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Impacts of Climate Change on Area and Production Under Different Crops in Bhandara District: Central India

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Abstract: ***The present study Impacts of Climate Change on Area and production under different crops in Bhandara district, Central India. The hydrological parameters such as rainfall, drainage analysis, topographic parameters, and land-use patterns were evaluated and interpreted for district management of the area. This has been done using the sofware of the Arc map module in Arc GIS 9.3 and ERDAS Imagine 9.2 satellite image analysis. The hydrological investigation shows that the climate of the basin is characterized by hot summer from March to May followed by a rainy season from June to September. The post-monsoon season is also observed in the month of October. The annual mean rainfall range varies from 1,000 to 1,400 mm. The temperature rises rapidly from March to May. The monthly average maximum temperature rises to 47.50 Celsius in the month of May. In summer, the nights are cool compared to the scorching heat of the day. Bhandara district receives more rainfall than other districts of Maharashtra. The main crop here is paddy (rice). And 70% of agriculture is rain dependent. Total average rainfall for five years in seven districts of Bhandara district was recorded. Considering the total average rainfall in 5 years, Lakhandur taluka has the highest rainfall while Tumsar taluka has the lowest.***
Keywords: Agriculture, Climate, Sustainable Water Resource Management

I. INTRODUCTION

Agriculture can be broadly defined as a business carried on by a farmer on his own farm for livelihood or as a business. From the produce to be taken from the farm, agricultural crops, rice farming, livestock farming, fish farming etc. Various types have come into existence. Also, according to the availability of irrigation, horticultural agriculture, arable farming are also types. According to the use of fertilizers, various types of organic farming, chemical farming have come into existence. Broadly, natural and economic factors lead to changes in agricultural patterns [1,2,3,4,5]. Agriculture is a very important part of human life in India. Natural or natural factors do not change from year to year. The most important among them are climate, land and topography. The crop that can grow in a restricted area depends on these factors. Long-term crops like horticulture cotton and sesame and sugarcane can grow well in low rainfall areas if water is available for irrigation. In this way, a viable form of agriculture that did not exist before can be created there. Rice farming and tropical fruit orchards are possible in Konkan [6,7,8,9,10].

Economic Factors Various natural factors determine what can be grown in a given terrain; But it is not possible to tell which crops or the type of agriculture will be profitable. It has to be determined from time to time changing economic factors. It has to be determined from time to time changing economic factors [11,12,13,14,15]. These factors are production costs, selling costs, competition with other industries, changes in the relative prices of farm produce, vicious cycles of unrealized growth and decline in production, specific demands of those markets, land prices, available capital, labor supply, crop pests and diseases, and personal Factors etc. Farming practices are planned keeping in mind their overall impact [16,17,18,19,20].

Nature has provided man with all kinds of resources through the earth to fulfil his basic and subsequent increasing needs. In order to take advantage of this opportunity, human beings must fully understand nature. Nature must be understood in order to understand how the actions and reactions in nature work and what are its effects and how humans can benefit from it. Therefore, without a thorough study of natural geography, human progress cannot be made [21,22,23,24]. Climate change is mainly caused by temperature and precipitation. These two factors are of great importance Temperature is an important factor that directly affects agriculture because temperatures higher than the specific temperature required for growth of any type of crop is detrimental to crop growth. The impact is also expected to increase or decrease in rainfall due to increase in temperature, which has a direct impact on agriculture.

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II. STUDY AREA

Geographically, Bhandara district (Figure 1) is located in the central part of India, in the eastern part of Maharashtra state, in the interior of the continent away from the ocean and in the central part of the Wainganga river basin [25,26,27,28,29]. The latitudinal extent of Bhandara region is 20039' North to 21036' North and the longitudinal extent is 79027' East to 80007' East. The north-south length of this region is 103 km. And the east-west length is about 45 km. Bhandara district has a total area of 3779.25 square km. The area is occupied. Bhandara may be a corruption of the word 'Bhanara'. Because in the excavations at Ratanpur AD. In an inscription found in 1100, the term 'Bhanara' is found. A.D. From 1818 to 1890, the region was ruled by royal families. At this time the district headquarters was at 'Lanji'. A.D. During 1827, the headquarters of 'Lanji' was changed to 'Bhandara'. A.D. In 1767 Balaghat district of Madhya Pradesh was created by cutting off a part of Bhandara district. The headquarters of Sangadi taluka in Bhandara district was changed to the headquarters of Sakoli. On 1 May 1999, the newly created Gondia district came into existence by bifurcating the district. Bhandara district is the eastern part of the Deccan Plateau and is isolated by the mining activities of the Wainganga, Kanhan, Maru rivers. In the north of this region are the Ambagad hills, Chandpur hills and Gaikhuri hills in the Satapuda range, in the north-west the Ramtek uplift region, in the west the border of Nagpur district, in the south the Pavani hills and the borders of Gadchiroli and Chandrapur district and in the east the border of Gondia district. Bhandara district includes 7 taluks [30,31,32,33,34,35].

