundwater potential zones (Pothiraj and Rajagopalan,2012). The lineament trending North east and South west are identified in the study area indicating regions of good groundwater source (Fig:5).

5) *Drainage:* Nandhiyar is the tributary of Kosasthalaiyarriver which runs towards east in the central part of the sub basin. The river Nandhiyar originates from Puttur hill at an altitude of 582 m near Singasamudram in Andhra Pradesh. Drainage map (Fig-6) of the study area shows in predominantly dentritic pattern.

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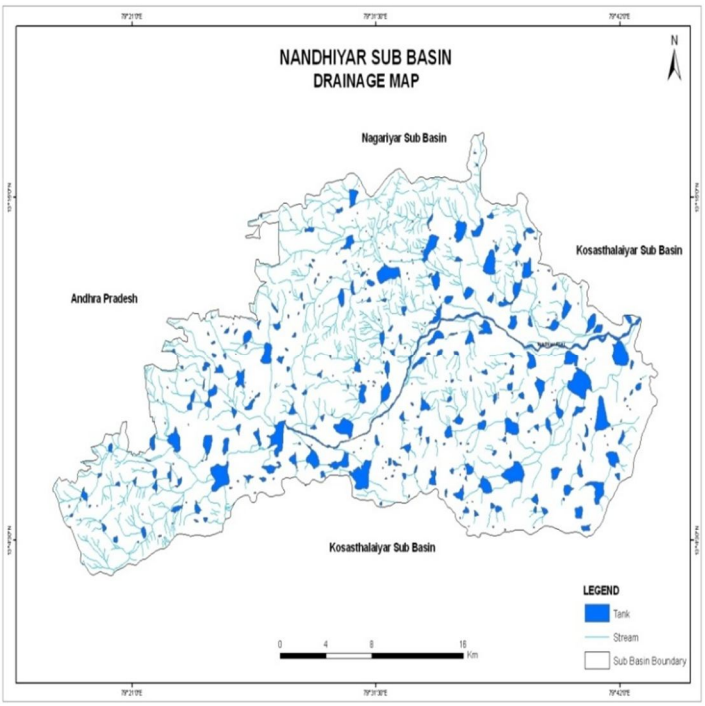

Fig: 6. Drainage Map

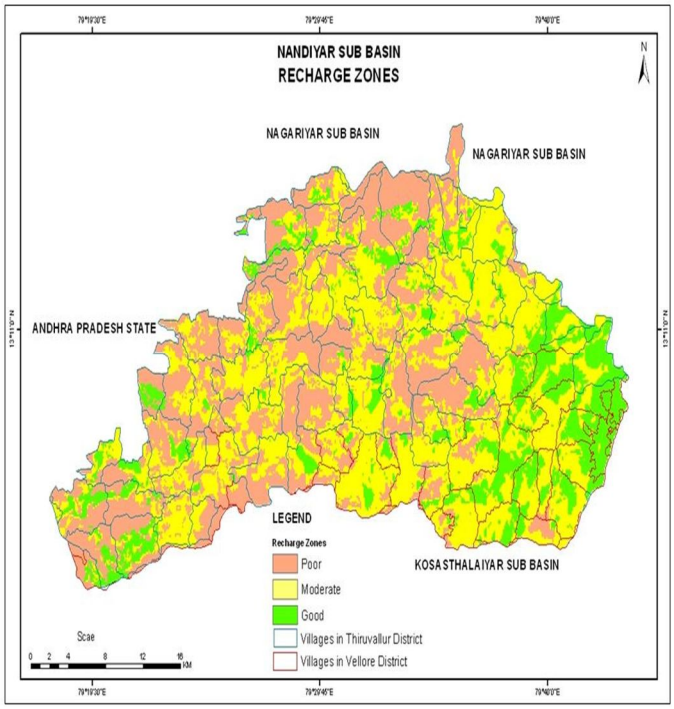

Fig: 7. Groundwater Potential Map

6) Groundwater potential zones: By integrating the various thematic maps such as geology, geomorphology, soil, lineament, and drainage, with Arc GIS 9.3 software using weightage index overlay analysis and the groundwater potential zone was classified as poor, moderate and good (Fig.7) and assigning the weighted values and there rank was shown in table:1.

TABLE :1 - RANKS AND WEIGHTAGES FOR VARIOUS PARAMETERS FOR GROUNDWATER POTENTIAL ZONE.

