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Correlation of Rainfalls and Water Levels in Panchganga Basin and Almatti Dam During Monsoon of Year 2010, and Multiple Regression Analysis of Rainfall and Water Level at Rajaram Bandhara (K.T. Weir) on Panchganga River for Prediction of Flood of Prediction

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ABSTRACT

During year 2010 the correlation among rainfalls in mm from July to mid-October of Five Tehsils in the Panchganga Basin as well as correlation between water level of Panchganga River of every day morning in meters at Rajaram Bandhara and daily rainfall during July to mid-October of each five tehsil is determined. Also, correlations between water levels in meter at Rajaram Bandhara, Rajapur and Almatti Dam are calculated. For investigating the water level at Rajaram Bandhara (K.T. Weir) of Kasaba Bawda, Tehsil Karveer, Kolhapur District with respect to rainfall is done by determining multiple correlation coefficients and multiple regression equation. Multiple correlation coefficients give the joint effect of the rainfall of five tehsils of Panchganga River and its tributaries in mm on water level in meters at Rajaram Bandhara. And with help of multiple regression equation, we can estimate approximate water level when rainfall of tehsils is known. The validity of our model is tested by using chi square test of goodness of fit this analysis can be used in prediction of flood on certain area.

KEYWORDS

Correlation, K.T. Weir, Multiple correlation coefficients, Multiple regression equation.

……

1. INTRODUCTION

Kolhapur district lies between $16^0$42’ N and $74^0$15'. E. [1]. Kolhapur district covers area of about 7685 km², and there are 12 Tehsils, 9 municipal councils, one municipal corporation and 1200 villages in Kolhapur district [2]. The population of Kolhapur is 38,74,015 out of which male and female were 19, 83,274 and 18, 90,741

respectively. There was change of 9.96 percent in the population compared to population as per year 2001. In the census of India 2001, Kolhapur District had 17.85 percent increase to its population compared to year 1991. The initial provisional data gives a density of 504 in 2011 compared to 458 of 2001. Total area under Kolhapur district is of about 7,685 km² [3].

In Kolhapur district, Panchganga the main river flows 136 km through Kolhapur district and meets the river Krishna at Narasobawadi [4]. Panchganga river is one of the principal tributary the Krishna river system lays within the $16^0$44'4'' to $16^0$31'22'' North Latitude and $74^0$14'33'' to $74^0$36'03'' East Longitude. The river incorporated with sub river basins of Kasari, Kumbhi, Bhogavati, Dhamani and Tulasi claims an area of 2099.63 km² that falls under Kolhapur district of western Maharashtra [5].The East- West Length of River Panchganga is 108 km and its North – South Length is 67 km. Panchganga river covers is area of 2730.40 km². Panchganga river having average breadth 110 m, Maximum Depth 14m and Minimum Depth 3m. Panchganga River receives average Rainfall of 2501.9 mm [6].

At Prayag Chikhali confluence marks the beginning of the Panchganga River proper which after receiving the waters of the four tributaries continues in a larger pattern [7]. Following are the Tributaries of Panchganga

Table-1. Tributaries of Panchganga:-

Sr. No.	River	Origin	Length Km	Confluence River	Confluence Place
1	Kasari	Gajapurwadi	60	Panchganga	Prayag Chikhali
2	Bhogavati	Aasane	72	Panchganga	Koge
3	Panchganga	Prayag Chikhali	92.70	Krishna	Narasobawadi
4	Kumbhi	Taliye	50	Bhogavati	Koge
5	Dhamani	(Rai) Kalaksandre	29.13	Kumbhi	Kale
6	Tulasi	Talgaon (Dhumalwadi)	31	Bhogavati	Beed

In the Panchganga Basin there are 5 dams namingRadhanagri (8.36 TMC Total Capacity and 10400 Cusec Total Discharge capacity), Tulsi (3.47 TMC Total Capacity and 640 Cusec Total Discharge capacity), Kasari (2.77 TMC Total Capacity and 22266 Cusec Total Discharge capacity), Kode L.P.T. (0.21 TMC Total Capacity and 8262 Cusec Total Discharge capacity) and Kumbhi (2.71 TMC Total

Capacity and 15046 Cusec Total Discharge capacity). Ordinary Flood Level of Panchganga River is 38 feet (541.77 meter), warning level is 39 feet (542.07meter) and Danger Level is 43 feet (543.29 meter).Following are danger levels crossed by Panchganga river Since 1989 at Rajaram Bandhara (543.29 meter -43'-0'').

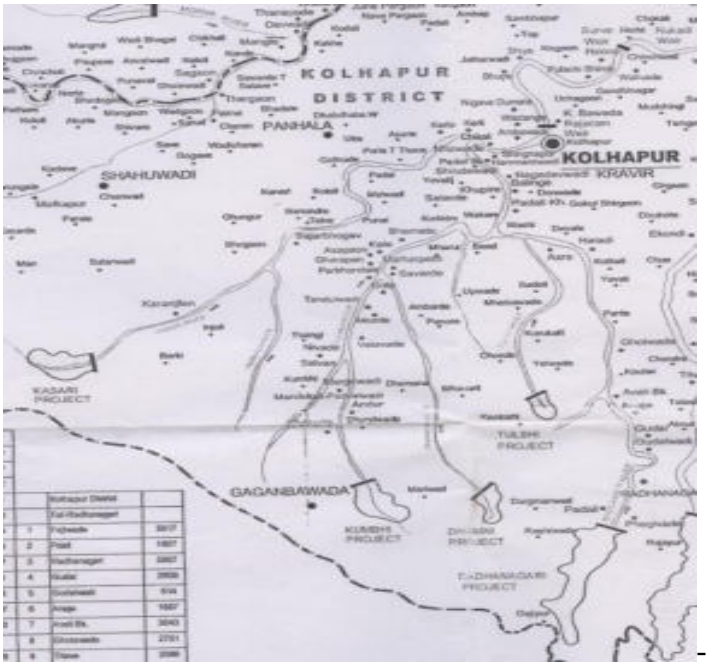
Table-2. Danger water levels of Panchganga River at Rajaram Bandhara K.T. Weir

Sr. No.	Date	Level meters	Level Feet	Discharge cubic feet/sec
1	27/07/1989	543.58	50 feet 6 Inch	73139
2	19/08/1990	543.34	43 feet 2 Inch	62870
3	29/07/1991	543.85	44 feet 10 Inch	64201
4	15/07/1994	544.41	46 feet 8 Inch	65676
5	02/08/1997	543.65	44 feet 2 Inch	63669
6	27/07/2005	545.27	49 feet 6 Inch	68030
7	12/08/2006	544.16	45 feet 10 Inch	65001
8	02/07/2007	543.39	43 feet 4 Inch	63003
9	13/08/2008	544.39	46 feet 7 Inch	65605

(8).

(9)

Figure-1. Panchganga River, its tributaries and Location of Rajaram K. T. Weir



(10)

Figure-2. Panchganga Basin

Figure-3. Location of Almatti Dam

Kolhapur districts were extensively flooded by the release of water from dams like the Koyna, Warna, and other in the region. The backwater effect of the Almaty dam in Karnataka did not allow flood waters to recede from the Kolhapur district. Year 2005 in the Kolhapur District Houses damaged 18458, 92811 Population Evacuated, 981 Villages affected / Towns [11]. Major rainfall of the Kolhapur district receives it's from the South-West monsoon winds, also Kolhapur district gets some rainfall from district gesturing two months that are April and May. The

rainy season is start from June and last up to October. The Western Ghats receives the heavy rainfall and Gaganbawada Tehsil receives 5000 mm average rainfall is known as the Cherapunji of the Maharashtra. Shirol Tehsil and Hatkanangle Tehsil talukas record poor rainfall around 500 mm [12]. In Kolhapur district there are a large number (188) of riverside villages which are prone to floods. High floods generally occur due to heavy rainfall in catchment area of major dams and release of excess water. Recent records show that high floods occurred in 1989 and 1994. In the floods of 1994, flood waters entered the following villages :Karveer taluka : Valivade, Kolhapur city, Ambewadi, Chikhali, Kasaba Bawada., Hatkanangale taluka : Nilewadi, Ingali, Ichalkaranji, Shiroli, Rangoli, Halondi,Chandur, Rui., Shirol taluka : Ganeshwadi, Nrisinhawadi, Bastawad, Kurundwad, Rajapur, Khidrapur, Bhairewadi, Shirdhon, Danwad, Rajapurwadi, Shirol, Kothali, Chinchwad, Ghalwad, Udgaon, Arjunwad Kavatheshwar., With a view to rehabilitate the villagers to safer places Gaothan Extension Programme for various villages is under implementation, During the high floods of 1989 and 1994, water discharge from Radhanagari dam into the Panchganga river was 3338.70 cusecs and 2774.42 cusecs respectively [13]. Rajaram K.T. weir located on the Panchganga River in the Kasaba Bawada and Raja Rivers the village situated at boundary of Kolhapur district as well as Maharashtra State. The Almatti dam is an ongoing project on Krishna River just downstream of its confluence with Ghataprabha River near Almatti village in Bagewadi taluk of Bagalkot district in Karnataka State [14].

Flooding due to storm events is a major concern in many regions of the world. Global warming increased need of the prediction of flood levels and damages. [15]. Identifying the rainfall and water level relationship in wetlands like Lake Catchment is very important for the efficient management of the water resources and for precautionary measures for prevention of potential natural disasters [16]. The rainfall and runoff relationship is one of the most complex hydrological phenomenon, having tremendous spatial and temporal variability of watershed characteristics and rainfall patterns and to the various variables involved in the modeling of physical processes [17]. Accuracy in the river water level prediction is necessary for reliable flood forecasting, which is a difficult due to the complex and inherent non-linearity of the catchment hydrological system [18]. An ANN model was prepared to estimate the water level during an irrigation period along the main drainage canal in the Chiyoda drainage basin [19]. Research work estimates the water budget of Lake Tana and its sensitivity to rainfall variations [20]. Floods impact is more people globally than any other type of natural disaster [21].

There are several sources of uncertainty that complicate our understanding of flood prediction accuracy, the main source of uncertainty is rainfall [2, 23, 24]. There were 70% to 80% of the variability observed in the terrestrial hydrologic cycle is attributed to rainfall [25]. The Study has considered the correlations between rainfall

events and rises in the water table at six sites on the Chalk of southern England [26]. The warnings of even a few hours or days can mitigate or greatly reduce catastrophic losses of life [27]. Hydrologists in present are beginning to realize that rainfall data from the vantage of space has the potential to become a cost-effective source of input for flood prediction [28]. The study regarding flood risk assessment of Panchganga River (Kolhapur district, Maharashtra) using GIS-based multi-criteria decision technique concluded that flood risk is basically determined as a result of probability and consequences. Accurate information on flood inundation and flood zonation is essential for sound planning and management of urban and rural land [29]. The flood risk assessment based on flood hazard and vulnerability indexes gives the risk of floods is achieved by incorporating hazard and vulnerabilities for cities located in Dobrogea Region [30]. The compound flood potential from river discharge and storm surge extremes at the global scale and provides a global perspective of the compound flood potential from riverine and coastal flood drivers [31]. The HEC-RAS model is able to simulate the surface profiles formed in different recurrent flows of the Tigris River in Diyarbakır, as well as that the flood boundaries in a public area can be easily obtained by using the HEC-RAS package program [32].

2. METHODOLOGY:

The multiple regressions are probably one of the most commonly used methods for multivariate data analysis. This can be used to test hypotheses regarding the relationship of one of more predictors to a dependent variable and it also lends itself easily for predicting or forecasting of the dependent variable values [33]. Correlation analysis and Regression analysis are popular multivariate analysis methods in many scientific fields. Regression analysis is a more general methodology than Analysis of Variance (ANOVA), it has been used for a more complex problem, especially in a multivariate environment [34].

The examination of the relationship between the Indian Ocean Sea-Surface Temperature Anomalies (SSTA) and the Indian Summer Monsoon Rainfall (ISMR) during the period, 1983 to 2006 showed high and positive correlation (0.51, significant at >99% level) is noticed between ISMR and SSTA over southeastern Arabian Sea (AS) in the preceding January [35]. Same research work was done of daily extreme rainfall at five geophysical dispersed high-quality stations in southwest Western Australia [36]. The two station's the past values of the water level are used in forecasting future values [37].

Rajaram Bandhara water level is one of the indicators of the flood level in Panchganga basin. By knowing daily rainfall in five tehsil, we can estimate the water level at Rajaram Bandhara on that day or time by using multiple regression equation.

3. RESULTS AND DISCUSSION

We compute Mean, Standard Deviation and Correlation coefficient between daily rainfall data of five tahsils [Karveer – T_1, Panhala – T_2, Shahuwadi – T_3 ,Radhanagari – T_4, Gaganbawada – T_5 from 1st July to 15th October] and water level at Rajaram Bandhara as on 8 A.M. in meters shown in the following table-1 [38].

Table-3. **Average, Standard Deviation and Correlation of Daily rainfall of Five Tehsils and daily water level at Rajaram K T Weir during July 2010 to 15th October 2010**

	Karveer	**Panhala**	**Shahuwadi**	**Radhanagari**	**Gaganbawada**	**Total**
Mean	6.12	9.48	13.41	22.87	45.35	535.82
SD	11.35	16.17	22.60	32.71	48.78	2.54

From **Table-3**. during 1st July 2010 to 15th October 2010, it has been seen that average daily rainfall of Gaganbawada Tehsil 45.35 mm was more than other five tehsils. At second position Radhanagari Tehsil received 22.87 mm average daily rainfall. Tehsil Shahuwadi also received average daily rainfall 22.87. As compare to above three tehsils other two tehsils received less average daily rainfall that is Panhala 9.48 mm and Karveer 6.12 mm. Also, Gaganbawada tehsil had large variation in daily rainfall as its Standard deviation was 48.78. Radhanagari and Shahuwadi had medium variation in daily rainfall as Standard deviation was 32.71 and 22.60. Tehsils Panhala and Karveer had less variation in daily rainfall as their Standard deviation were 16.17 and 11.35 respectively.

Correlation coefficient between daily Rainfalls of five tehsil [Karveer – T_1, Panhala – T_2, Shahuwadi – T_3 ,Radhanagari – T_4, Gaganbawada – T_5 from 1st July to 15th October] is calculated as shown in the following Table-4

Table-4. Correlation coefficient between daily Rainfalls of five tehsil

Sr. No.	**Tehsils**	**Correlation Coefficient**
1	T_1& T_2	0.792801
2	T_1& T_3	0.746787
3	T_1& T_4	0.779697
4	T_1& T_5	0.663052
5	T_2& T_3	0.815512

6	T_2& T_4	0.781036
7	T_2& T_5	0.635381
8	T_3 & T_4	0.862679
9	T_3& T_5	0.730109
10	T_4 & T_5	0.681251

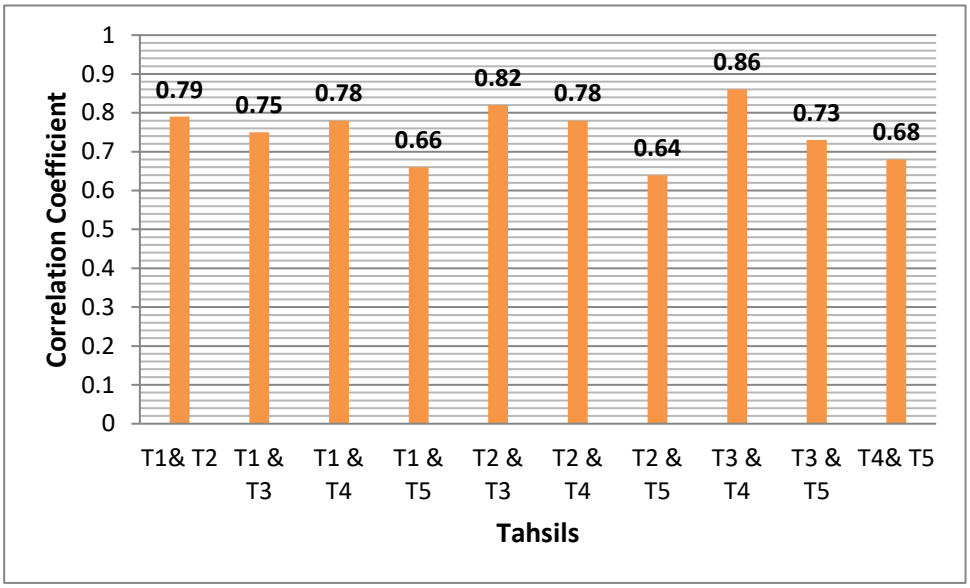


Figure - 4. Correlation coefficient between daily Rainfalls of five tehsil

From the **Table-4** and **Figure -4** it is cleared that all the rainfalls in the year 2010 (July to mid-October) in the Kolhapur District is correlated as all the values of Correlation coefficients more than 0.5. Among the above rainfalls Shahuwadi – T_3 and Radhanagari – T_4 are highly correlated as value of Correlation coefficient is 0.86. There was high correlation found between Panhala – T_2 and Shahuwadi – T_3 the Correlation coefficient value is 0.82. Karveer – T_1 and Shahuwadi – T_3 had Correlation coefficient value 0.79 hence it is highly correlated also. Other Correlation coefficients showed also high correlation that is Karveer T_1, - Radhanagari T_4 and Panhala T_2 Radhanagari T_4 Correlation coefficients 0.78 for both. Karveer T_1, Shahuwadi T_3 and Shahuwadi – T3, Gaganbawada – T_5 had high correlation as Correlation coefficient is 0.75 and 0.73 respectively. As compare to other Radhanagari T4-Gaganbawada T_5, Karveer T_1- Gaganbawada T_5 and Panhala T_2- Gaganbawada – T_5 had less correlation as correlation coefficient is 0.68, 0.66 and 0.64 respectively.