III. OBJECTIVE

The main objective is to study the effects of climate on agricultural area, temperature, rainfall, cultivated area and crop production by studying available instruments in Bhandara district.

IV. DATA BASE METHODOLOGY

The study is based on the secondary sources of data. For certain characteristics some aspects taken from relating articles, document and published and unpublished data while analyzing several tables, diagrams and maps have been used. For the analysis of the rural urban population socio- economic bulletin, census hand book 2001, 2011 of the district have been used to study the present distribution of population as well as its nature in last decade. The statistical information was collected from the census hand book and the offices of the statistical department. The topographical data is obtained from a one-inch topographic map of Survey of India (1:63,360 or 1:250,000) with the help of toposheets.

V. RESULT ANALYSIS

A. Procedure

The present study is entirely based on secondary data. Some conclusions have been drawn after obtaining the necessary information from the census booklet, district economic and social commentary and various government offices, classifying and analyzing it.

B. Climate Change in Bhandara District

Temperature Precipitation Latitudinal Extent Distance from sea level are factors that are effective for climate change Here we are looking at only two important factors namely temperature and precipitation Generally the climate of the district is heterogeneous i.e. very hot in summer and very cold in winter. Due to the position of the Sun between the Tropic of Cancer and the Equator, the temperature fluctuates greatly throughout the year. Also, both summer and winter seasons are more intense here. Therefore, the average temperature of the room is higher. The temperature rises rapidly from March to May. The monthly average maximum temperature rises to 47.50 Celsius in the month of May. In summer, the nights are cool compared to the scorching heat of the day. Afternoon heat is pleasant due to occasional gusts of wind. The climate is very hot and dry as there is no rain during this period. Also the relative humidity of the air is also low. The average maximum and minimum temperature in May is 47.50 Celsius and 21.60 Celsius respectively. The average daily temperature is around 25.90 Celsius [36,37,38,39,40].

C. Bhandara District : Climate

Climate has a direct effect on geomorphic processes, natural vegetation, cropping systems, human occupations, types of housing, living conditions, etc. Hot and dry summers, cold and dry winters, and extensive rainfall in monsoons are the salient features of the climate of Bhandara and its adjoining region. Winter is from December to February, summer is from March to mid-June, monsoon is from June to September and post-monsoon is from October to November. The temperature soilrises rapidly from March to May. The monthly average maximum temperature (**Table 1**) rises to 47.50 Celsius in the month of May. In summer, the nights are cool compared to the scorching heat of the day [41,42].

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Table 1: Annual Maximum and Minimum Temperature – 2011 (Temperature in 0C)

Sr.No.	Months	Maximum Temperature	Minimum Temperature	Average Temperature
1	January	31.7	10.9	21.3
2	February	32.7	11.8	22.25
3	March	38.9	13.4	26.15
4	April	43.1	18.2	30.65
5	May	47.5	21.6	34.50
6	June	46.1	21.6	33.85
7	July	36.1	21.8	29.35
8	August	34.8	21.8	28.3
9	September	34.2	21.4	27.8
10	October	35.5	17.4	26.55
11.	November	32.6	8.5	20.55
12	December	30.5	7.4	18.95
	Annual average	37.04	16.33	26.69

Afternoon heat is pleasant due to occasional gusts of wind. The climate is very hot and dry as there is no rain during this period. Also the relative humidity of the air is also low. The average maximum and minimum temperature in May is 47.50 Celsius and 21.60 Celsius respectively. The average daily temperature is around 25.90 Celsius. The monsoon season begins after mid-June and ends by the end of September due to the southwest monsoon. Bhandara region received an average monthly rainfall of 280 mm during this period. It's raining. Due to this, the humidity in the atmosphere increases and the temperature decreases. After June till July the maximum monthly temperature decreases by 100 Celsius. After that, the decrease in maximum temperature decreases in the months of August and September. But the average monthly minimum temperature remains constant throughout the monsoon season. The weather in Bhandara region is very pleasant as the monthly average maximum (31.80 Celsius) and minimum (9.70 Celsius) temperatures decrease during the winter season from November to February. December is the coldest month. When a cold wave comes from North India, the temperature drops considerably. At that time the minimum temperature drops to 7.40 Celsius.