Criteria	Features	Weightage	Rank
Geology	Sand stone /shale	3	High
	Quartz gravel	3	
	Talc schist	2	Medium
	Amphibolite/Pyroxenite	1	Low
	Epidote,,Hornblende Gneiss	1	
	Granite/Charnockite, Dolerite/ Gabbro	1	
Geomorphology	Buried pediment(Deep)	3	High
	Buried pediment(Moderate)	2	Medium
	Buried Pediment (shallow)	2	
	Pediment	1	Low
	Structural hill	1	
Lineament	Present	5	High
	Absent	1	Low

III. CONCLUSION

GIS plays a more important role in the evaluation of groundwater potential. It is a prime component for the integration and analysis of the spatial and non-spatial information. By integrating all the thematic layers, the study area classified in to (i) Poor (ii) Moderate and (iii) Good groundwater potential zone. The study reveals that combination of Buried pediment (deep), Lineament, lineament intersection and drainage shows good source of groundwater. From this study observed that remote sensing and GIS tool can utilize successfully to categorize the groundwater potential zones. This groundwater potential zone map will be useful for effective

identification of apt locations for withdrawal of groundwater. It can be used for future development and management the groundwater source in the study area.

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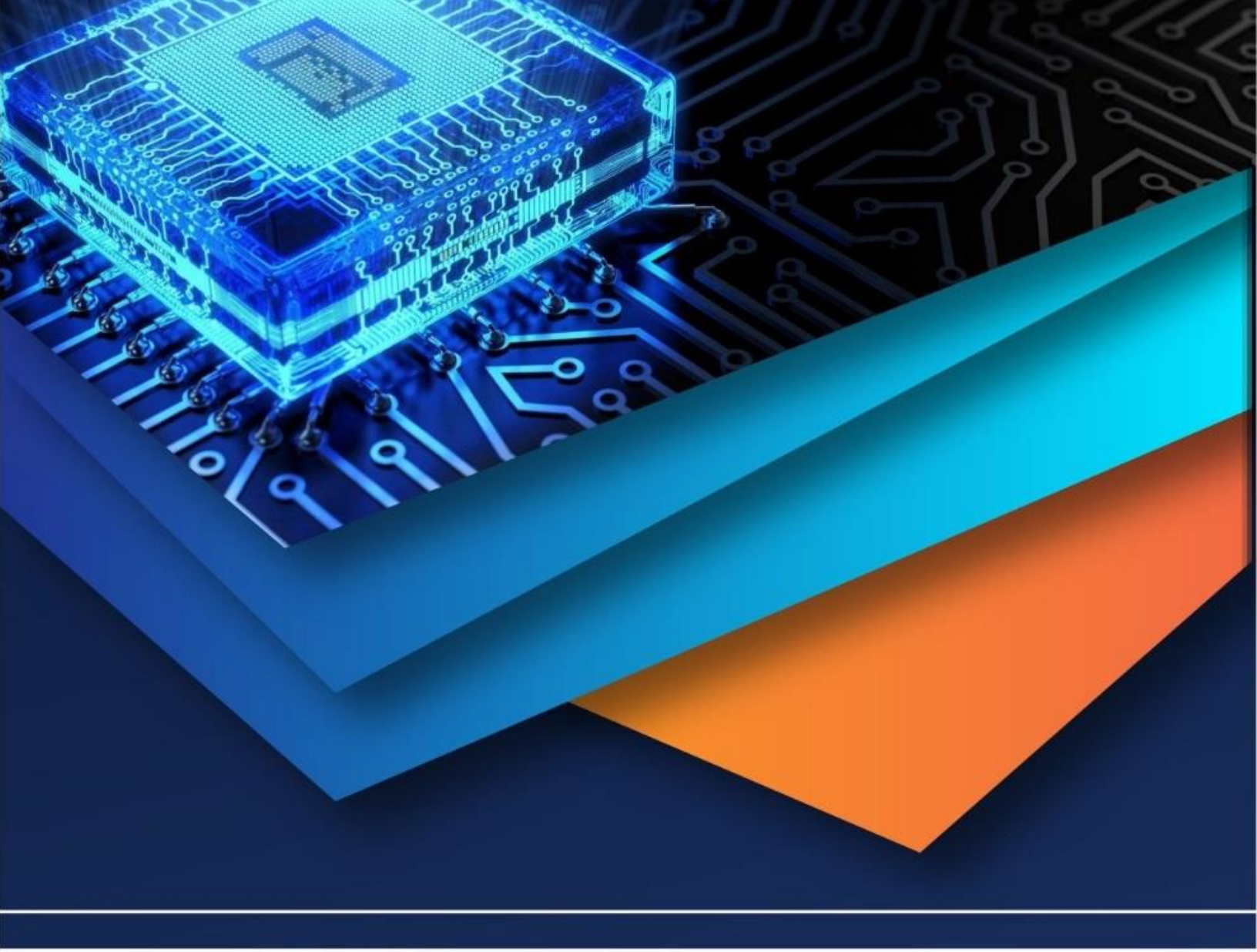

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