Table-5. Correlation of daily rainfall of five tehsils in the Panchganga Basin and water level at Rajaram K.T. weir during 1st July to 15th October 2010

	Karveer	Panhala	Shahuwadi	Radhanagari	Gaganbawada
Correlation W	0.52	0.62	0.68	0.75	0.54

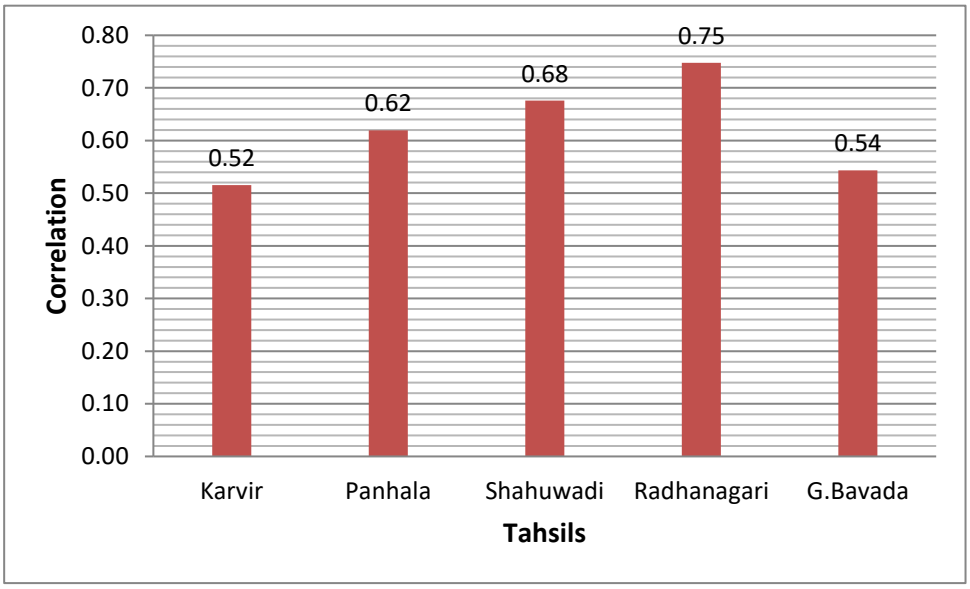


Figure-5. Correlation of Daily rainfall of five tehsils and daily water level at Rajaram K T Weir.

From **Table -5** and **Figure-5**, it is cleared that in the Panchganga basin, the effect of Radhanagari tehsil on the water level of Panchganga River is more than any other Tehsil that is as correlation value is 0.75 as Radhanagari received second higher rainfall during the year 2010 in the basin. Rainfall of Shahuwadi also had second most effect on the water level at Rajaram Bandhara K.T. weir (Correlation 0.68) as Shahuwadi received third most rainfall during the year 2010 in the basin. After Shahuwadi Tehsil Panhala Tehsil had third most effect on the water level of Panchganga river (Correlation 0.62) as Panhala Tehsil received fourth most rainfall during 2010. Gaganbawada received highest rainfall during year 2010 but the effect of the rainfall on water level at Rajaram Bandhara is 0.54 less as compare to other tehsils mentioned above. Another Tehsil Karveer had less of the correlation that is 0.52 as compare to other tehsils in the Panchganga Basin.

The effect of Rainfall on water level of Panchganga River at Rajaram Bandhara is depends upon discharge and capacity of the number of dams on tributary rivers and number of K. T. weirs in the basin before Rajaram K.T. weir.

In the Panchganga Basin there are 5 dams naming Radhanagari (8.36 TMC Total Capacity and 10400 Cusec Total Discharge capacity), Tulsi (3.47 TMC Total Capacity and 640 Cusec Total Discharge capacity), Kasari (2.77 TMC Total Capacity and 22266 Cusec Total Discharge capacity), Kode L.P.T. (0.21 TMC Total Capacity and 8262 Cusec Total Discharge capacity) and Kumbhi (2.71 TMC Total Capacity and 15046 Cusec Total Discharge capacity) [39].

And there are 45 K.T. weirs before Rajaram K.T. weir that are on Dhamani 5, Tulasi 9, Kumbhi 10,Kasari 14,Bhogavati 6 and on Panchganga after Prayag Chikhali there is only 1 K.T. weir [40].

Table – 6. Correlation between water level at Rajaram Bandhara (W1), Rajapur (W2) and Almatti dam Karnataka (W3)

Sr. No.	Correlation
W1 and W2	0.8508377
W1 and W3	0.0478492
W2 and W3	0.4265485

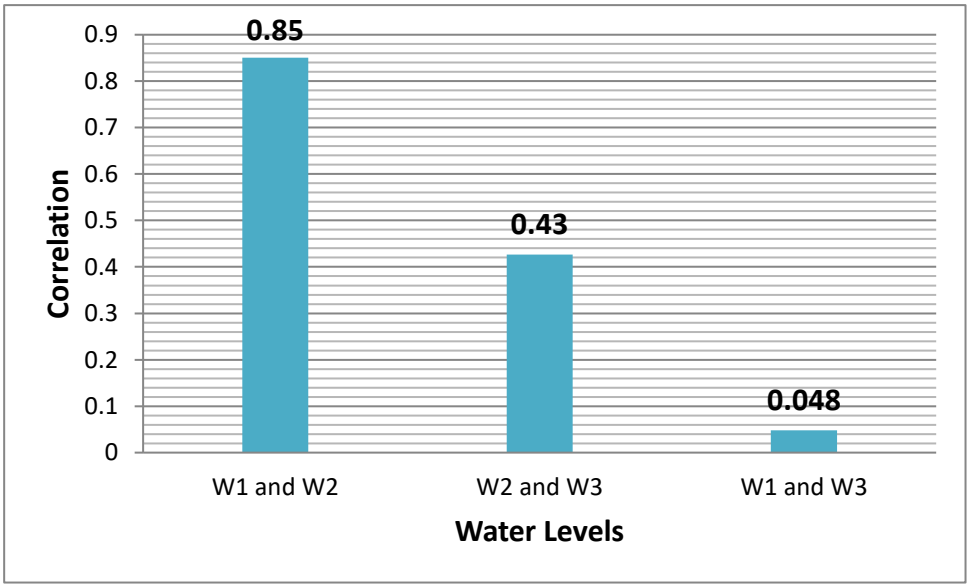


Figure-6. Correlation between water level at Rajaram Bandhara (W1), Rajapur (W2) and Almatti dam (W3)

Table – 6 and **Figure-6** shows that very high correlation between water level at Rajaram K.T. weir and Rajapur is more i.e 0.85. But correlation between water level at Rajapur and Almatti dam is very low i.e 0.43.And Correlation between water level at Rajaram K.T. weir and Almatti dam is negligible 0.048.

For determining the water level at Rajaram K.T. weir depending upon Daily Rainfall of Five Tehsils we formed correlation matrix as follows (**Table**-7**).**

Table-7. Correlation Matrix

	W	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
W	**1**	**0.515615**	**0.619376**	**0.675781**	**0.747746**	**0.543617**
T_1	**0.515615**	**1**	**0.792801**	**0.746787**	**0.779697**	**0.663052**
T_2	**0.619376**	**0.792801**	**1**	**0.815513**	**0.781036**	**0.635381**
T_3	**0.675781**	**0.746787**	**0.815513**	**1**	**0.862679**	**0.730109**
T_4	**0.747746**	**0.779697**	**0.781036**	**0.862679**	**1**	**0.681251**
T_5	**0.543617**	**0.663052**	**0.635381**	**0.730109**	**0.681251**	**1**

By using the elements of above matrix, the value of determinant D and minors D_1, D_2, D_3, D_4, D_5, D_6 are as shown in the **Table-8.**

Table-8. The values of determinant D

Sr. No.	**M DETER**	**Value**
1	D	0.004319
2	D_1	0.010551
3	D_2	-0.00317
4	D_3	-0.002
5	D_4	0.000566
6	D_5	-0.00768
7	D_6	0.000917

Multiple Correlation Coefficients between water level at Rajaram K.T. weir (W) and daily Rainfall of five tehsils in Panchganga Basin (T_1, T_2, T_3, T_4, and T_5) is given by,

$$\mathbf{R^2 = [1-(D/D_1)] = 0.590687}$$

$$\mathbf{Therefore,\ R = 0.768562}$$

Multiple Correlation Coefficient R = 0.768562 is the joint effect of daily Rainfalls of five tehsils T_1 , T_2, T_3, T_4, and T_5on water level at Rajaram Bandhara. As it is highly positive and nearer to one, it indicates that the water level at Rajaram Bandhara is highly correlated with the rainfall at five tehsils. Multiple regression equation of water level at Rajaram Bandhara and daily Rainfalls of five tehsils T_1, T_2, T_3, T_4, and T_5 is given by,

$D_1/\sigma_1 (W- \bar{W}) - D_2/\sigma_2 (T_1-\bar{T_1}) + D_3/\sigma_3 (T_2-\bar{T_2}) - D_4/\sigma_4 (T_3-\bar{T_3}) + D_5/\sigma_5 (T_4-\bar{T_4}) - D_6/r_6 (T_5-T_5) = 0$

By substituting values from tables 1, 2 and 3 we get equation as

$$\mathbf{W = 534.36555 - 0.0671445T_1 + 0.029771T_2 + 0.00661395T_3 + 0.0565T_4 + 0.004522T_5}$$

Thisis multiple regression equation of W on T_1, T_2, T_3, T_4, and T_5.

The Above model is tested for goodness of fit by using chi square test. Under the hypothesis the test statistic is

$$\chi^2 = \sum \left[(O_i - E_i)^2 / E_i\right] \sim \chi^2_{(n-1)} \longrightarrow$$

We have $\chi 2 = 0.52523$, hence our model is accepted at 5 % level of significance.

4. CONCLUSION:

During 1st July 2010 to 15th October 2010 Gaganbawada received more rainfall then Radhanagari , Shahuwadu, Panhala and Karveer in descending order. Among that Gaganbawada had large variation in daily rainfall. Radhanagari and Shahuwadi had medium variation in daily rainfall while tehsils Panhala and Karveer had less variation daily rainfall. All the rainfalls of all five tehsils were correlated as they gave values in between 0.6 to 0.9. Among the correlations of the rainfalls of the five Tehsils rainfall of Shahuwadi and Radhanagari was highly correlated and rainfall of Panhala and Shahuwadi was also highly correlated. Other correlations of rainfall of tehsils showed values between 0.64 to 0.79. Correlation of daily rainfall of five tehsils and daily water level at Rajaram K T Weir shows that rainfall of Radhanagari tehsil has more impact on the water level other four tehsils. Shahuwadi and Panhala had medium effect on the water level at Rajaram K.T. weir. Other tehsils Gaganbawada and Karveer had fewer effects on the Panchganga water level at Rajaram K.T. weir as compare to other tehsils.

In between the water level at Rajaram K.T. weir, Rajapur and Almatti dam, water level at Rajaram K.T. weir and Rajapur is more correlated or in other words

water level at Rajapur certainly affects water level at Rajaram K.T. weir. Also water level at Almatti dam affects in moderately as correlation value found to be medium. But water level at Almatti dam affects water level at Rajaram K.T. weir in very less amount as correlation value is very small. The reason behind that Rajaram K.T. weir and Rajapur are nearer than Almatti dam. But this correlation showed three water levels are interdependent.

The flood disaster, on the banks of the river Krishna and its tributaries, in July - August 2005, was due storage in Almatti reservoir. Their calculations show that Sangli and Kolhapur will be submerged under the depth of more than 8 meters of floods due to backwater curve. Because of this hundreds of villages all along the course of the river between districts Kolhapur, Sangli, Karad and Almatti dam will be submerged causing great Losses [41]. The HEC-RAS model is able to simulate the surface profiles formed in different recurrent flows of the Tigris River in Diyarbakır, as well as that the flood boundaries in a public area can be easily obtained by using the HEC-RAS package program [42].

Multiple regression equation is calculated for water level at Rajaram K.T. weir and rainfall of five tehsils. By using this multiple regression equation with help of rainfall data of any given day we can estimate the approximate water level of the Rajaram Bandhara in a best possible way. As well as from water level of the Rajaram Bandhara and rainfall of any four tehsil we can estimate approximate rainfall of fifth tehsil by using multiple regression equation. Therefore this multiple regression equation is useful for predicting the possibility of getting flood of any given day which is further useful in early warning system. Hence this is useful in the Flood mitigation.

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Assessment of Pressmud Enriched with Isolated Micro Flora from Pressmud on Growth and Quality of Sugarcane

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ABSTRACT
Indian economy is mainly depending on the agriculture sector. Sugar industry is the second leading agro based manufacturing sector in India. Sugar industry manufactures white sugar, pressmud and molasses as by product. About 5.4 million tons of pressmud and 40 billion liters of distillery effluent are being produced every year. These waste products cause disposal and pollution problems to the surrounding environment. To overcome this problems present experiment was carried out in planting season of sugarcane for the period of 2012-2013 at Department of Environmental Science, Shivaji University, Kolhapur, Maharashtra, India by using saplings of sugarcane co:86032 obtained from Warana Research Lab, dist-Kolhapur. This experiment was designed with a examination to work out the outcome of enriched pressmud on growth and quality of sugarcane plant. The phyto-chemical parameters like chlorophyll content, protein content, amino acids content etc. and physico-chemical parameters of soil before planting and after harvesting of crop. It was taken with the three different combinations viz. Control with no inoculums (T0). Composted pressmud (T1), Enriched composted pressmud by inoculated with isolated bacteria (T2). The result showed that the plant amended with dose of 5% pressmud enriched with microbial flora i.e. combination T_2 gives 2.01% ± 0.56, 1.03 ± 0.53%, 0.29 ± 0.34% NPK over the control T_0, and had promising growth and growth related parameters such as chlorophyll, carbohydrates, proline, phenolics and flavonoids etc.

KEYWORDS
Sugarcane, Pressmud, Enrichment and sugarcane co: 86032.

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1. INTRODUCTION

Sugarcane is a multiple product commodity. It provides food, feed, fuel, fiber, fodder, foreign exchange and organic manure. India has the largest area under sugarcane among cane growing countries of the world [12]. Sugarcane has

essentially four-growth phases viz: germination phase, tillering (formative) phase, grand growth phase, maturity and ripening phase [39]. Sugarcane is an important cash crop of India. Sugarcane, popularly known as noble cane, due to its high sucrose content and low fiber content is one of the most important industrial crops of the world.

Sugar industry is the second largest agro based industry in India. During the manufacture of white sugar, pressmud and molasses are produced as by product. About 5.4 million tons of pressmud and 40 billion liters of distillery effluent are being produced every year. These waste product cause disposal and pollution problems [33]. Most part of these wastes is usually burnt in the field due to lack of proper management techniques, which creates severe environmental pollution and health hazards [31].

Pressmud is a good source of organic matter, NPK and important micronutrients has established its importance in improving fertility, productivity and other physical properties of agricultural soils [29]. The high amount of NPK contents has made it a valuable nutrient resource along with luxurious amount of organic matter, important micronutrients like Zn, Cu, Fe and Mn are also abundant in pressmud, being deficient in calcareous soils. Therefore, pressmud is more likely to improve the micronutrient distribution and enhance microbial activities [33].

Application of processed pressmud greatly increased bacterial and fungal population of soil and also responsible for a large increase in the number of non spore forming bacteria and various fungi including Neurospora crassa, Trichoderma viride, Aspergillus sp. and Penicillium sp. [37]. An increase in the spore forming Bacillus and Actinomycetes, which have a positive influence on soil aggregate stability was observed in the final stage during composting of pressmud [34]. Control of nematodes in soil also was reported due to pressmud application [5].

Conversion of composted pressmud into rich organic manures by inoculating it with isolated microflora from pressmud not only solves the problem of disposal and pollution but also replenishes the soils and reduces the fertilizer cost. The overall objective of the study is to develop a comprehensive strategy to utilize our organic waste in environmentally safe manner. The present study is therefore, planned to investigate the quality of pressmud and its impact on soil health and growth and quality of Sugarcane crops.

2. Materials and Method:

2.1. General:

The lab experiments were conducted in spring planting season of sugarcane during 2012-2013 at Department of Environmental Science, Shivaji University,

Kolhapur, Maharashtra, India using sugarcane saplings 86032 took from Warana Research Laboratory, dist-Kolhapur.

The experiment was laid out with a view to work out the effect of enriched pressmud on growth and quality of sugarcane plant such as phyto-chemical parameters like chlorophyll, protein, amino acids content and physico-chemical parameters of soil before planting and after harvest of crop.

The experiment was laid out in big container with three replications. The container size was 45cm (Length)* 30 cm (Height). Total three combinations including control were employed.

The data of phyto-chemical and physico-chemical characters were recorded accordingly at appropriate time of above combinations.

2.2. Collection of composted pressmud

Pressmud composted by windrow method was collected from Kumbhi Kasari S.S.K., Kuditre situated about 12 km west of Kolhapur city having its crushing capacity 350 TCD and Distillery of 45000 LPD.

2.3. Isolation of micro flora from pressmud and enrichment with isolated micro flora

Bacterial strain was isolated from pure pressmud by dilution method on Ashbys medium. The isolated bacterial strain was *Caditatus Rhizobium macilli* , *Bacillus weihenstephanensis* NBRC 101238, *Bacillus flexus* IFO15715 separately cultured in nutrient broth. A loopfull of 4 days old colony of bacterial strain was separately transferred to sterile 100 ml nutrient broth kept on orbital shaker (110 rpm) at R.T. for 5 days till broth showed dense turbidity that make the cell density 10^7cells/ml.

2.4. Formulation of the bacterial consortium

The experiment was conducted in the laboratory using large plastic containers (58 × 43 × 18 cm). The container was filled with 1 kg of sterile Compost Pressmud CPM collected from Kumbhi Kasari S.S.K. The study was carried out with microbial consortium (Inoculum) sprayed over CPM. Bacterial counts in the CPM were monitored periodically using pour plates of individual enriched media. Also Nitrogen, Potassium, Phosphorous, pH, and total organic matter were analyzed.

2.5. Sugarcane saplings plantation in controlled conditions

The sugarcane co: 86032 variety was planted in container having size 45cm (Length)* 30 cm (Height) during suru season (June planting) of 2012-2013 at Department of Environmental Science, Shivaji University, Kolhapur (Maharashtra, India). With three different combinations viz. Control with no inoculums (T_0). Composted pressmud (T_1), Enriched composted pressmud by inoculated with

isolated bacteria (T_2). Each combination was replicated three times. The experimental units were arraged in completely randomized design.

2.6. Analysis of physico-chemical parameters of pressmud and soil

The pressmud and soil were analyzed for pH and moisture content [3], organic carbon content , organic matter [1], available phosphorus [30], total nitrogen [22], calcium [8] and magnesium [43], potassium [15].