D. Rainfall

Rainfall is a very important factor in terms of irrigation. The average annual rainfall (**Table 2**) in Bhandara is 1246 mm. is While the median value is 1250 mm. That's it. This shows that it is not significantly different from the average [33, 34]. The table shows the total average of rainfall in 5 years from 2011 to 2015. Bhandara district receives more rainfall than other districts of Maharashtra. The main crop here is paddy (rice). And 70% of agriculture is rain dependent. Total average rainfall for five years in seven districts of Bhandara district was recorded. Considering the total average rainfall in 5 years, Lakhandur taluka has the highest rainfall while Tumsar taluka has the lowest rainfall. Overall, all the seven talukas have recorded more rainfall than the average.

Table 2: Average Rainfall - 2011-2015 (Rainfall cm)

Sr. No	Taluke	2011	2012	2013	2014	2015	Average Rainfall
1	Tumsar	948.80	985.60	1499.50	1260.80	1002.70	919
2	Mohadi	955.30	1043.40	1488.80	1260.80	803.70	1110
3	Bhandara	974.90	1216.90	1773.60	1260.80	955.30	1236
4	Sakoli	1186.50	1385.90	1921.80	1399.10	1050.30	1389
5	Lakhani	1027.80	1270.30	2014.00	1451.30	945.80	1342
6	Pawani	1195.70	1304.70	1824.30	1227.40	822.40	1275
7	Lakhandur	1416.60	1553.40	1912.80	1451.30	784.30	1424
	Total	1086.80	1251.50	1809.80	1330.20	909.20	12420

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E. Bhandara District: Taluk wise General Land Use:

In 1991, out of total area (385300 ha.) in the district, 95700 ha. (24.80%) area is under forest. So 42500 is. (11.03%) area not available for agriculture is 14900 ha. (3.87%) area is falling and is 129615. (33.64%) area under net crop while 22700 ha. (5.89%) area under pasture and 21823 ha. (5.66%) area is under other use. In the year 1991, Sakoli taluka has the highest area under forest in all the talukas in the district which is 30.80%. So below that, 30% area is under forest in Pavani taluka too. Mohadi taluka has the lowest area under forest in the district which is 17.90%. In other taluks this area is 20% to 25%. Bhandara taluka has the highest percentage of non-cultivable area in the district this year which is 17.49%. And below that in Lakhandur taluka this ratio is 15.03%. In all other talukas, this ratio is 7% to 10%. In the year 2011, special changes are observed in the general land use of the district. Sakoli taluka has the highest forest area in the district this year with 30.47%. Whereas in Bhandara and Pavani two taluks, the area under forest is 11% to 13%. Tumsar taluka has 10.35% and Lakhni 7.41%. In Lakhandur taluka this proportion is 5.30% and lowest forest area is 2.80% in Mohadi taluka.

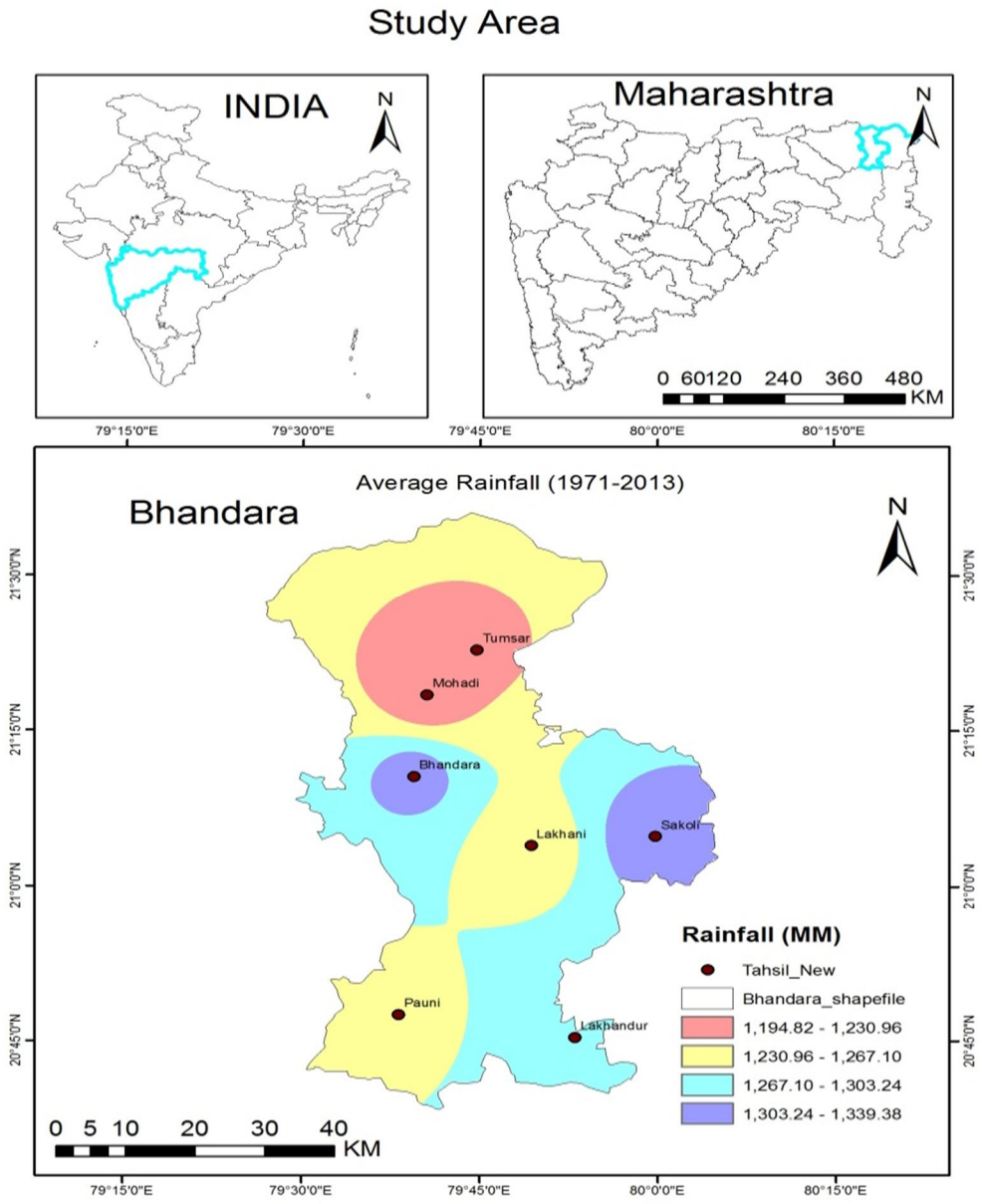


Figure 1: Study Area

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Bhandara taluka has the highest non-cultivable area in the district at 21.23% while Tumsar and Sakoli talukas have almost the same area at 13%. In Mohadi, Lakhani, Pavani and Lakhandur talukas, the area not available for agriculture is less than 10%. Tumsar taluka has the highest fallow area in the district which is around 7%. Whereas the lowest area is in Lakhandur taluka which is 1.12%. In all other talukas, the ratio is 3% to 4%. The highest proportion of net area under crop is found in Mohadi taluka which is 68.91%. Whereas in Lakhani taluka this ratio is 66.68% and in Bhandara taluka 60.01%. Pawni taluka has a net area ratio of 57.18%. In addition, three taluks namely Tumsar, Sakoli and Lakhandur have less than 50% net area. The highest area under pasture in the district is 8.08% in Lakhni taluk. Whereas in Bhandara and Sakoli talukas, this ratio is almost the same and it is found up to 6%. In Tumsar taluk the proportion of area under pasture is 5.82% and in all other taluks it is less than 5%. The maximum area under other use is in Lakhandur taluka which is 33.71%. In Tumsar taluka this ratio is 19.23% and in Mohadi and Pavani taluka it is almost 16% to 17%. In addition, Bhandara and Sakoli talukas have less than 5% of land under other uses.