2.7. Analysis of phytochemical parameters of sugarcane plant

The biochemical characteristic of vegetative parts of sugarcane was done in terms of their chlorophyll content [11], total phenolics [46], total flavonoids [40], protein [26], carbohydrates [16], ascorbic acid [36], proline [2].

2.8. Data analysis

Results obtained were the mean of three or more determinants. Analysis was carried out on all data at $P< 0.05$ using Graph Pad software (Graph Pad Instate version 3.00, 193, Graph Pad software, San Diego, CA, USA).

3. Observations:

Table-1. Composition of a Sugarcane cultivated soil at Dept.of Environmental Science laboratory, Shivaji University, Kolhapur.

Parameters	(%)	Parameters	(%)	Parameters	(%)
Moisture content	25.34±0.48	Nitrogen (N)	1.60±0.12	Calcium (Ca)	0.80±0.01
Organic Carbon	1.77±0.02	Phosphorus (P)	0.41±0.02	Magnesium (Mg)	0.24±0.04
Organic Matter	3.06±0.01	Potassium (K)	0.15±0.04	Water Holding Capacity (WHC)	42.27±0.53

pH of the soil was 7.02, The values are represent Mean ±

Table-2. Composition of Composted Sugarcane pressmud (T1) produced by Kumbhi Kasari S.S.K. Ltd., Kolhapur.

Parameters	(%)	Parameters	(%)	Parameters	(%)
Moisture content	59.07±0.46	Nitrogen (N)	2.54±0.14	Calcium (Ca)	1.00±0.07
Organic Carbon	31.00±0.03	Phosphorus (P)	1.38±0.05	Magnesium (Mg)	0.60±0.06
Organic Matter	53.44±0.01	Potassium (K)	0.66±0.04	Water Holding Capacity (WHC)	68.20±0.34

pH of the soil was 7.33, The values represent Mean ± SD

Table-3. Composition of Enriched Composted Sugarcane pressmud (T2) produced by Kumbhi Kasari S.S.K. Ltd., Kolhapur

Parameters	(%)	Parameters	(%)	Parameters	(%)
Moisture content	60.07±0.54	Nitrogen (N)	2.64±0.15	Calcium (Ca)	0.50±0.06
Organic Carbon	32.34±0.04	Phosphorus (P)	1.45±0.07	Magnesium (Mg)	0.60±0.08
Organic Matter	55.75±0.03	Potassium (K)	0.72±0.05	Water Holding Capacity (WHC)	54.22±0.34

pH of the soil was 6.84, The values represent Mean ± SD

Table-4. Effect of Enriched composted pressmud on physico-chemical characters of Soil.

Sr. No.	Parameters	T0	T1	T2
1	pH	7.02±0.01	7.34±0.06	6.28±0.04

2	Moisture (%)	25.34±0.32	27.54±0.26	28.66±0.45
3	OM (%)	3.06±1.54	4.62±1.69	5.14±0.98
4	OC (%)	1.77±1.07	2.68±1.08	2.98±1.02
5	Nitrogen (%)	1.60±0.45	1.73±0.63	2.01±0.56
6	Phosphorous (%)	0.41±0.22	0.78±0.21	1.03±0.53
7	Potassium (%)	0.15±0.04	0.22±0.06	0.29±0.34
8	Calcium (%)	0.80±0.08	1.00±0.07	0.50±0.30
9	Magnessium (%)	0.24±0.23	0.61±0.25	6.61±0.32
10	WHC (%)	42.27±0.20	48.78±0.21	51.43±0.46

OM: Organic Matter, OC: Organic Carbon, WHC: Water Holding Capacity, the values represent SD ± 3

Table-5. Effect of Enriched composted pressmud on growth of Sugarcane

Sr. No.	Parameters	No. of Leaves	Height (ft)	No. of Nodes	Cane Girth (cm)
1	T0	14	7	10	4
2	T1	15	8	12	5
3	T2	17	9	13	6

The values represent SD ± 3

Table-6. Effect of Enriched composted pressmud on phyto-chemical characters of Sugarcane.

Sr. No.	Parameters	T0	T1	T2
1	Chlorophyll	0.97±0.08	1.37±0.05	2.26±0.07
2	Carbohydrates	5.9±0.65	7.7±0.76	9.4±0.85
3	Proline	0.078±0.002	0.021±0.003	0.024±0.002
4	polyphenols	0.11±0.052	0.13±0.063	0.16±0.081
5	Flavonoids	0.96±0.21	1.04±0.63	1.1±0.56
6	Ascorbic acid	6.2±0.45	5.9±0.31	5.5±0.64
7	Protein	1.23±0.45	1.57±0.62	2.24±0.34

The values represent SD ± 3, all value represented in mg g-1

4. Results and discussion:

4.1. Physico-chemical Characters of soil (T_0), composted pressmud (T_1) and enriched composted pressmud (T_2):

The soil used for the experiment was analyzed for physico-chemical properties shown in (Table 1). The results revealed that the soil was a clay loam with pH 7.02 and NPK 1.60 ± 0.12%, 0.41 ± 0.02% and 0.15 ± 0.04% respectively. This indicates that soil used for experiment had low NPK value.

The data presented in (Table 2) shows the physico-chemical characters of composted pressmud produced by Kumbhi Kasari S.S.K., Kuditre has pH 7.33 and NPK 2.54 ± 0.14%, 1.38 ± 0.05% and 0.66 ± 0.04% respectively. Pressmud is a good source of organic matter, NPK and important micro-nutrients and has established its importance in improving fertility, productivity and other physical properties of agricultural soil.

Table 3 represents physico-chemical characters of composted pressmud enriched by addition of bacterial culture. This bacterial culture can fix nitrogen but in a free-living state not in a root nodule which was isolated from fresh pressmud. It shows 6.84 pH and 2.64 ± 0.15% N, 1.45 ± 0.07% P, 0.72 ± 0.05% K respectively.

4.2. Effect of composted pressmud and enriched composted pressmud on physico-chemical characters of soil:

The data presented in (Table 4) shows the Effect of composted pressmud and enriched composted pressmud on physico-chemical characters of soil:The pot experiments after six months of plantation results obtained are as follows.

4.2.1. pH:

T_0 shows no changes in pH. The pH of soil of T_1 shows 7.34 ± 0.06 and pH of soil T_2 was 6.33 ± 0.04. It indicates that during conversion of NH_4^+ to No_3^- acid residue is formed which creates the residual acidity.

4.2.2. Organic carbon and organic matter:

In general, percentage of organic carbon and organic matter increased significantly with change of combination of pressmud. The organic carbon and organic matter of control (T_0) soil were 1.77 ± 1.07% and 3.06 ± 1.54%. Among all the combinations T_2 showed superior effect as compared to T_0 and T_1. Maximum organic carbon and organic matter was recorded in combination T_2, 2.98 ± 1.02% and 5.14 ± 0.98% respectively, where T_1 shows 2.68 ± 1.08% organic carbon and 4.62 ± 1.69% organic matter. The bacteria capable of fixing atmospheric nitrogen lead to an ultimate increase in organic carbon and nitrogen of the soil [14].

4.2.3. Nitrogen (%):

Enriched pressmud with bacterial inoculum were found to have significant effect on nitrogen content of soil. Unlike carbon content, nitrogen was increased gradually (Table.4). Among all the combinations, T_2 showed maximum nitrogen content (2.01% ± 0.56). This combination was found superior than control T_0 (1.60 ± 0.45%) and other combinations i.e. T_1 (1.73 ± 0.63%) respectively. The nitrogen fixing free living micro-organisms have frequently been reported as plant growth promoters. These bacteria are capable of fixing atmospheric nitrogen, solubilize phosphorus and enhance production of plant hormones [7].

4.2.4. Phosphorus (P) and Potassium (K):

Among all the combinations T_2 was found 1.03 ± 0.53% P and 0.29 ± 0.34% K superior over control T_0 0.41 ± 0.22% P and 0.15±0.04% K and other combinationT_1 showed 0.78 ± 0.21% P and 0.22 ± 0.06% K respectively. There was significant increase in phosphorus and potassium content of soil with enriched pressmud inoculated with bacterial suspension. Phosphorus and Potassium are essential elements for plant growth and development and they are not only improve the level of phosphorus and potassium of the plant body, but also improve the quality of crop [45].

4.2.5. Water Holding Capacity (WHC):

After application of enriched composted pressmud (T_2), soil shows increase in WHC i.e. 51.43 ± 0.46 %. Since biofertilizer can improve physical structure and water holding capacity of soil (30) while combination T_1 showed 48.78 ± 0.21 % and T_0 showed 42.27 ± 0.20 % WHC respectively.

4.3. Effect of composted pressmud and enriched composted pressmud on phyto-chemical parameters of Sugar plant:

4.3.1. Chlorophyll content:

The chlorophyll is the most essential pigments of photosynthesis. The Sugarcane with enriched composted pressmud i.e. T_2 showed higher total chlorophyll content (2.26 ± 0.07 mg g^{-1}) followed by T_1 (1.37 ± 0.05mg g^{-1}). The control plant showed less chlorophyll content i.e (0.97 ± 0.08 mg g^{-1}). The data is shown in table no.4. According to [10] Mg and N are the only soil nutrient that constitute chlorophyll. These nutrients were present in good amount in pressmud were applied to the plants as T_1 and T_2 may have enhanced the chlorophyll content. It is well stated that higher chlorophyll content is the indication of physiologically active healthy plants and those which are deprived in their nutritional condition showed poor growth and chlorosis [44].

4.3.2. Carbohydrate content:

Carbohydrates play important role in plant growth, development and stress responses. The Sugarcane plant shows higher carbohydrate contents which with enriched composted pressmud i.e. T_2 (9.4 ± 0.85 mg g^{-1}) followed by T_1 (7.7 ± 0.76 mg g^{-1}) while control plant shows less carbohydrates content i.e. T_0 (5.9±0.65 mg g^{-1}). According to [18] the level and quality of carbohydrates depend on species, organ, growth conditions and many other parameters, but globally it reflects the balance among photosynthesis and growth. The application of enriched pressmud shows good growth which directly reflects the concentration of carbohydrates.

4.3.3. Proline content:

The results revealed highest proline accumulation in Sugarcane plants supplemented with combination T_2 (0.024 ± 0.002 mg g−1), whereas T_1 showed 0.021 ± 0.003 mg g−1) and control T_0 (0.078 ± 0.002 mg g-1) proline content. Previously, it has been reported that under stress conditions, many plant species accumulate proline as an adaptive response to the adverse conditions [41]. However, there are also some circumstantial evidences suggesting that proline accumulation may occur in physiological nonstressed conditions for the development purposes. The proline accumulation may play an important role in flowering and developmental both as a metabolite and as a signal molecule or in the increase demand of protein synthesis [27].

4.3.4. Total phenolics and flavonoids content:

Polyphenolics are broadly distributed in the plant kingdom and considered as the most potent natural antioxidants [18]. The Sugarcane plants supplemented with enriched composted pressmud showed increase in their content of total phenolics and flavonoids. The result were shown in Table No.4, T_2 showed (0.16 ± 0.0810 mg g^{-1}) of polyphenol while (1.1 ± 0.56 mg g^{-1}) flavonoid content. The plant treated with composted pressmud showed (0.13 ± 0.063 mg g^{-1}) polyphenol and (1.04±0.63 mg g^{-1})flavonoid content. The control showed i.e., T_0 (0.11 ± 0.052 mg g^{-1}) phenolic content and (0.96 ± 0.21mg g^{-1}) flavonoid content respectively. In plants, polyphenols are generally involved in defense mechanism against biotic and abiotic stress as well as contributing to plant colors. They are ubiquitous in all plant organs and therefore a vital part of the human diet including fruits which are considered as a supplementary dietary source of various antioxidant phytochemicals. The antioxidant activities of polyphenols may be related to their redox properties, which allow them to act as a reducing agents or hydrogen / electron donors, scavenge free radicals, and terminate radical chain reactions [24]. Several polyphenolic compounds including flavonoids (catechins, flavonols, flavones and isoflavonoids) which can impede carcinogenesis by scavenging free radicals or interfere with the binding of carcinogens to DNA [10; 37]. Accordingly, the plants rich in antioxidants, have

received the greater attention and have been studied extensively, since they can reduce the risks for cardiovascular disease or several types of cancers [23]. The sugarcane juice contains flavonoids such as apigenin, luteolin and tricin derivatives and among phenolics, hydroxycinnamic, caffeic and sinapic acid, representing a total content of around 160 mg/L [20] whereas, sugarcane leaves contains luteolin – 8 – *C* -(rhamnosylglucoside) as major compound with radical scavenging activity [17].

4.3.5. Ascorbic acid content:

Sugarcane is rich a source of Ascorbic acid, also known as Vitamin C, is an important antioxidant molecule that is widely utilized in cellular metabolism [25]. According to [35], the concentration of ascorbic acid is adversely affected by the presence of different plant pathogens mainly with smut fungus. Hence an attempt was made to investigate the ascorbic acid content in three combinations i.e. T_0, T_1 and T_2. The Sugarcane plant showed (5.5 ± 0.64 mg g^{-1}) of ascorbic acid in leaf of plant with enriched composted i.e. T_2, T_1 showed (5.9 ± 0.31 mg g^{-1}) of ascorbic acid, while control shows (6.2 ± 0.45 mg g^{-1}) of ascorbic acid. Ascorbic acid also acts as primary substrate in the cyclic pathway for enzymatic detoxification of hydrogen peroxide; hence, it plays an important role in the activation of biological defense mechanisms [6]. Ascorbic acid has an additional role on thylakoid surface in protecting and regenerating oxidized carotenes and tocopherols, which are also helpful in protecting the plants against oxidative damage [4].

4.3.6. protein content:

Proteins act as important macro molecules that participate in every aspect of plant growth and development. Proteins are involved in processes such as catalyzing chemical reactions, facilitating membrane transport, intracellular structure and energy generating reaction, which involves electron transport. The sugarcane plant showed increase in protein content which was treated with enriched composted pressmud i.e. T_2 (2.24 ± 0.34 mg g^{-1}) followed by T_1 (1.57 ± 0.62 mg g^{-1}) respectively. The control showed less protein content in the Sugarcane leaves T_0 (1.23 ± 0.45 mg g^{-1}). Since the microorganisms present in enriched composted pressmud convert the atmospheric nitrogen in to NH_3. This NH_3 resulting from fixation can be transported in to plant tissue and incorporated in to amino acids, which are then made in to plant proteins [42].

4.4. Effect of enriched composted pressmud on growth of sugarcane

The cane height and number of nodes were significantly influenced by the combination T_2 as compared to T_1 and T_0, also T_2 showed significant effect on number of leaves and cane girth where as the effect of T_1 and T_0 were not showed significant effect as compared to T_2. Data related to Sugarcane growth were shown in Table No.5.

A possible factor which is required for healthy plant may be due to nutrient supply present in enriched composted pressmud along with N_2 fixation contributes N whenever the plants require it, suggested by [9].

5. Conclusions

The present study highlighted a successful process for the application of enriched composted pressmud inoculated with isolated micro flora as a source of organic nutrient to Sugarcane crop. These enriched composted pressmud constitutes a promising approach in sustaining soil properties and promoted the production of plant sources rich in health beneficial compounds and helpful in increasing NPK value of soil which is required for the plant growth. The results indicated that this method will play the dual role as a bioenhancer to reduce use of chemical addition to agriculture and use of sugar industry waste disposal problem. Such cost effective practices could reduce resistant waste and obtain a valuable product that can open several avenues for further research and large-scale commercial production.

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Agro-Industrial Waste Generation, Utilization and Management Through Carbon Sequestration Potential

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ABSTRACT
Composting is the controlled conversion of decaying organic matter and waste into sustainable products with the help of microorganisms. Chemical fertilizers make nutrients easily available to plants, but their degradation outweighs their benefits. Such fertilizers contribute to the effects of salinity, environmental pollution, biodiversity loss, marine pollution, and human diseases. This review recommends that slightly decaying organic material can be tested to determine its mineral content, which may be useful for long-lasting plants. Viricides, fungicides, and bacteria or organic sources can also be added to improve compost quality. Improving the length of composting period will also be helpful for soil quality and plant growth. Compost is used in agriculture to improve soil fertility through the provision of mineral fertilizers, such as potassium, phosphorus, and nitrogen. In addition, composting is also useful for soil carbon sequestration which is an important part of soil fertility. Composting is responsible for an increase in the formation of stable carbon compounds, namely substances such as humus and clusters. It aims to return organic materials to the natural cycle, to reduce the volume and quantity of solid waste, and stabilize waste for land filling. In this paper, we review the information on composting for treating waste as a means of addressing solid waste pollution concerns.

KEYWORDS
Waste Management, Agricultural & Agro industrial waste, Composting, Carbon sequestration.

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1. INTRODUCTION

Growing world population and resulting higher consumption goods and services caused a rapid increase in organic waste from households, industry and agriculture [1]. These practices breed insects and pests, release offensive odours, are unsightly and contribute to global warming (during combustion). Organic waste transformation is either aerobic or anaerobic. When transformed under aerobic conditions, compost is formed [2]. When treated anaerobically, biogas as well as effluents that can be used as

bio fertilizers are formed [3]. The by-products differ from those present in native soil, coals, and peats because they contain "humic-like" substances. Through the composting process, various degradable wastes can be transformed into goods that can be used effectively and safely as biofertilizers and soil supplements [4].

As a compost additive, biochar improves composting performance, the humification process, increases microbial diversity and activity, reduces greenhouse gas emissions, and immobilizes potentially toxic metals and organic pollutants linked with compost. [5]. During the composting process, the temperature increases rapidly in the presence of biochar so does the period of the thermophilic phase. Since biochar does also enhance the Water Holding Capacity (WHC), the desired moisture content of most compost in the range of 50–60% is ensured when biochar is added at the beginning of the composting process. Different types of feed stock derived biochar and composts have different carbon to nitrogen ratios, which directly affects the speed of organic matter decomposition [6].Biodegradation during composting and vermicomposting is one such strategy to convert organic wastes into organic supplements. These amendments can be applied to soil to increase soil carbon stocks and linked ecosystem services[7]–[9] or used as potting media. It has been demonstrated that disposing of biodegrable waste in landfills causes environmental deterioration, particularly when methane and lechates, two pollutants, are produced. It has been established that the disposal of recyclable waste results in the generation of highly contaminated lechates and methane gas, which both degrade the environment. According to the Kyoto protocol, methane is one of the sixth greenhouse gases that contribute to global warming and must be reduced in order to combat the problem [10]. The methane gas emission from landfills constitutes about 30% of the global anthropogenic methane emission to the atmosphere come from landfills[11].