F. Taluk wise Cultivated Areas

Humans have been using land surface for different purposes since ancient times in their lives.Initially it was used for construction of farm houses and unpaved roads etc. Even in present time its use is still increasing.Bhandara district has a geographical area of 679.25 sq.km and a population of 1200334 (as per census 2011). Bhandara district has a total of 838 villages and its land is useful for production. When the area under cultivation in Bhandara district is studied, it is noticed that there is a decrease in the ten years from 1991 to 2001. In 1991 it was 255343 hectares and in 2001 it was 233364 hectares. That is, during ten years, the area under cultivation has decreased by 21979 hectares, but in 2011, the area under cultivation has increased to 260957.

Table 3: Taluk wise Cultivated Areas

Sr. No	Taluke	The total area under cultivation (1991)	Total area under cultivation (2001)	Total area under cultivation (2011)
1	Tumsar	37934	38105	41044
2	Mohadi	37877	39307	45524
3	Bhandara	36654	35043	32375
4	Sakoli	45084	27625	24452
5	Lakhani	Nil	Nil	28138
6	Pawani	51379	50524	44344
7	Lakhandur	46415	42760	45080
	Taluke	255343	233364	260957

G. Area and production under different crops in Bhandara district

The main occupation of Bhandara district is agriculture and in this rice is the main crop out of the total area under cultivation 29918 hectares of rice is cultivated according to the data obtained for ten years it can be seen that the cultivated area has decreased by 972 hectares but the production has increased by 350.95 hectares. Out of the total area under wheat cultivation in Bhandara district, the average area under village is 40279 hectares. During the ten year period from 2001 to 2011, the area under wheat crop cultivation has increased. Therefore, the production has also increased from 216.38 tonnes to 976.8 metric tonnes. Out of the total area under gram cultivation, the average area under gram has increased from 25036 ha to 34333 ha in 2001 but the production has not increased as much as desired compared to 2001. The average area under cultivation in Tur Bhandara district is 23502 hectares in 2001 and it has decreased to 2984 hectares in 2011. The production has also decreased in 2011 as compared to 2001. The total cultivated area of pea and sorghum has decreased and the production has also decreased in the last 10 years. Statistics show a decline [41, 42, 43, 44,45, 46.47.48].

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H. Area And Production Under Different Crops In Bhandara District

Table 4: Area and production under different crops in Bhandara district

Sr. No	Name of the crop	Area hectare 2001	Production 00 MT Area Hectare	Area hectare 2011	Production 00 MT Area Hectare
1	Rice	30890	2620.73	29918	2971.68
2	wheat	34551	216.38	40279	976.8
3	gram	25036	50.81	34333	51.51
4	Tur	23502	73.66	20984	21.53
5	pea	-----	----	---	---
6	sorghum	21083	2.82	34025	00

VI. CONCLUSION

Average rainfall in Bhandara district is 1246 mm. falls to The average value of rainfall for 35 years is 1250 mm. is, which is higher than the average, so monsoon rainfall is reliable. As irrigation resources increased in the district from 1981 to 2011, the area covered by forest decreased from 12% to 11% and the area under fallow and pasture also decreased by 5%, resulting in the net area under crops falling from 50% (192400 ha) to 55% (208368 This.) has gone up. The area under non-agricultural and other uses also increased by around 3%. In the year 1991, Sakoli taluka has the highest area under forest in all the talukas in the district which is 30.80%. So below that, 30% area is under forest in Pavani taluka too. Mohadi taluka has the lowest area under forest in the district which is 17.90%. In other taluks this area is 20% to 25%. In the year 2011, special changes are observed in the general land use of the district. Sakoli taluka has the highest forest area in the district this year with 30.47%. Whereas in Bhandara and Pavani two taluks, the area under forest is 11% to 13%. Tumsar taluka has 10.35% and Lakhni 7.41%. In Lakhandur taluka this proportion is 5.30% and lowest forest area is 2.80% in Mohadi taluka. According to the data obtained for twenty years from 1991 to 2011, it is clear that the total area under cultivation in Bhandara district has decreased by 21979 hectares in 2001 as compared to 1991 but again in 2011 the area under cultivation has increased to 260957 hectares. That is, it is seen that the climate has affected agriculture. The indirect effect of climate is also felt on the area under crop and its production in which the area under paddy has decreased by 972 hectares but the production has increased by 350.95 whereas the area under wheat has increased so the production has also increased from 216.38 metric tons to 976.8 metric tons. is Also, there has been an increase in the area under gram crops, but the production has not increased to the desired extent. The area under the cultivation of peas and sorghum has decreased and the production has also decreased from the statistics of the last ten year.