2. PROBLEM OF CHEMICAL FERTILIZERS:

Fertilizers are substance used to add nutrients to the soil to help soil fertility and increase plant growth. Use of fertilizers, especially, the chemical fertilizers has brought in blessings on humanity, which helped to decrease hunger and death in different corners of the world. Through , chemical fertilizers increases, crop productivity, their overuse has hardened the soil, decreased fertility, strengthened pesticides, polluted water and air, and releases the green house gases, thereby, bringing hazards to environment and human health as well. The adverse effect of chemical fertilizers itself begins with the processing of chemicals whose products and by-products are certain dangerous chemicals or gases that cause air pollution, such as NH_4, CO_2, CH_4, etc., and it will cause water pollution also when the waste from industries is disposed off in nearby water bodies. It also involves the most damaging impact of the accumulation of chemical waste in the water bodies, i.e. eutrophication.

The adverse effects of these synthetic chemicals on human health and the environment can be reduced by adopting innovative agricultural practices, including the use of organic manure, bio fertilizers, bio pesticides, slow-release fertilizers and nanofertilizers, etc., moving away from chemical intensive cultivation. [12]. Since the chemical fertiliser increases the growth and strength of the plant, it thus meets the world's food security, but the plants grown in this way do not expand good plant characteristics such as good root system, shoot system, nutritional characteristics and will not have time to grow and mature properly [13] The effect of chemical fertilizers on air pollution with ammonia emissions from adjacent fertilized land results in deposition in ecosystems and damage to vegetation. NH_3 may be oxidized and turn into nitric acid and sulfuric acid from industrial sources, creating acid rain after the chemical transformations. Acid rain can damage vegetation. Also, it can harm organisms that they live in both lakes and reservoirs [14].

3. ADVANCEMENTS IN ORGANIC FERTILIZER:

The cyclical dynamics of the element allow for their reuse in ecosystems but also in agro ecosystems. Organisms represent a stage where they are stored slowly and temporarily in order to follow the flow in different places, such as space. Potential sources of nutrients, found in recycled materials, include polluted water; sewage sludge; animal dung; urban waste; compost; Vermicomposting; digestion; bio carbon; inorganic by-products such as struvite, ammonium sulphate, and food waste from agribusinesses; and other industries. Composting is a simple, affordable, and environmentally friendly biological decomposition process that converts organic waste, mostly food waste, into nutrient rich food for plants. The different components of organic waste are transfer into relatively stable humus-like compounds during the biochemical process of composting, which can then be used as an organic fertilizer or soil amendment [15]. It has been observed that cattle dung controlled nitrogen production in manure contributed 44 percent of the manure nitrogen followed by goats, sheep, pigs, and poultry. Nitrogen application in the form of manure on farms accounts less than one-fifth of the total nitrogen fertilizer production during the study. Dung nitrogen production is expected to increase in the coming decades due to the growing demand for livestock as per the population growth and dietary changes through high meat consumption [16].

Organic fertilizers comprise a variety of plant-derived materials that range from fresh or dried plant material to animal manures and litters to agricultural by-products [17]. In Thailand, liquid organic fertilizers are produced from agricultural residues and industrial wastes are becoming increasingly popular. These fertilizers are formed by simple fermentation processes using organic wastes as carbon substrates. Liquid organic fertilizers consist of necessary plant nutrients and beneficial microorganisms, which reuse organic matter. Microorganisms have an important function on the humiliation of substrates in the fermentation process. At the last part of the

fermentation process, phytohormones such as auxin and cytokinin, organic acids and plant growth stimulants are present in liquid organic fertilizers. [18]

3.1 The Composting process with different phases:

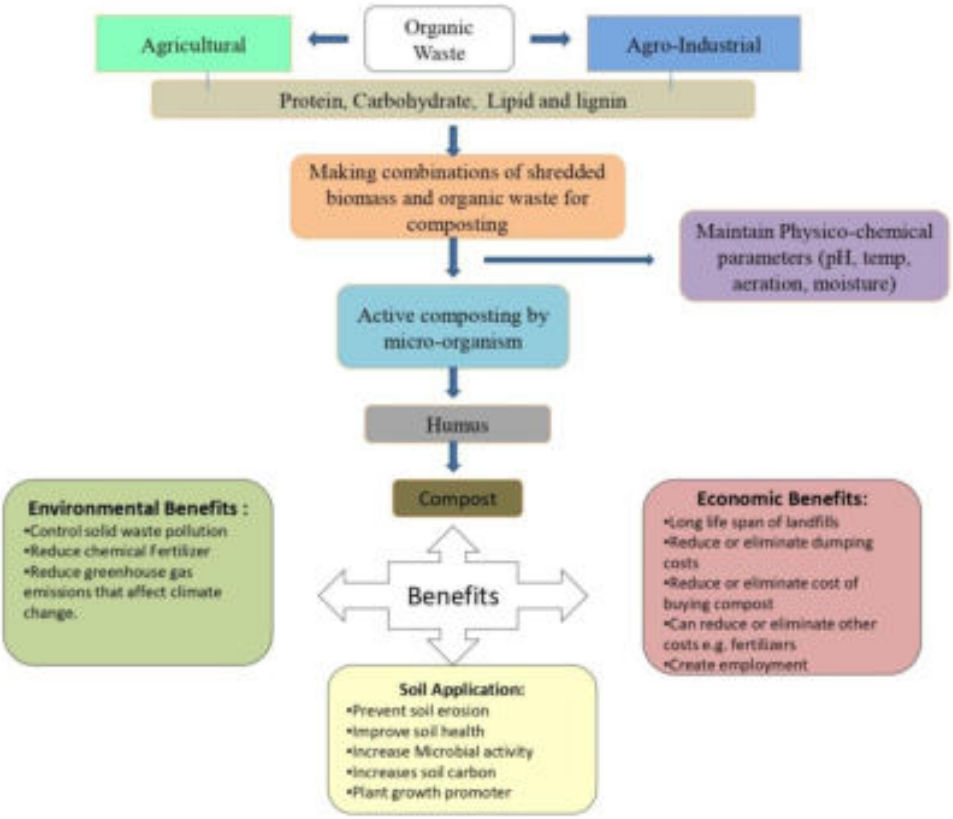

Figure-1. Overview of Organic Waste Management

Composting is generally defined as the biological oxidative decay of organic constituents in wastes of almost any nature under controlled circumstances. Since composting, as mentioned above, is a biological process of decomposing organic materials, it requires special Conditions, particularly temperature, moisture, aeration, pH, and C/N ratio, related to optimum biological activity in various stages of the process. The main products of aerobic composting are carbon dioxide, water, mineral ions, and stabilized organic matter, frequently called 'humus'. The process takes place in different stages, i.e.

1. Initial phase during which readily degradable components are decomposed.

2. Thermophilic phase during which cellulose and similar materials are degraded by the high bio-oxidative activity of micro-organisms.

3. Maturation and stabilization phase.

The process can also be discussed in terms of two well-defined phases, namely, (1) mineralization and (2) humification. Mineralization is a very intensive process involving the degradation of readily fermentable organic substances like sugars, amino acids, etc. The degradation is followed by intensive microbial activities producing heat, carbon dioxide, and water, along with a partially transformed and stabilized organic residue. The humification phase is conducted by specific micro-organisms which synthesis the complex tri-dimensional polymers that create the energy substratum for future microbial activities, [19].

3.2 Role of microbes in composting:

In composting, microorganisms convert organic materials such as manure, sludge, leaves, fruits, vegetables, and food wastes into products like soil humus [20]. The composting can be considered microbial farming, so they need energy, food, and habitat. These microorganisms want carbon as an energy source and nitrogen to build proteins. Bacteria produce enzymes to break down complex carbohydrates into simpler forms [21] and use them as food. Through composting organic waste materials are decomposed and stabilized into a product that can be used as a soil conditioner and/or organic fertilizer [22]. Decomposers include bacteria, actinomycetes, and fungi widespread in nature. Composting process continues until the remaining nutrients are consumed by the last microorganisms and most of the carbon is converted into carbon dioxide and water [20]. The nutrients that become available through decomposition remain in the compost within the bodies of dead microorganisms and in humus. There are two main types of composting processes:

a) Aerobic: Composting is the process of organic wastes being broken down in the presence of oxygen to produce CO_2, NH_3, water and heat. All type of organic waste can be treated using this method, but effective composting requires the right combination of nutrients and environmental factors. These include moisture percentage of approximately 40 to 60% and carbon to nitrogen (C/N) ratio of 25 to 30:1. In general, wood and paper are important sources of carbon, whereas sewage sludge and food waste are important sources of nitrogen. Aeration of waste, whether forced or passive, is required to ensure a sufficient supply of oxygen throughout [22].

b) Anaerobic: Anaerobic decomposition, or composting, is the breakdown of organic wastes without the need of oxygen, producing gases like CH4, CO2 and NH3 as well as minute amounts of other gases and organic acids. Animal manure and sewage sludge were traditionally composted using anaerobic composting, but recently it has become more conventional to treat some municipal solid waste and green waste in this manner [22]. The process of composting occurs in three phase. (a) The mesophilic phase, (b) the thermophilic phase, which can last from a few days to several months (c) the cooling and maturation phase which lasts for several months.

The accumulation is generally slightly acidic and at room temperature when composting first begins. In the early stages of composting, soluble and easily degradable carbon sources such as monosaccharides, starch, and lipids are used by microbes. The pH was reduced because organic acids are produced during the decomposition process from these components. The pH rises and ammonia is released when microorganism begin to break down proteins in the next stage. Thermophilic microorganisms grow as the temperature rises [23]. More durable substances like cellulose, hemicelluloses, and lignin are broken down and converted into the intermediate metabolites humic acid, fulvic acid and phenolic after breakdown because carbon sources have been depleted [24].The process of composting can convolute by the following chemical equation:

Agro industrial waste (Cellulose + Lignin + Protein) + $O_2 \longrightarrow CO_2 + H_2O$ + Compost+ Heat

4. IMPORTANCE OF COMPOSTING:

Composting methods vary during decay and the ability to stabilize, ripen and sanitize. This study was intended to investigate the effectiveness of comparing the four different composting methods namely. Windrow composting, Vermicomposting, Pit composting and Windrow Combined with Vermicomposting in stabilizing, maturing and cleaning solid municipal solid waste mix and dried sewage sludge [25]. In cases of depletion of organic matter in the soil, the use of natural residues, by-products or waste finds significant importance in improving soil fertility and crop nutrition. Several agro-industrial fossils are highly nutritious compared to nutrients, and these can regulate the physiological and chemical composition of the soil. Some research has been done on the effect of agricultural industrial waste on soil fertility and crop nutrition. Some scientists [26] who use press mud, molasses and rice husks, [27], [28] use powdered milk to make milk, use olive oil fertilizer,[29] with a variety of solid agro-industrial waste, and [30], [31] used tobacco waste.

Mixed compost fertilizers are currently in trend due to the recent campaign against the use of synthetic fertilizers. According to [32] compost helps to improve soil fertility and crop yield. Composting with artificial fertilizer can be another way of applying compost to plant growth. The literature has shown that artificial fertilizers may be more effective than compost in promoting plant growth [33] therefore; we suggest combined use of both in appropriate doses. Compost also holds germs that promote plant growth, which helps to increase soil fertility and plant growth. Soil to determine its fertility as a result of erosion. Erosion results in significant losses of potassium, phosphorous, and nitrogen. The use of top-level natural amendments has been reported to be very successful in combating soil erosion. Compost increases water retention capacity, soil structure, and the stability of compacted soil [30]. This is due to the presence of humus (a stable residue caused by a high level of organic rot) that

binds to the soil and can be said to act as a ‘glue’ of soil that holds parts of the soil together [34].

4.1 Problem of agro industrial waste:

Agricultural-based industries produce large amount of residue every year. If these residues are released into the environment without proper disposal, it could cause environmental pollution and a detrimental effect on human and animal health. Most agro industrial waste is not treated and used adequately, so in many cases it is dumped by burning, dumping or random landfill. These untreated wastes create various climate change problems by increasing the number of greenhouse gases. A part from this, the use of fossil fuels also contributes to greenhouse gas (GHG) emissions [35]. These wastes cause a serious disposal problem, for example, the juice industry produced huge amounts of waste such as husks, the coffee industry produced coffee pulp as waste, and the grain industry produced husks. All over the world around 147.2 million metric tons of fiber sources are create, whereas 709.2 and 673.3 million metric tons of wheat straw residues and rice straws were estimated, respectively, in the 1990s [36], [37]. Agro-industrial residues are defined as many different wastes from the food and agricultural industries. These residues include various materials of plant origin such as straws, stems, stalks, leaves, husks, shells, husks, fibers, seeds, pulps, stubble, bagasse, coffee grounds, brewer's grounds and some animal by-products, including feathers and whey [38]. Agricultural products and livestock are not only cultivated grown and produced for nutritional consumption. They are used for other purposes and it is not unlikely that such activities result in solid agricultural waste. Wood processing and clippings readily come to mind as a source of agricultural solid waste. Paper production using agricultural products as raw materials also generates a certain amount of agricultural solid waste [39]. Dry leaves have fallen from trees every day causing a large amount of leaf litter. Traditional methods for leaf litter disposal are burning and landfilling. Both methods have several drawbacks. By burning, some toxic compounds occur, causing air pollution problems [40].

5. UTILIZATION OF AGRICULTURAL AND AGRO-INDUSTRIAL WASTE FOR COMPOSTING:

Agricultural debris includes leaves, grass, stem, shell, husk, peel, gourd, stems, seeds etc. which are grains of wheat (wheat, rice, corn, sorghum, sorghum, barley, and maize), nuts, cotton, jute, legumes. (Beans, tomatoes, soybeans) cocoa, tea, olive, coffee, fruit (mango, cashew, cocoa, banana) and palm oil. While studying industrial waste, there are agricultural experiments and methods that have a significant impact on various industries, such as textiles, food, etc. which lead to the production of waste residue. These wastes are transferred to incineration or disposal to decompose; otherwise they endanger human health and the environment [37]. The various studies report that different kinds of waste such as pomegranate peels, lemon peels and green

walnut husks can be used as natural antimicrobials [41]. When agro-industrial waste is used for the solid waste fermentation process, the residues of various fruits and vegetables, such as fruit and vegetable peels, are commonly known as waste. Many researchers have focused on these barks and achieved good results. Thus, these wastes are considered as a valuable raw material for the production of various pharmaceutical products [42].

6. AGRICULTURAL AND AGRO INDUSTRIAL WASTE USING FOR COMPOSTING:

6.1. Compost by using Leaf litter in agriculture:

Garbage can pollute the air in addition to the water and soil. More than 40% of the waste produced worldwide is burned outside, producing potentially harmful emission. These emissions have been linked to respiratory issues, various health issues, and even the development of acid rain [43].Agriculture is a very diverse industry where a huge number of products are being cultivated and produced. Most of this burning result from household burning of materials, as a fuels source, field burning and release of greenhouse gases (GHGs) and black carbon (C) into the atmosphere, because of no foreseen value [44], [45]. When burning these materials, many beneficial things are lost that could otherwise be used for beneficial purposes. Plus, there is the Since the times of the industrial revolution, there has been a significant increase in the amount of CO_2,N_2O, $CH_4$and other GHGs found in the atmosphere [46]. Anthropogenic activities has led to increased concentration of green house gases especially carbon and these has led to the search for ways to reduce CO_2 emission and carbon sequestration from the atmosphere in order to mitigate the potential effects of global warming and climate change[47].

Leaf litter fall is one of the various carbon pools that exist in a forest ecosystem. It represents a major pathway for the transfer of carbon and nutrients between the vegetation and soil and as such, any alteration in litter fall will have an effect on below ground process [47].An attempt was made to prepare good quality compost from different forest tree leaf litter (Neolamarkiacadamba, Acrocarpusfraxinifolius, Dalbergia sissoo and Grewia tiliifolia) using fruit based Effective Microorganisms (FEM). Changes in compost quality parameters such as temperature, pH, EC, total carbon content, total nitrogen, total phosphorus, C/N ratio, total potassium and microbial population were monitored for 60 days. The state of compost maturity was indicated by changes in the C/N ratio (around 14:1), stable temperature and normal pH (around 7.0). During composting, the pH of the litter material was raised from 6.71 to 7.21. As composting progressed, the nutrient content increased. The increase in nitrogen of the compost was around 0.90 % to 1.40 %, phosphorus from 0.03% to 0.42% and potassium from 1.10% to 2.13%. [48].

6.2. Compost by using Pressmud from sugar industry:

Sugar cane is a widely consumed food source with a variety of applications. Global sugar production is about 181 million tons per year, with India leading the way with 29 million tones. Over 50 million farmers grow sugarcane over an area of roughly 5 million hectares for their livelihood. With its 65 sugar industries and a production capacity of 3.70 million tons, Karnataka is one of the major producers of sugar in India. The average sugar recovery rate from these industries is about 10.50%. The sugar industries major by-products include bagasse, molasses and pressmud. Bagasse is generated around 27- 30% cane crushed and can be utilized as a raw material for the paper and pulp industries as well as a feedstock for animals. Molasses is generated around 3.8 - 4.0% of cane crushed and is used as a raw material in distilleries to produce industrial alcohol or ethanol. Similarly, pressmud is one of the significant by-products generated about 3.5 - 4.0% of cane crushed. [49]. In a time when the cost of chemical fertilizer is rising daily and is becoming unaffordable for farmers, Pressmud has promise as the most affordable source of plant nutrients for sustainable crop production [50] and improvement in the physical (structure, texture, aeration, water-holding capacity, and porosity), chemical (pH, EC, CEC) and biological (microbial dyanamics) properties of the composts amended soil [51]–[53].

Since the industrial era (1880) the amount of greenhouse gases see; CO_2, nitrous oxide (N_2O) and methane (CH_4) are increasing significantly in the atmosphere (10), thereby increasing the average surface temperature of the Earth, and for this number of emission sources are responsible for one of the factors being undecomposed silt, and a by-product of the sugar industry [54]. Carbon sequestration is the transferring of CO_2 into pools of C that can be stored for long periods of time [44]. Pressmud is one of the main products of the sugar industry. Pressmud is used in the agricultural field as compost after making compost. Pressmud manure is an important source of macro-micro nutrients, plant-based steroids and biodiversity that help increase soil fertility and promote plant growth [55]. Application of pressmud as an organic manure shows 150% increase in organic carbon after first application, as level of initial organic carbon in soil is very low, i.e. 0.66% and it has the potential to accumulate more carbon. During subsequent cropping season it shows the increase in organic carbon content by 36.36% and 30.67% respectively [56].

6.3. Compost by using Poultry waste:

The poultry industry is one of the largest and fastest growing agricultural sectors in the world. This can be attributed to the increasing demand for poultry meat and egg products. The massive accumulation of waste, including manure and litter, which can cause disposal and pollution issues unless environmentally and economically beneficial management systems are developed however, a significant issue facing the poultry industry [57], [58]. The development of best management practices to minimize the environmental effects of air and water quality parameters affected by land application and the development of affordable, innovative technologies that

provide an alternative to applying poultry waste to soil will likely be essential to the poultry industry's continued productivity, profitability and sustainability [59], [60]. Air quality has become a major environmental issue for the poultry industry. Dust, odours and bioaerosols generated during the production, storage and spreading of poultry manure are the most common sources of complaints in the livestock industry [61]. Uncontrolled decomposition of manure produces foul-smelling gases, including amines, amides, mercaptans, sulphides, and disulfides. These harmful gases can cause respiratory disease in animals and humans [62].

Poultry waste comprise all essential nutrient and also micronutrient it is also a good source of rare plant nutrients [63], [64], especially for organic developer [65]. Adding of poultry manure to soils not only help to overcome the disposal issue but also raise the physical, Chemical and biological prolificity of soils. Such as, sustained cultivation of tillable soils usually results in a deterioration of the soil structure, which causes a decrease in crop production. However, if poultry manure is added to cultivated soil, then fertility is improved by increasing soil organic matter, increasing water holding capacity, overall soil stability and improving oxygen diffusion rate [66]. This review examines the composition of poultry manure in relation to nutrient content and environmental contaminants, its value as a nutrient source, soil amendment, animal feed and fuel source, and cost effective innovative technologies to improve its value. Poultry litter provides a major source of nitrogen, phosphorus and trace elements for crop production and is effective in improving physical and biological fertility, suggesting that land application remains a major option for utilizing this value resource. Alternative use of poultry litter; as a feed and fuel source, it is imitated by contaminants and high moisture content [67]. Currently, poultry manure is frequently used by vegetable farmers and gardeners in combination with inorganic nitrogen base fertilizers like urea and NPK, as poultry manure alone is thought to be only marginally soluble and may not produce the same yields of vegetables and fruits.

Similarly, poultry manure adds nutrients to living plants and non-living plants and increases water volume, water quality and beneficial biota in the soil and the economic impacts of incorporating chicken manure into planting systems. The addition of poultry manure improves the production of dry plants both on cultivated soil and pasture because it has the potential to improve the apparent fertility of the soil. Composted poultry litter can be utilized as a soil conditioner or fertilizer since it is a more stable and consistent material than fresh litter, which would likely increase soil carbon, aid prevent soil erosion, and reduce nitrate leaching from the soil [68].

6.4. Compost by using sludge from Dairy industry:

The management of solid wastes and their conversion into useful manure is essential and generally several methods are used in the case of dairy sludge treatment such as anaerobic digestion, composting, land spreading, constructed wetlands and lime

stabilization [68]. In an industrial society, the enhancement of living conditions increases the amount of waste material and the potential to pollute the environment. Pollution prevention is expensive, but with the use of waste, the costs can be attributed to a new form of industrial recycling of waste material [69]. The dairy industry is a major component of the food industry in India. In many countries, it is considered the largest source of wastewater in food processing. Although the dairy industry is not normally associated with serious environmental problems, it must constantly consider its impact on the environment - especially since dairy pollutants are mostly of organic origin (proteins, carbohydrates, lipids, suspended oils and/or fat) with a high concentration of suspended solids, biochemical oxygen demand (BOD), chemical oxygen demand (COD) and nitrate content [70].

In an industrialised society, improvements in living conditions increase the amount of waste materials and the potential to pollute the environment. Pollution prevention is expensive but, with waste recovery, costs can be assigned to a new form of production recycling of waste materials. Dairy sludge can be used as a composting source, but it has high lipid content and causes hardening during the composting process. The use of combined microbes such as *Rhizopus oligosporous* and *Aspergillus niger* in the pretreatment of dairy sludge can cause lipid reduction. The aim of this research is to determine the influence of *Rhizopus oligosporous* as a microorganism of anaerobic fermentation and *Aspergillus niger* as a microorganism of aerobic fermentation of the pretreatment of dairy waste sludge for the next composting process and to compare the composted products with the technical requirements for used organic compost [71]. The agronomic value of dairy sludge should be determined before its use in agriculture, which will give farmers more confidence in its use. The fertilizer equivalent value is defined as the application amount of mineral fertilizer that is equivalent to the effect of biological fertilization on crop yield or nutrient uptake[72].

6.5. Compost by using sludge from Agro industries:

Solid waste management is one of the biggest environmental challenges facing the world today due to growing population and urbanization. A sustainable approach to deal with this will be to treat and reprocess industrial waste on site to produce useful products. In India, the pulp and paper industry is one of the highest water consuming industries and causes serious pollution problems. The series of food and agricultural wastes present different challenges. Examples of industries include: meat and poultry products, dairy products, canning and preserving fruits and vegetables, grain products, sugar and related confectionery, fats and oils, and beverages and brewing, among others. This is a source of waste that is generated in agro-industry. Solid sludge is unavoidable for wastewater treatment plants for the agricultural industry. Sludge management is considered an additional burden on the industry due to its sheer volume and weight. These wastes cause a severe disposal problem [73] . For example, the juice industry produced huge amounts of waste as husks, the coffee industry produced

coffee pulp as waste, and the grain industry produced husks. There are approximately 147.2 million metric tons of fiber resources worldwide, while 709.2 and 673.3 million metric tons of wheat straw and rice straw residues were estimated in the 1990s, respectively [36].

Regarding the composition of these agro-industrial residues, they have a high nutritional perspective; therefore they are increasingly taken into account in quality control and also classified as agro-industrial by-products [74].Among the agricultural industries, the rice processing industry is the largest industry in India. In addition, it has the largest area for rice cultivation. Almost all rice mill wastewater comes from parboiling the rice. Discharges processed wastewater, solid particles and solid waste. Rice husks generate rice husk ash when burned as fuel in boilers/furnaces which need to be disposed of properly [26]. Composting more than one type of waste together may be a more appropriate solid waste management process. Sawdust, rice husk cow dung can be added as additives to absorb excess moisture and also to achieve optimum C:N ratio [75]. Coconut pulp is another commonly used bulking agent. [76]. ETP latex sludge is an industrial by-product with a high nutrient content (N-1.9%, P-9.12%, K-12.89%), which is possibly biodegradable. Since there are few alternatives for its practical use, its use as an agricultural fertilizer is suggested. Thus, this paper studies composting as a method to treat latex sludge and use the compost obtained as a growing medium for cowpea [77]. The composted sewage sludge is a potential organic fertilizer for use in sugarcane production. It is obtained from sewage sludge produced in large quantities in wastewater treatment plants (WTP). Sewage sludge has significant amounts of organic matter and plant nutrients, including N, P, Ca, B, Cu, Fe, Mn and Zn. [78].

Sludge cannot be composted separately due to unfavorable microbial conditions and physical structure. Therefore, they had to be mixed with bulking agents (Chauhan et al., 2008). The addition of bulking agents for composting optimizes substrate properties such as air space, moisture content, C:N ratio and pH, which positively affects the rate of decomposition(Gabrielle et al., 2005; Schenkel, 1996). Composting of industrial waste together with other agro-industrial waste is currently gaining momentum. Composting is economical with sustainable option for organic and industrial wastes like sludge from treatment plants as it is easy to operate and can be conducted in contained space, provided it is managed well to produce a good quality produce. Composting is increasingly popular as an alternative to waste disposal as a beneficial waste recycling option [79], [80]. Composting reduces and stabilizes waste and transforms it into hygienic and safe products that add economic value to the final product.

7. CARBON SEQUESTRATION THROUGH COMPOST:

Composting has the potential to boost water storage, improve soil health, and enhance air quality to help address these issues. Applying compost improves soil health because it encourages the growth and abundance of bacteria. These microbes store carbon produced by photosynthesis in the soil. Many central valley farmers currently apply compost made from organic matter to their crops on a regular basis. Still, they are not given credit for doing so or for the favorable externalities of carbon sequestration. Farmers and the environment benefit from using compost in the soil, even though its application is not always in line with environmental ideology. While the environment benefits from increased carbon sequestration, microbial health, and even worker health from a potential decrease in pesticide application, farmers profit from organic matter buildup, soil biology and health, crop production, and water retention. Compost's beneficial effects on the soil could potentially reduce California's reliance on inorganic fertilizers, which are currently very polluting. Compost made from agricultural waste, primarily manure, can also be an efficient approach to collecting carbon and keeping it from being released into the atmosphere. One of the state's most significant sources of greenhouse gases, the practice has the potential to reduce its carbon footprint [81].

Evaluation of land management practices for atmospheric carbon sequestration in agricultural topsoil can be misleading, as the terms carbon sequestration and carbon storage are often used interchangeably [82]. To avoid confusion, we have adopted the definitions of carbon sequestration as stated in: "The process of CO_2 transfer from the atmosphere to the soil of a soil unit through unit plant, plant residues, and other organic solids stored or retained within the unit as part of the soil organic matter". The process of sequestered SOC should increase the net pool of SOC during and at the end of the study above pre-treatment levels. The carbon sequestration potential of a certain management practice represents the maximum increase or decrease in the SOC stock for a certain climate during a certain time period and a certain soil depth, especially the 0–20 cm soil depth [83], [84].

The use of compost with cover crops boosted soil carbon by 12.6%, according to a recent study by scientists at the University of California, Davis, whereas cover crops resulted in a net loss of soil carbon. The experiment, which alternated tomato and corn plots, lasted 19 years. Only chicken dung compost was employed in the study, which suggests that it has a better nutrient balance than other types when it comes to boosting soil fertility for crops. Compost created from other organic matter, such as yard trash and food waste, is currently the subject of research. Although it is not yet obvious how the compost affected or countered the cover crops' efforts to trap carbon, the researchers say the findings increase the likelihood that the West Country will serve as an agricultural space and carbon sink. Applying manure to soil eliminates waste while increasing soil nutrients, but is considered a major contributor to greenhouse gas emissions from the livestock sector [85]. The Composts made from manure and plant residues are an alternative to manure applications. Most composting systems maintain

more aerobic conditions and lower GHG emissions compared to the wet and static conditions of many manure management facilities and landfills [86], where high CH4 emissions may result from low redox potential. Carbon sequestration is the transfer of CO2 to C stocks that can be stored for long periods of time [44], [54], After applying pressmud 3.5 times increase in observed organic carbon is achieved, with a onetime increase in organic carbon over the initial level after using pressmud as mulch. It demonstrates that the adoption of improved agricultural practices can increase soil carbon sequestration rates and clarify the role of organic matter in agricultural practices, not only for soil improvement but also for mitigating climate change [56].

Positive changes in agricultural practices can lead to better carbon sequestration in the soil. Agricultural practices can help increase soil volume carbon sequestration is 89.41% in soil carbon level after compacted mud application. When properly decomposed, Pressmud is a product that can be used as high quality organic manure. With its slower release of nutrients and trace elements, high water holding capacity, and mulching properties, the application of pressed sugarcane sludge is also less expensive [87]. Biochar is pyrolyzed biomass consisting of approximately 50% or more resistant organic materials. It is a promising soil amendment that improves the physical and chemical properties of soils and also provides better environmental services such as improved nutrient cycling, increased C sequestration and reduced greenhouse gas emissions. However, studies on the effects of biochars in agro forestry systems are limited [88], [89].

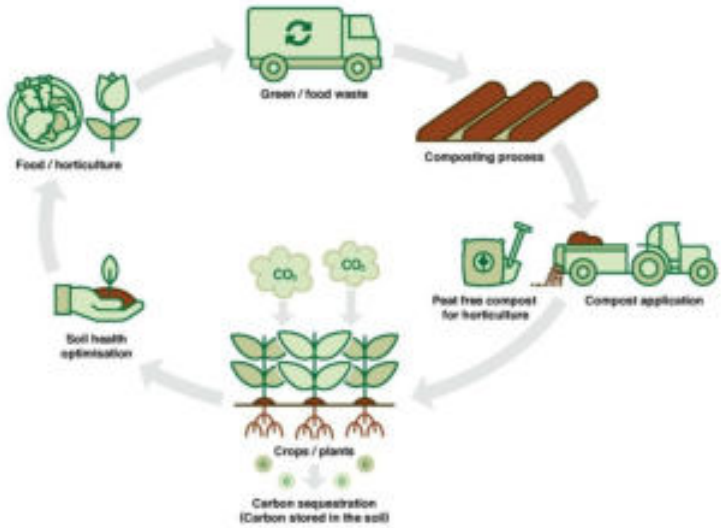

Figure-2. Process of Carbon Sequestration [90]

8. CONCLUSION:

Agricultural wastes are residues from the cultivation and processing of agricultural raw materials, are non-product outputs of production and processing and may contain material that can be beneficial to humans. These residues come from a range of agricultural activities and include cultivation, livestock production and aquaculture. It is important that we do not assume from the findings so far that proper collection, storage, processing, transportation and utilization of waste is a panacea for a healthy environment. Proper use of waste will help develop our agricultural sector and provide a viable source of biofuels for many. After the application of compost, a one-time increase in the level of organic carbon is achieved, compared to the initial level after using compost as mulch. It demonstrates that adopting improved agricultural practices can increase soil carbon sequestration rates and clarify the role of organic matter in agricultural practices, not only for soil improvement but also for climate change mitigation.

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Women In Environmental Conservation and Sustainability

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ABSTRACT
Women have historically played a significant role in protecting the environment. They are closely bonded to the environment. It has been observed that poor management of natural resources has an impact on women's lives, either directly or indirectly. The lack of resources is having an impact on the entire society in addition to the health, time, income position, and luxury of women. Women's participation in environmental protection has been shown to assist societies in cultivating the sense of accountability essential to preserve a healthy equilibrium between human and natural resource use. The goal of this article is to look at the role played by women in previous and present national and international efforts to conserve nature.

KEYWORDS

Women, Environmental conservation, Sustainability, Natural resources.

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1. INTRODUCTION

In Indian philosophy, women symbolize ‘Shrishti’ which means ‘Nature’. The woman in Indian culture is referred to as "Shakti," the force that propels the entire system. Indian philosophy also emphasizes the crucial role that women have in protecting the environment. It is a well-known truth that women handle issues relating to natural resources more delicately than men [1]. Women take a very dominant position in solving some of the most important environmental issues. The paper's main goal is to highlight the role played by women in previous and contemporary national and international efforts to preserve the environment. Women have a close linkage to natural resources. Natural resource depletion directly affects women's time, income, personal health, and function in society. In essence, strong desires for sustainability and devotion to it led Indian women to become crusaders against it. In history, there are many examples of women leaders who sacrificed their lives for the aim of environmental conservation. Rural women are strongly connected to their local environment as they work on farms, fetch water from far locations, and gather firewood for cooking. Therefore, any degradation of nature immediately impacts

women, children, and underrepresented groups [2], [3] Women are more immediately impacted and influenced by nature than males, thus they take an active role in protecting the environment [4]. [5] Noted that women have played a vital role in assisting community's management and their natural environments consequently have developed a variety of coping strategies to deal with the many environmental crises they have been encountered.

The Indian women were always ahead in the prevention of pollution and protection, preservation, conservation, and improvement of the environment. Women's participation in environmental protection has been shown to aid societies in cultivating the sense of accountability necessary to preserve a healthy equilibrium between human and natural resource usage.

2. ENVIRONMENTAL MOVEMENTS LEAD BY INDIAN WOMEN

Amrita Devi belonged to the Bishnoi community, was the first woman to be recognized as an environmental champion and she challenged the Maharaja of Jodhpur for the sake of preserving the Khejari trees 300 years ago. She died in the attempt, resulted a large-scale protests by the local villagers [6]. Gaura Devi, a 50-year-old illiterate woman who became an environmental activist in the 1970s, established the Chipko Movement to stop the destruction of trees in the Uttar Pradesh hill regions. Hundreds of women took part in the movement by hugging trees to stop them from being cut down by government-employed local contractors.

A newly well-known movement in India is Narmada Bachao Andolan, which opposes the construction of a major dam on the Narmada River. Medha Patkar, the leading environmentalist in the Narmada BachaoAndolan, served as the leader of this movement. This project was expected to pose one of the greatest threats to the local biodiversity and be a significant factor in the eviction of locals, particularly tribal people. A multi-crore project, the proposed Sardar Sarovar Dam would have uprooted more than 3, 20,000 people.

Sunita Narayan is the publisher of Down to Earth and the general manager of the Centre for Science and Environment (CSE). She started her career in the 1980s and co-edited the State of India's environment report with Anil Agarwal, another well-known environmentalist. Sunita presided over the Tiger Task Force for conservation in 2005 following the tiger population's decline in Sariska. She is a representative of the National Ganga River Basin Authority and the Prime Minister's Council for Climate Change. She was listed on the US publicationForeign Policy's list of the top 100 public intellectuals in the world in 2005, 2008, and 2009.

Maneka Gandhi is a leader for animal rights as well as an environmentalist. She established People for Animals in 1994, which is now India's largest organization for animal protection. She adhered to the principles of ahimsa and thought that India

need a movement to put an end to the abuse of animals. She so served as the host of the television program "Heads and Tails" and wrote a book with the same name. She eventually won some of the highest honors in the world for her groundbreaking work with animals.

Vandana Shiva is a renowned environmentalist and eco-feminist who supported various studies and research programs, especially on farmers' rights, organic farming, and campaigns for biodiversity conservation. She is well known for her proletarian initiatives to preserve regional biodiversity, coordinate women's networks, and safeguard forests. She received TIME's 2003 Environmental Hero Award. The Research Foundation for Science, Technology, and Natural Resource Policy is led by Vandana Shiva in Dehra Dun. In 1993 she received the Right Livelihood Award, a distinction compared to the Nobel Prize. One of her most important pieces of work is the rejection of corporate patents on seeds, which she refers to as "seed freedom." In 1991, Navdanya was founded as a nationwide movement to safeguard the variety of living resources. More than 2000 different rice varieties have been preserved during its 20-year history, and 34 seed banks have been set up across 13 states.