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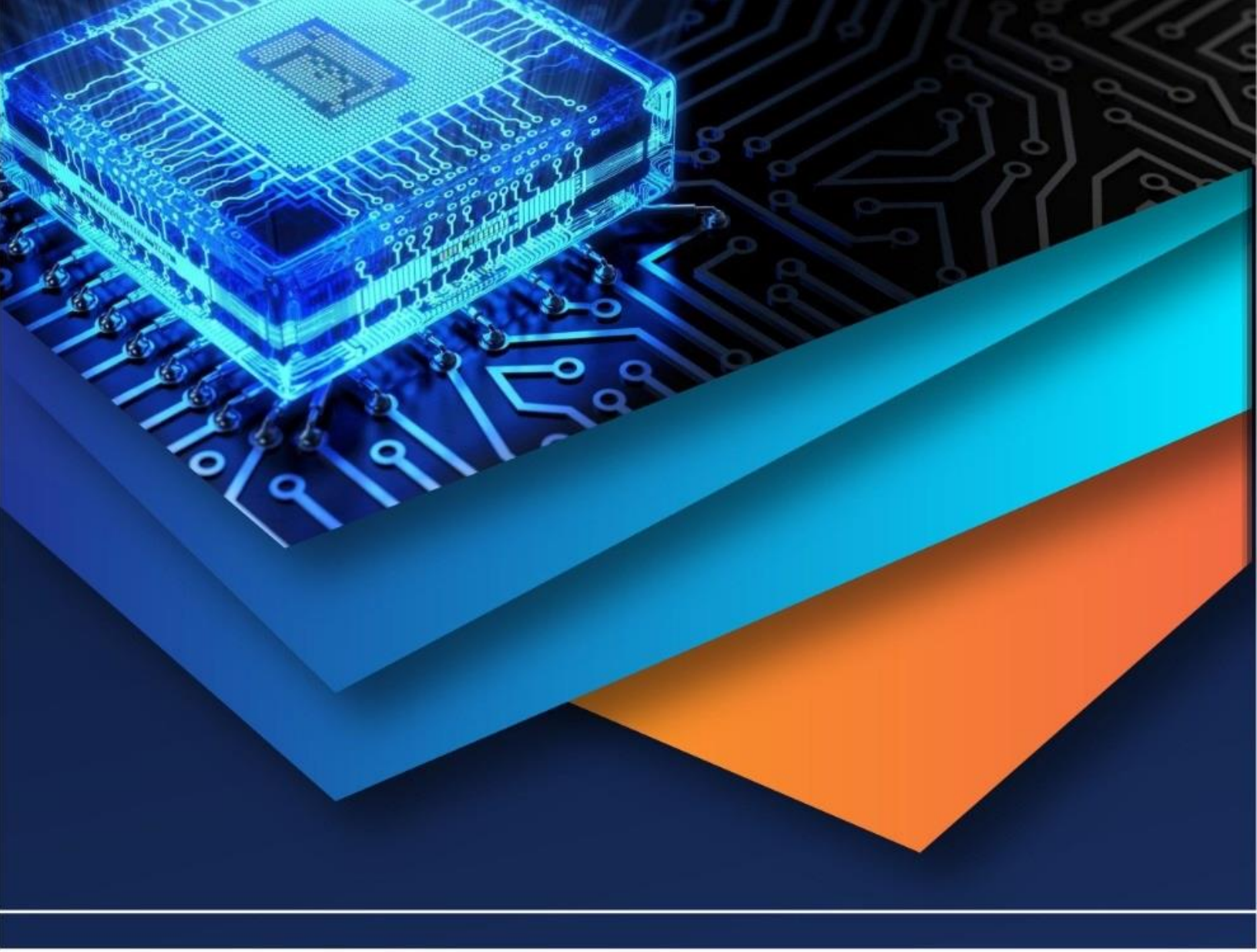
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