Rahibai Soma Popere is an Indian farmer and nature conservator. She is illiterate and without any formal schooling. She has spent her entire life working in fields and has a remarkable awareness of the variety of crops. She prepares hyacinth beans for self-help groups as she assists other farmers in switching back to local crop kinds. On the BBC's list of "100 Women 2018," she is one of three Indians. She was dubbed "Seed Mother" by scientist and Council of Scientific and Industrial Research Director General RaghunathMashelkar. She has developed her own techniques for collecting water from farms and converting the waste area into a useful workspace. She imparts knowledge on how to choose seeds, maintain healthy soils, and control pests to farmers and students.

3. WOMEN ENVIRONMENTALISTS FROM OTHER COUNTRIES

Greta Thunberg, one of the youngest environmental activists, began her powerful global activities about the climate catastrophe when she was only 15 years old. Thunberg first became well-known for her youth and her open and direct speaking style. She began spending her school days outside the Swedish Parliament holding a placard that read, "School strike for climate," calling for more aggressive action to be taken.

Wangari Maathai's Green Belt campaign was a further revolution in the history of women and the environment on a global scale. She received the Nobel Prize in recognition of her meritorious efforts in the environmental sphere. In 1977, a small group of women planted seven trees in Maathai's backyard. Participants in the Green Belt initiative had planted 30 million trees on both public and private properties by the

year 2005. The movement's goal was to combine environmental restoration with social and economic advancement in Kenya, where forests are vanishing at an alarming rate. The movement also aimed to empower rural women by preserving the environment, with a focus on planting native trees.

Rachel Carson, a biologist, author, and ecologist, lived from 1907 to 1964. She concentrated on the environmental consequences of chemicals and pesticides. She published a book called Silent Spring that shed attention on how human activity affects nature. This book helped launch the contemporary environmental movement. Carson had the view that nature and people are interdependent. She stated that industrial practices like the use of pesticides can harm the earth's ecology and will have long-lasting ecological effects including difficulties with future human health. The same things she highlighted in her book are happening in the world now.

Women's participation in environmental protection would aid society in developing the sense of accountability required to preserve a healthy balance between people and the planet's resources. The environment and women continue to face a variety of challenges, though. Women's participation in environmental preservation is low, and factors such as male dominance, inadequate technical skills, a lack of women in leadership roles due to family obligations, and a lack of women engaged in research and teaching in the natural sciences are all having an impact.

4. CONCLUSION

It is well-known fact that women are good managers of natural resources. Even though there are some sprints making women supreme decision-makers in the case of environmental matters, they can be empowered through societal support. As a result, women ought to be directly engaged in all aspects of environmental judgment call. By bolstering organizations at the local, national, and global levels that assess how enhancement and environmental policies affect women, many environmental concerns can be deeply tackled.

Data Accessibility: All supporting data were obtained from previously published work available via references below and from the output of the international and national articles on which the paper is based.

Conflict of interest: The author declares that there is no conflict of interest regarding the publication of this manuscript.

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Geographical Significance of Mangroves along Malvan Coast of Sindhudurg district Maharashtra

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ABSTRACT
Malvan coast is declared as a Marine Sanctuary by Maharashtra Government in 1987. Malvan is a rich biodiversity coast with diversified species of flora and fauna found in and around the Malvan Coast and the sea. Different bio-geographical species such as fish, coral reefs, phytoplankton and mangrove. Ongoing research concerted on study of Mangroves species. Along the Malvan coast, area of Kolamb Creek (coordinates 16°04'21.09'' North Latitude - 73°28'23.24'' East Longitude) and Karli Estuary (coordinates 15°59'43.84'' North Latitude - 73°29'38.5'' East Longitude) bearing maximum area under the mangroves. There are 18 species of mangroves recorded by the Government of India, Department of ocean development, Integrated Coastal and Marine Area Management, Project Directorate Chennai. Google Earth, CZMP maps and Toposheets are used to find out the area and location of mangroves used. Mangroves generally signifies for the minimizing inundation impact on the coast. Mangroves are proved very significant for minimizing rate of soil erosion and the coastal degradation. It is required for the balance of biodiversity along the coast.

KEYWORDS

Malvan coast, Biodiversity, Mangrove species, Degradation, Ecological functions.

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1. INTRODUCTION

Ecosystem is a community of living and non-living organisms of the environment. There are different types of ecosystem: Grassland ecosystem, Desert ecosystem, Tundra ecosystem, Freshwater ecosystem and Marine ecosystem. Mangrove is a part of marine ecosystem. Mangrove is also known as coastal forest. Local name of Mangrove is "Kandalvan" and "Kharphuti Jungle". In the point of view of common people; there is no importance of mangroves, they called it is a waste material on earth. But scientific point of view, mangroves have huge potentiality to serve people and nature. Mangroves are the biological productive system in coastal region [1].

Mangroves are plants which grow in intertidal zone of salt water. These are salt tolerant plants. Mangrove plants roots grow out side of the soil, because salt marshes

soil has no more pocket of oxygen, it takes oxygen outside form nature. It grows up in coast lines that are salt marshes, estuary, creek and mudflats etc.[2]

2. OBJECTIVE

Present paper aims to study the significance of mangroves with the spatial distribution of the mangroves species in Malvan tehsil of Sindhudurg district, Maharashtra.

3. STUDY AREA

Malvan Coast is extending from Pirwadi (Co-ordinate 16°12’01.63’’North latitude ----73°26’07.21’’East Longitude) to Devbag Spit-beach (Co-ordinate 15°58’06.59’’North latitude -73°30’07.44’’East Longitude). Along Malvan coast three creeks and one estuary is identified. There are two types of zone. One is littoral zone and other is limnetic zone. Limnetic zone is an open water area and littoral zone consists beaches, estuary, creeks etc. The coastline of Malvan tehsil extends up to 31 km which includes beaches, estuary, creek, cliff, spit and ports. Due to availability of rich flora and fauna Malvan has been declared as Marine sanctuary by Maharashtra Government on 13th April 1987 [3-4].

4. METHODOLOGY

Since methodology is a most significance part of research, for this research paper Google Earth is used to find out mangrove location. Toposheet No.E43T7 (47H/7), E43T8 (47H/8), E43T9 (47H/9), E43T11 (4H/11) and E43T12 (47H/12) has been also used to identify mangrove cover, with the help of Maharashtra CZMP maps actual area of Mangrove cover were delineated. The data about mangrove species were collected from fieldwork and government publications.

5. DISCUSSION

According to Forest survey of India, Dehradun, India State of Forest Report (2019); mangroves occupies 4975 sq.km. Area of Indian Territory, among these mangroves cover area of Maharashtra is 304 sq. km.

Along the Malvan coast 18 species are recorded by Government of India, Department of Ocean Development Integrated Coastal and Marine Area Management Project Directorate, Chennai. (2001) [5]

Kolamb Creek, Karli Estuary, Kalavali Creek and Achara Creek these sites have highest diversity among mangroves. There are two islands in Kalavali Creek one is Pankhol Juva (Hadi) and second is Banda Island. Near these islands mangroves pockets were identified[6-7].

Table-1. Mangrove Species Name along Malvan Coast.

1) Rhizophora Mucronta	**10) Exoceriaagallocha**
2)Sonneratia alba	**11) Acanthus ilicifolus**
3)S. papetala	**12) Derris heterophylla**
4) Avecennia alba	**13) Sesuviumportulacastrum**
5) A. Marina Var	**14) Aleuropuslagopoides**
6) A. officinalis	**15) Salvadora persica**
7) Ceriops tagal	**16) StenophyllusSp**
8) Lumnitzeraracemosa	**17) Thesepesiapopulnea**
9) Aegiceracorniculatum	**18) Clerodendruminerme**

Table-2. Spatial Distribution of Mangrove.

Mangroves area Creek/ Estuary Name	**North latitude**	**East Longitude**
Achara Creek	16°12’47.04’’	73°26’47.32’’
Kalavali Creek	16°06’24.79’’	73°27’47.04’’
Kolamb Creek	16°04’21.09’’	73°28’23.24’’
Karli Estuary	15°59’43.84’’	73°29’38.5’’

Figure-1. Location map of Malvan mangrove area. (Source: Google Earth).

The dense mangroves cover is found in Achara Creek, Kalavali Creek, Kolamb creek and Karli Estuary. But all these pockets are declared as a Critically Vulnerable Coastal Areas (CVCA) by Maharashtra government. Because most of these areas were degraded by human activities like boating, tourism activities, constructions of Jetties, construction of developmental activities, mangrove miss use by local people. Mangroves pockets are habitats for marine fishes. Lack of these habitats various species were became extinct. Threats to mangroves are directly effects on fish diversity. To maintain balance in marine ecosystem it is necessary to conserve mangroves pockets along coast line [8].

5.1 Ecological Functions of Mangrove

From the ongoing study of the mangroves, following are the significant functions are marked:

1) Mangroves protect coastal soil from tidal erosion.
2) Mangroves are breeding ground of variety of fishes.
3) Mangroves have the ability to absorb up to four times more carbon dioxide by area than upland terrestrial forests (Donato et al., 2011)
4) Mangroves are used for medicinal purpose.

6. CONCLUSION

Mangroves generally signifies for the minimizing inundation impact on the coast. Mangroves are proved very significant for minimizing rate of soil erosion and the coastal degradation. It is required for the balance of biodiversity along the coast.
Malvan coast is a reach marine biodiversity center. Various varieties of mangroves species are identified in this area. Mangroves forest are reproductive region for various fish species. It also helps to protect coastland from various natural hazards like storms, tsunami, cyclone, etc in Malvan. But now a day's this mangrove area is degraded by human activities which is responsible for imbalance in coastal ecosystem.

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Monitoring Land use and Land Cover Change Detection in Eastern part of Sangli District (Maharashtra) Using Geospatial Techniques

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ABSTRACT

This study attempt to detect the land use land cover change in eastern part of Sangli district, Maharashtra state between 1998-2018 using remote sensing technology, geographical information system and multi temporal imagery to estimate the area of each class of land use in 1998, 2008 and 2018 . Observations of land use trend and land cover change lead to find the possible reasons behind these changes. Land use/land cover (LU/LC) changes were determined in an urban area; these studies were employed by using the Survey of India topographic map and the remote sensing data of Landsat-V (1998) and Landsat-VII for 2008 & 2018. The study area was classified into four categories on the basis of field study, geographical conditions and remote sensing data. In study area especially land use land cover changes was easily identifiable because most of the land cover area have swallowing by human activity. Natural vegetation, forest cover, grasslands are converted into built-up area, settlement, corporation zone, commercial complex etc. the final output of this project is maximum area of forest, vegetation cover, barren land and water bodies are minimized and built area of the study region was goes increase and increase.

KEYWORDS

Land use, Land cover, Change detection matrix, Remote sensing, Drought.

…….

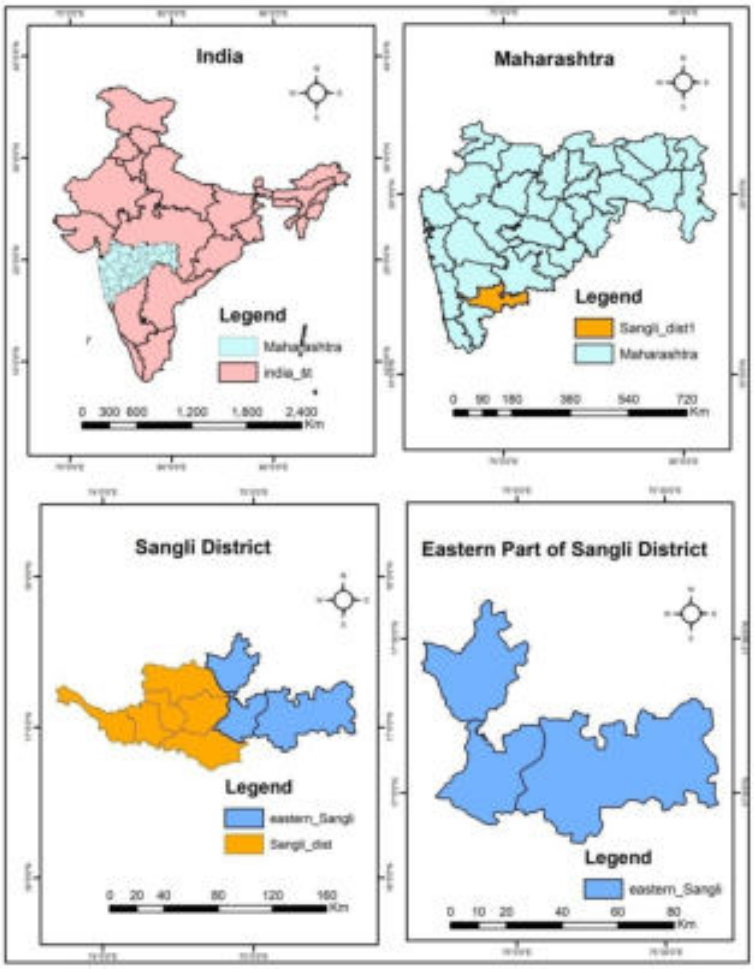
1. INTRODUCTION

Land resources are important because human beings do not only live, but also do all the economic work on the land. In addition, the land also supports wildlife, natural vegetation transport and communication activities. Five percent of your basic needs and needs such as food; clothing and shelter come from the land. Land resources are limited because only 43% of the total land area is straightforward, suitable for agricultural activities, industrial development and transport and communication systems. About 5% of the total land area is covered by plateaus which are in moderate habitat. Mountains cover about 5% of the total area and are highly

populated. Land has become a limited resource as the land is deteriorating at a rapid pace. Due to deforestation, irrigation, construction of large dams, mining and excessive steps, the source of the land has been damaged. Therefore land use and land cover monitoring is crucial steps to find out land use land cover in particular region or state as whole.

2. STUDY AREA

The present study is focused on Land use/ Land Cover in eastern part of Sangli district. The Sangli district is located at the extreme south of the state and bordering between the states of Maharashtra and Karnataka. Total area of study region is 3846.29 sq. km.



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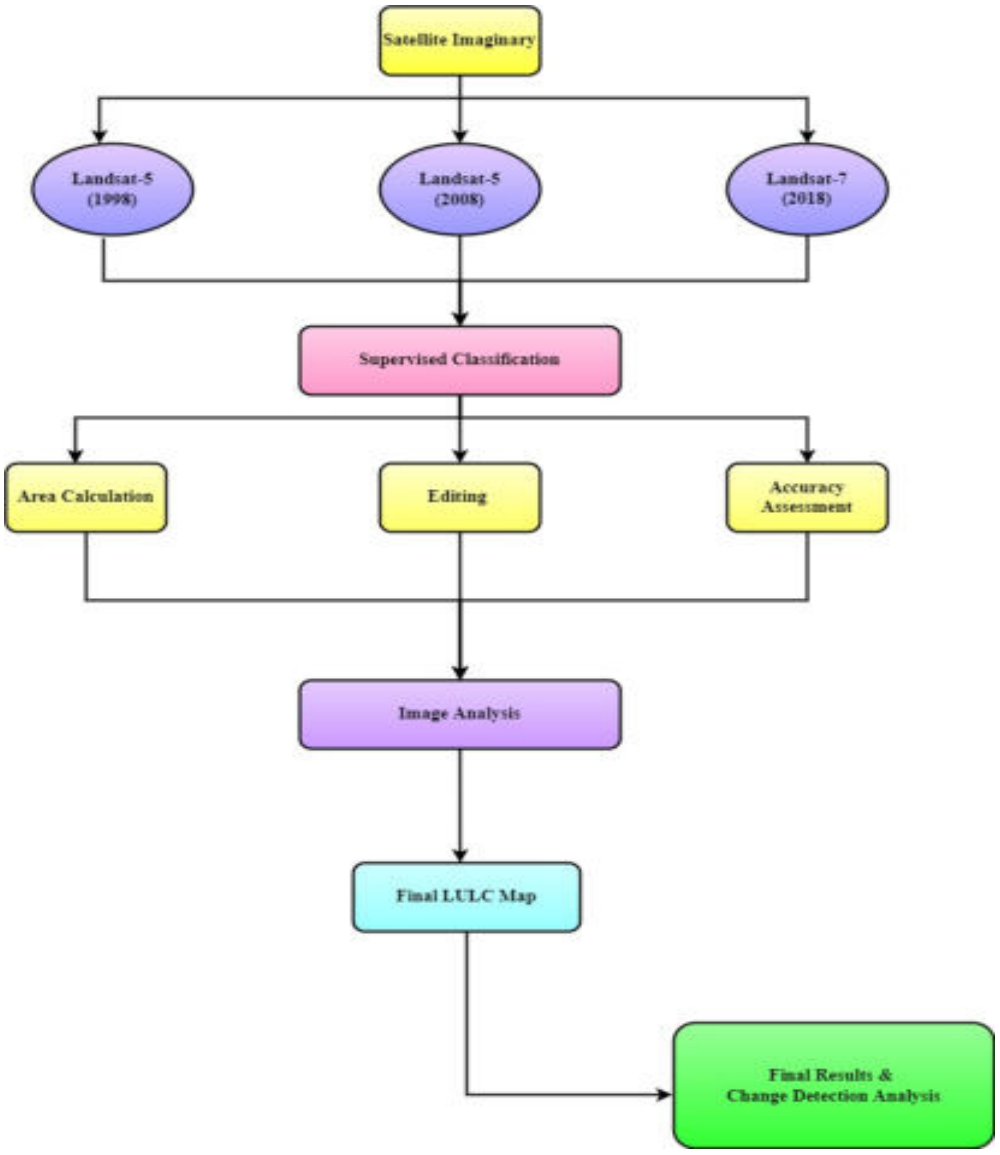


OBJECTIVE

1) To find out Land Use/ Land Cover in Study Area.
2) To look into Spatio-temporal Changes of Land Use/ Land Cover in Study Area.

4. METHODOLOGY

5. DATA BASE

5.1 **Data used**

Both remote sensing and ancillary data are used.

Remote Sensing data:

- LANDSAT-5: Satellite data of 30th December, 1998
- LANDSAT-7: Satellite data of 17th December, 2008
- LANDSAT-7: Satellite data of 29th December, 2018

Ancillary data

Survey of India Toposheet of Sangli District (1:50000)

5.2 Computer software and other material used:

Q GIS 2.16.0- software was used for image processing, digitization, importing, exporting and analyzing raster and vector data.

6. RESULT & DISCUSSION

Remote sensing and geographic information systems (GIS) are the foundational tools for natural resource inventory and analysis that have attracted a large number of regional, rural, and local planning, management, and development projects, as well as underdeveloped and developing regions around the world. Remote sensing and GIS technology are both cost-effective and sufficient for identifying soils suited for various crops, conducting field surveys, and determining land use classifications and capabilities. With the continually expanding realm of potential, remote sensing and GIS have become intriguing and enticing. The following section discusses the study's primary findings and conclusions, which are relevant to the detection of land use/land cover change for land use planning in the eastern portion of Sangli district using remote sensing and GIS. The end-results have been extensively debated and studied.

6.1 Land Use

The land as a whole must be used to serve as many legitimate requirements and wishes of the people in the nation as a whole,' according to the definition of land use [10]. Land use refers to the usage of surface for all developed and unused land on a specified space at a given moment. Crops, woods, pastures, mining, transportation, residential, recreational, industrial, and commercial use all take places on land. Uncultivated waste, i.e. barren and fallow land, makes up the unused lands. 'Land use is also linked to the conservation of land as it transitions from one major use to

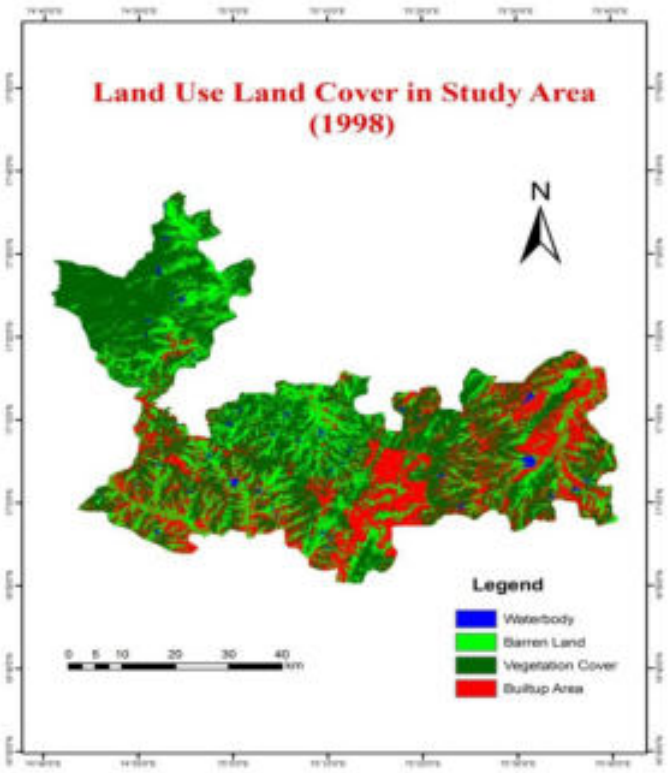
another [6]. ‘Land use means surface utilization of all developed and vacant lands for a specific point at a given time and space’ [4].

6.2 Land Cover

The observed (bio) physical cover on the earth's surface is referred to as land cover. Land cover should be limited to the description of vegetation and man-made objects when considered in its purest form. As a result, places with bare rock or bare soil on the surface are considered land rather than land cover [3]. Also, whether water surfaces are true land cover is debatable. In practice, however, the scientific community commonly refers to these characteristics as land cover. Land cover is typically characterized as natural or planted flora, as well as man-made structures (buildings, etc.) that occur on the earth's surface [11]. Land cover includes water, ice, bare rock, sand, and other similar surfaces. Land cover describes the surface cover on the ground, whether it is vegetation, urban infrastructure, water, bare soil, or something else; it does not represent the use of land, and the use of land for areas with the same cover type may be different [5]. For example, a forest land cover type may be used for timber production, wildlife management, or enjoyment; it could be private land, a protected watershed, or a well-known state park.

Table- 1. Land Use Land Cover1998.

Sr. No	Class	Area (Sq. km)
1	Water body	5.47
2	Barren Land	2075.61
3	Vegetation Cover	375.20
4	Built-up Area	1390.01
Total		**3846.29**



In the vegetation cover category open forest, dense forest and agricultural land categories are included. Barren land category negative change has been identified in last two decade but the other side built-up area in the study area increases noticeably. Eastern part of the Sangli district Jat, Atpadi and Kavathe-Mahankal tehsils of Sangli district facing severe drought condition every four or five year's duration. The area under water body also declined due to less rainfall occurrence. Atpadi tehsil of Sangli district having maximum area under barren land and vegetation cover it compares to Jat and Kavathe-Mahankal tehsil.

Table-2. Land Use Land Cover2008.

Sr. No	Class	Area (Sq. km)
1	Water body	12.95
2	Barren Land	1772.97
3	Vegetation Cover	346.55
4	Built-up Area	1713.14
Total		**3846.29**

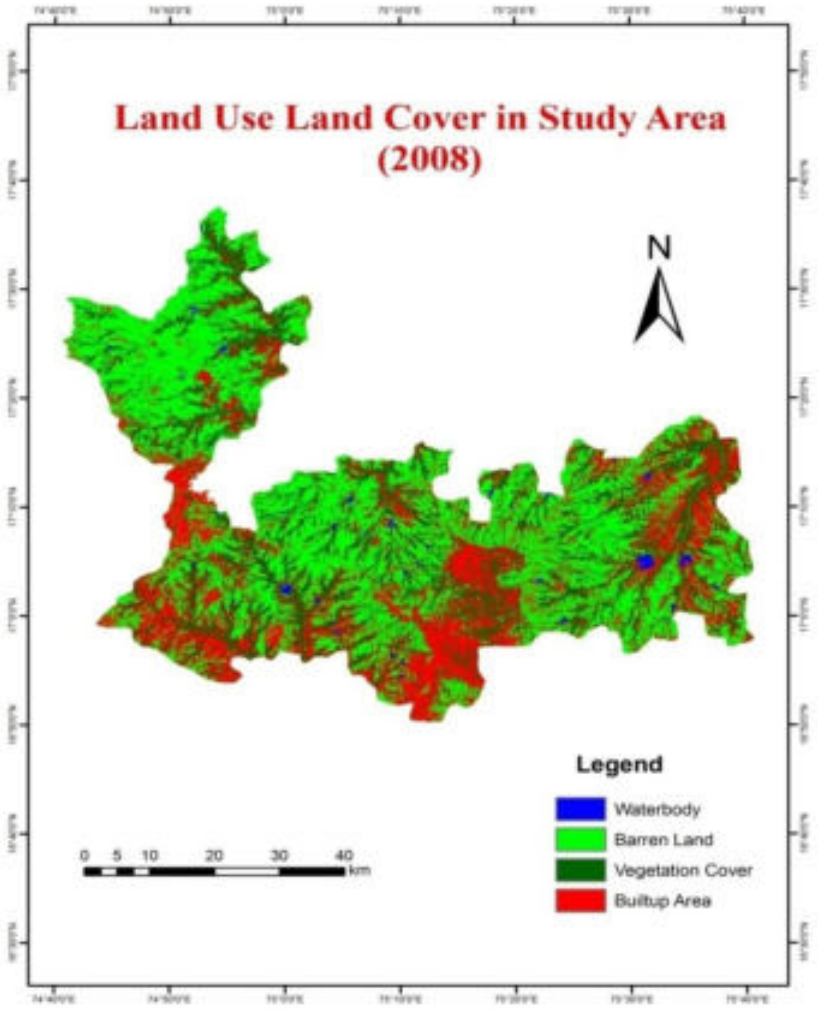


Table 3: Land Use Land Cover2018.

Sr. No	Class	Area (Sq. km)
1	Water body	8.41
2	Barren Land	1464.51
3	Vegetation Cover	314.72
4	Built-up Area	2059.07
Total		**3846.29**

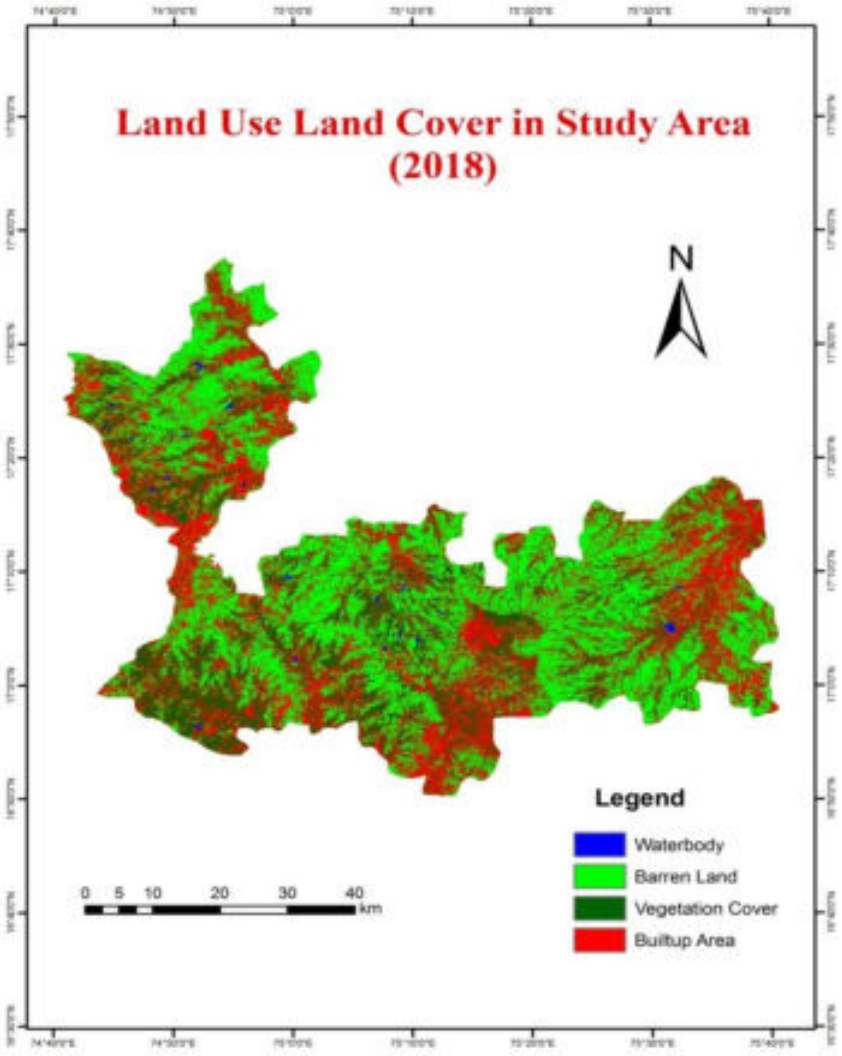


Table-4. Land Use Land Cover Change Detection (1998-2008).

Sr. No	Class	Year 1998 Area (Sq.km)	Year 2008 Area (Sq. km)	Change Area (Sq. km)
1	Water body	5.47	12.95	7.48
2	Barren Land	2075.61	1772.87	-302.74
3	Vegetation Cover	375.2	346.35	-28.85
4	Built-up Area	1390.01	1713.12	323.11

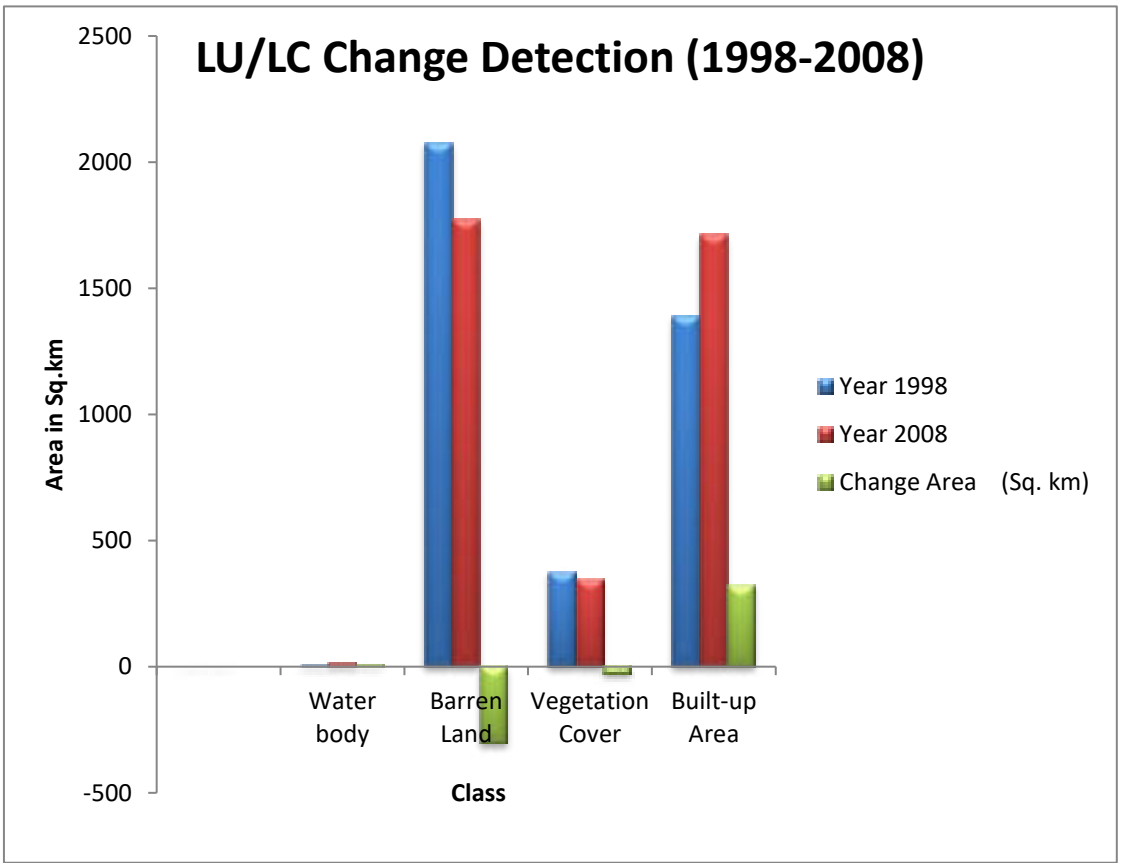
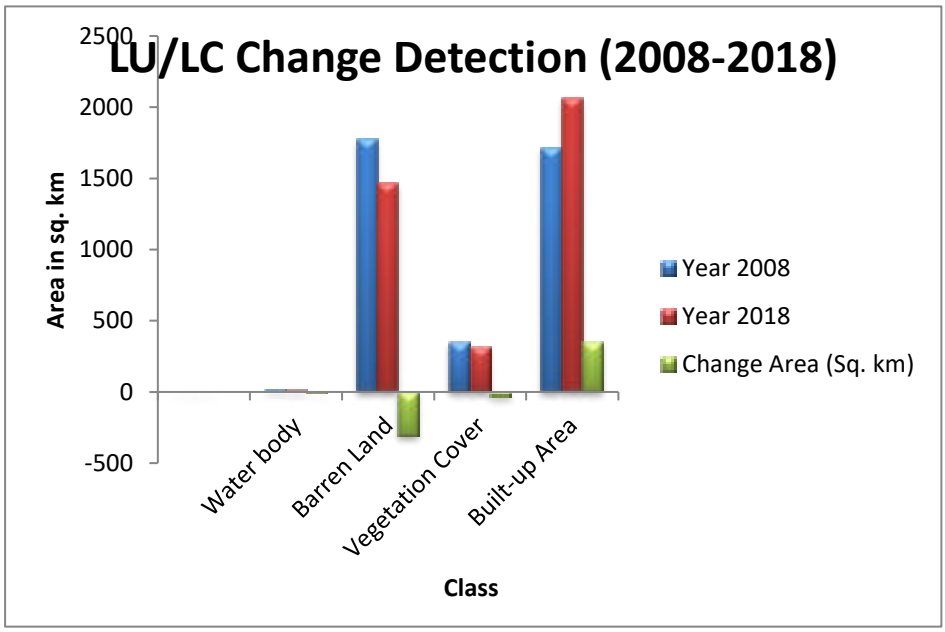
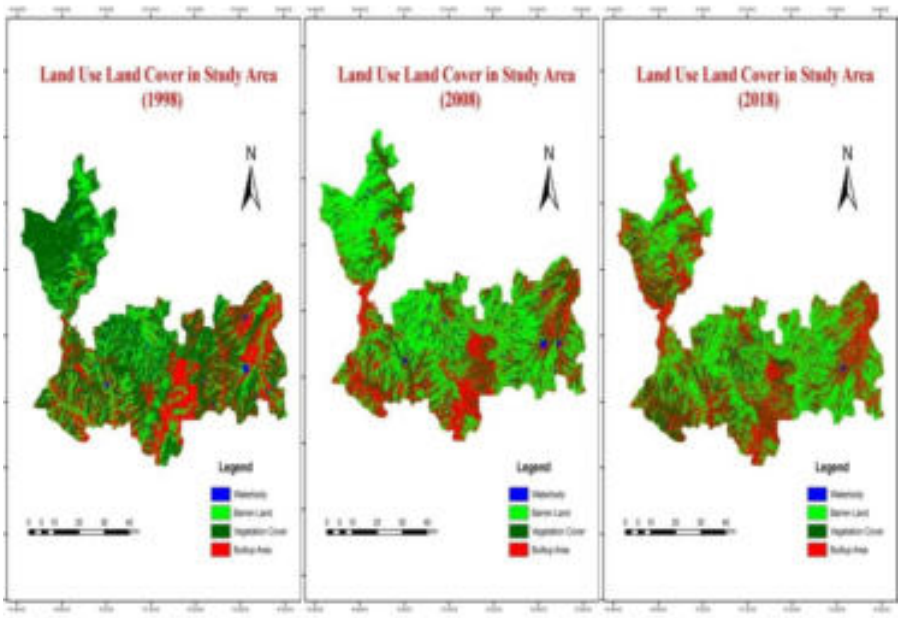


Table-5. Land Use Land Cover Change Detection (2008-2018).

Sr. No	Class	Year 2008 Area (Sq. km)	Year 2018 Area (Sq. km)	Change Area (Sq. km)
1	Water body	12.95	8.41	-4.54
2	Barren Land	1772.87	1464.31	-308.56
3	Vegetation Cover	346.35	314.5	-31.85
4	Built-up Area	1713.12	2059.07	345.95



Land Use/ Land Cover Change Detection (1998-2018)



Results from classified maps indicated that in 1998, 2008 and 2018 the area occupied in different classes has been changed. In 1998 area under water body was only 0.14% slightly increased in 2008 (0.33%). The scenario of barren land classification the ratio was declined 53.96% to 46.09% in 2008 and its down 38.07% 2018. Built-up area classification has been increased by 36.13% to 44.54% in 1998-2008 and 44.54% to 53.53% in 2008-2018. Diminutive changes are occurred in Vegetation cover indices in study area.

7. CONCLUSION

Eastern part of the Sangli district having very less rainfall area its compare to western part of the district. Jat, Kavathe-Mahankal and Atpadi tehsils facing severe drought condition every four or five years as per the Indian Meteorological report of 1901-2020. In Sangli district Miraj, Tasgaon, Palus, Khanapur and Kadegaon tehsils having various agricultural cropping pattern and built-up areas because of descent condition of rainfall. Land use Land cover change detection matrix gives the information about barren land or agricultural area has been converted in to built-up area within the study period. The impact of biotic and abiotic forces on the region's prevalent land use and land cover is reflected in spatial land use and land cover change. The intensity as well as the rate of change in land use and land cover is influenced by both topographical and climatic factors. The possible sensitive areas to change as a result of the different driving forces can be identified using GIS-based analysis of the study region's temporal data of land use and land cover.

The current changes in land use and land cover have major implications for ecological sustainability and climate change. To understand the origin of this irreversible change, it is critical to examine changes in land use and land cover in terms of spatial extent, intensity, and amplitude. Because the majority of the land cover area (land used by nature) is swallowed by human activity, land use and land cover changes in the study region were easily discernible. Natural flora, forest cover, and meadows have been transformed into built-up areas, settlements, corporation zones, and commercial complexes, among other things. The final output of this research is maximum area of forest, vegetation cover, barren land and water bodies are minimized and built area of the study region was goes increase and increased. This research is needful to planners, government agencies and society.

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Multi-dimensional Analysis of Population in Sindhudurg District, Maharashtra, India

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ABSTRACT

Sindhudurg is an administrative district in the state of Maharashtra in India which was carved out of the erstwhile Ratnagiri district Headquarters are located at ores. The district occupies area of 5207 km2 Sindhudurg district belongs to the greater track known as the 'Konkan' which is historically famous for its long coast line and safe harbor. The district is gifted with a coastline of 121 km.spatial distribution of population of Sindhudurg district is very crucial because the population of the district was mainly located at coastline and foothills of the Sahyadri ranges, Sex ratio, Density of Population, Literacy rate and Occupational structure of study area population in between 2001 and 2011. Literacy rate of the Sindhudurg district population has been changed and improved in last ten year because of new established schemes related to the education has been create some positive results in social area. Not only Sex ratio but also Density of Population has been minimized compares to 2001 census data to 2011 census data of Sindhudurg district.

KEYWORDS

Literacy rate, Occupational structure, Spatial distribution, Sex ratio, Density.

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1. INTRODUCTION

Spatial distribution describes how spread out a population is (what area it occurs in), while population density describes how many individuals are found in a given area. Learning is a continuous process that starts from a young age throughout to the old age. Globalization has significantly impacted on the modern learning process. The sex ratio is used to describe the number of males per 1000 males. The sex ratio is a valuable source of finding out the population of women in India and the proportion of women in men. Literacy rate: The total percentage of the population of an area at a particular time aged seven years or above who can read and write with understanding. Here the denominator is the population aged seven years or more [9].

For humans, the population density is the number of people per unit area, usually quoted per square kilometer or square mile, and which may include or exclude water or glacier areas. Business Structure: Total distribution of businesses in a community classified by skill level, economic function or social status. Professional Design of India: The distribution of population according to different types of business is called business design.

2. STUDY AREA

Sindhudurg district is situated between the North latitudes of $15^0$37' and $16^0$40' and the east longitude of $73^0$19' and $74^0$18' Covering a total area of 5207 Square Kilometers, the district of Sindhudurg lies in the Konkan area of Maharashtra, Comprising both the seashore as well as mountains. The district covers eight tehsils, namely Dodamarg, Sawantwadi, Vengurla, Kudal, Malvan, Kankavali, Devgad, and Vaibhavwadi.

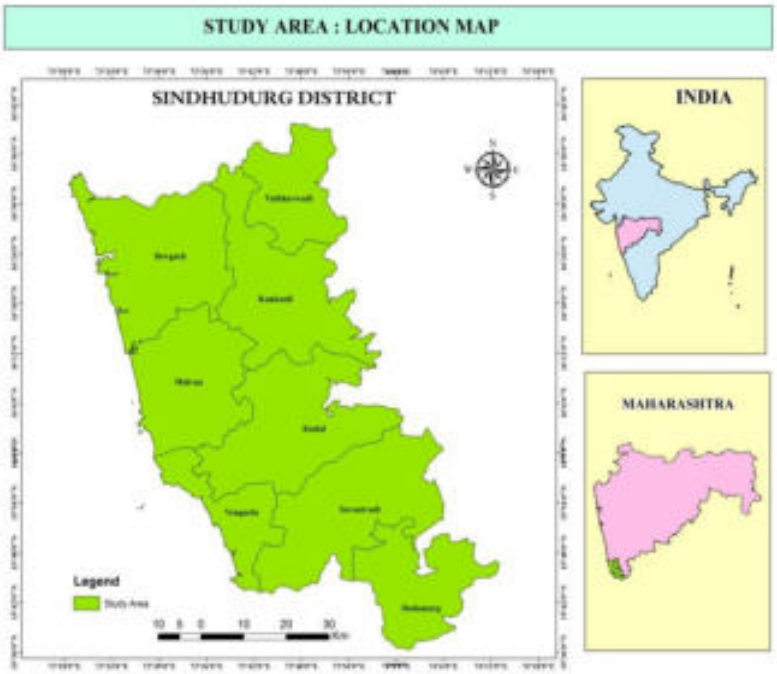


Figure-1. Location Map of Study Area

3. OBJECTIVES

For the present study, following objectives have been framed.

- To look into spatial distribution of population at tehsil level in Sindhudurg district of Maharashtra state.
- To examine the Spatio-temporal changes of population in study region.

4. DATABASE AND METHODOLOGY

The present study is based on secondary sources of data. Secondary data was collected from various available sources.

4.1 SECONDARY DATA

The secondary data was collected from the Census reports published by the Government of India for 2001 and 2011, Primary Census Abstract of Maharashtra state 2001-2011,Socio-economic Review and District Statistical Abstract of Sindhudurg district, Dissertations, Books, Journals, and Articles etc.

4.2 METHODOLOGY

The data collected through secondary sources is processed, edited and analyzed by using different quantitative and statistical methods.

Following techniques will be employed for the proposed study.

- **Sex Ratio Formula**:

$$\text{Sex Ratio} = \frac{\text{Male Population}}{\text{Female Population}} \times 1000$$

- **Literacy Rate Formula**:

$$\text{Literacy Rate} = \frac{\text{Literate Population}}{\text{Total Population 7-year age and above}} \times 100$$

- **Density of Population Formula**:

$$\text{Density of Population} = \frac{\text{Total Population}}{\text{Land Area (Sq. km.)}}$$

- Computer Technique: Usual computer technique has been employed for compilation, analysis and presentation of secondary data.
- GIS Technique: GIS techniques are used for making various Map related the population in the study region.

5. REVIEW OF LITERATURE:

Dube & Misra (1981) has analyzed level of education in Madhya Pradesh. The level of education and development in the state has been evaluated by using composite index from a set of carefully selected variables. **Ahmad and Nuna (1986)** assessed the inter-regional disparity in literacy in Maharashtra. They found that the inequitable development of literacy among the scheduled castes, scheduled tribes and nonscheduled tribes/castes populations on the one hand and among the male-female and rural-urban components of these populations on the other and raised a number of issues.

Chaturvedi (1987) examines the role of voluntary organizations in rural development with a historical perspective. **Charyulu U.V. (1989),** studied on voluntary agencies and their role in rural development, examines the nature of the voluntary organization in the field of rural development. **Bose and Desai (1989)** discussed that demographic data can be utilized to understand the differential impact of development on various sections of the population like male-female, urban-rural, inter and intra region migration, age groups, etc. help us to form policies to improve the health and living condition of the people.

Ramotra (1990) has studied some aspects of tribal literacy in Maharashtra- with geographical perspective. **Panse and Dubey (1993)** worked on the dynamics of regional disparities in levels of socio-economic development in Malwa region of Madhya Pradesh and for this study they used Kendall's coefficient technique. **Devi (1996)** studied district wise disparity in literacy of Orissa at three points of time, (i.e. 1971, 1981 and 1991). At the Millennium Summit in 2000, a framework for progress consisting of eight Millennium Development Goals (MDGs) was derived from the Millennium Declaration adopted by the world leadersfkom 189 Member States who agreed to help the world's poorest countries significantly by the year 2015. The MDGs serve as a time-bound, achievable blueprint for reducing pwerty and improving lives agreed to by all countries and all leading development institutions. They guide and focus development priorities for governments, donors a

District Human Development Report, Hooghly (2011) finds that women's health, nutrition, and survival are affected by the sex ratio, defined as the number of females per 1000 males. Gender disparity is shown by the low number of women per thousand men, which may be due to female foeticide (girl children are less desired), dowry deaths, lack of maternal health care, nutrition, etc. The district's blocks and municipalities have diverse sex ratios.

Ziyauddin (2009), focuses on social factors like housing, health, employment, and education in his exclusion theory. In which social arrangements, normative value systems, and customs exclude certain communities and groups from interaction and social resources.

Choudhury and Naoremi, (2015) discusses the causes of women's marginalization discrimination and inequality between men and women, which are the most critical and fundamental disparities in Indian societies.

S.K. Mazumder (2020) investigated fishermen's socioeconomic conditions in Jelepara, Pahartoli, Chittagong. 50 fishermen from 200 were interviewed. 94% of fishermen were male, while 6% were female. 88% were Hindus, 12% Muslims. Marriage was 84%. Single families outmatched joint families (94%).

Ganesh Kumar et al., (2019) Their study aims to understand the process of innovative marketing models in the fisheries sector and draw lessons from the success stories to upscale and institutional agencies, opportunities for supplementary occupations, and better marketing infrastructure for traditional fishermen.

6. DATA ANALYSIS

6.1 SPATIAL DISTRIBUTION OF POPULATION (2001-11)

As per the census of India 2001 the tehsil Kudal having highest population (17.60%) was observed and lowest was in Dodamarg Tehsil (5.75%) which is situated southern part of the district. Maximum number of urban populations was falls in Kudal tehsil because of this tehsil is benefited to educational facilities, commercial complex, industrial hub and important thing is job opportunities was very high therefore, most of the population was observed here. Similar condition was observed in year 2011.

Table-1. Sindhudurg District: Spatial Distribution of Population, 2001 & 2011.

Sr.No.	Name of Tehsil	Census Year 2001	Census Year 2011
1	Devgad	125288	120909
2	Vaibhavwadi	48350	43845
3	Kankavli	138167	135295
4	Malvan	116682	111807
5	Vengurla	88387	85801
6	Kudal	152939	155624
7	Sawantwadi	148980	147466
8	Dodamarg	50032	48904
	Total	**868825**	**849651**

Source: Census of India, District Census Handbook of Sindhudurg District 2001 & 2011.

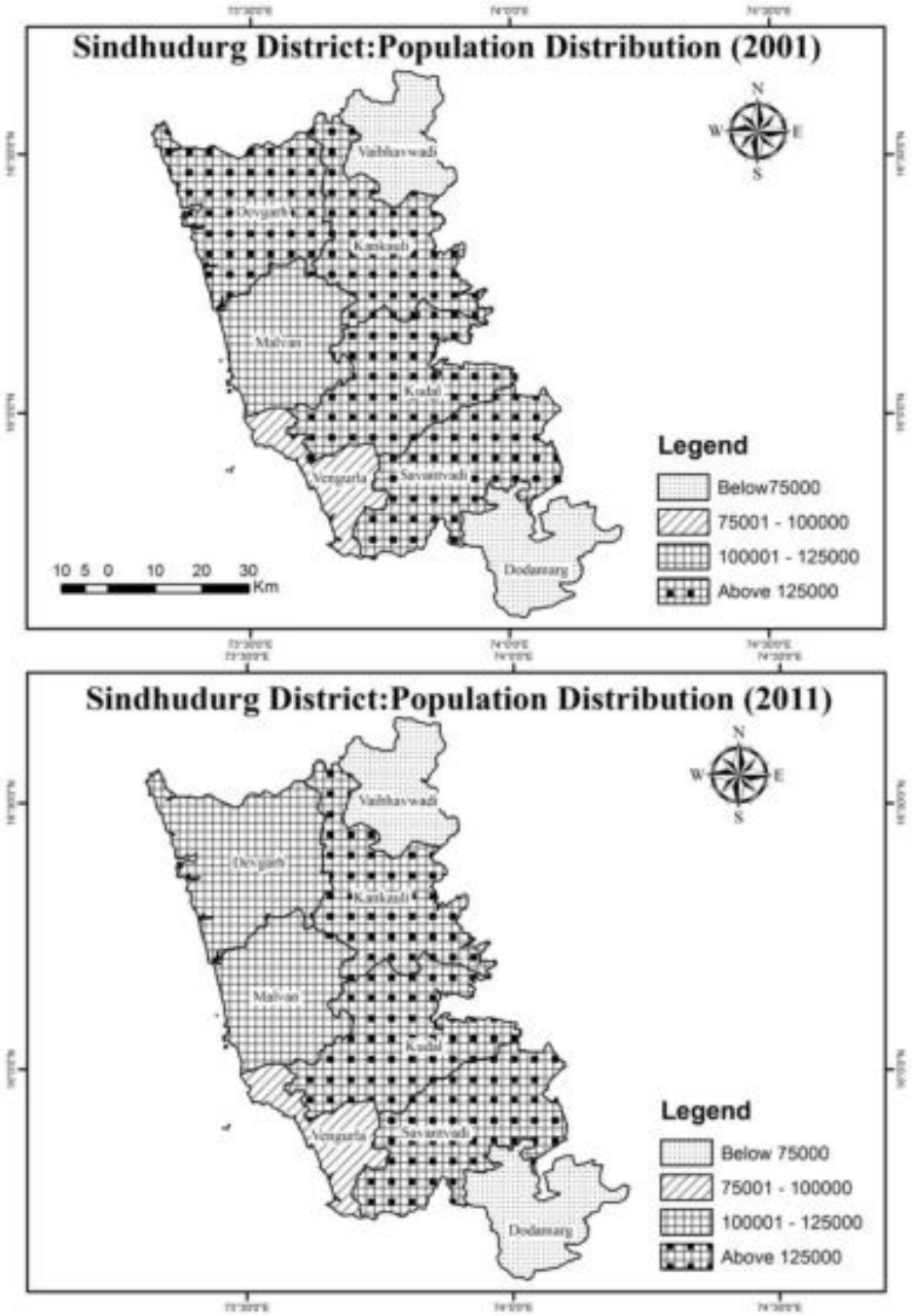


Figure-2. Sindhudurg District, Population Distribution (2001-11)

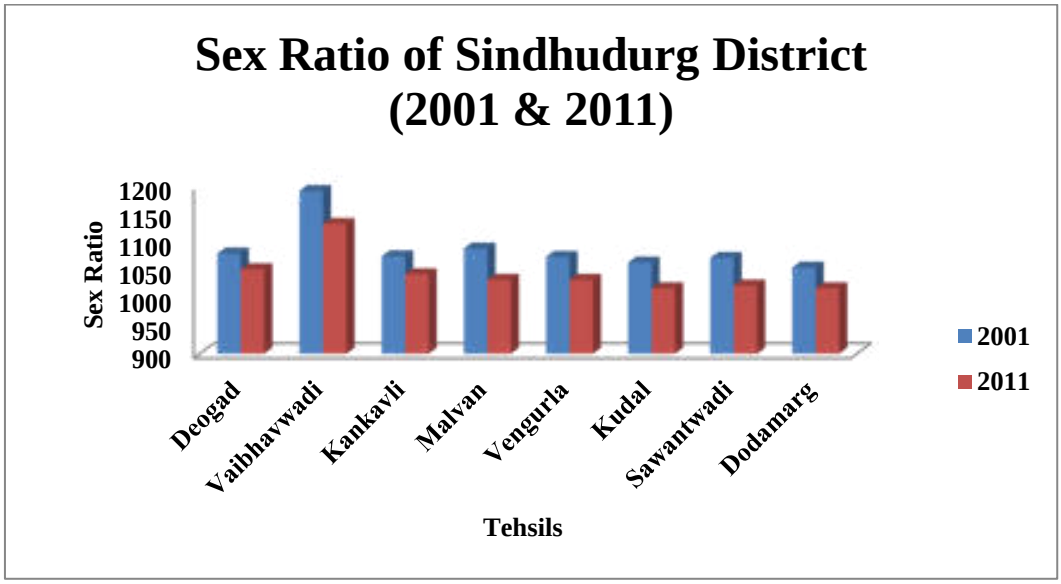
6.2 SEX RATIO (2001-11)

Sindhudurg is one of the districts in Maharashtra where sex ratio was above 1000 male population in both the census year, the main reason behind that is maximum number of the male-female population is literate therefore awareness is good compares to the other districts. Highest sex ratio was indentified in Vaibhavwadi tehsil 1191 in 2001 and 1132 in 2011 census and the otherhand lowest sex ratio was observed in Dodamarg tehsil 1054 in 2001 and 1017 in 2011.

Table-2. Sindhudurg District: Sex Ratio, 2001 & 2011.

Sr. No.	Name of Tehsil	Census Year 2001	Census Year 2011
1	Deogad	1079	1051
2	Vaibhavwadi	1191	1132
3	Kankavli	1074	1042
4	Malvan	1088	1032
5	Vengurla	1073	1032
6	Kudal	1063	1017
7	Sawantwadi	1071	1022
8	Dodamarg	1054	1017
	Average	**1086**	**1043**

Source: Census of India, District Census Handbook of Sindhudurg District 2001 & 2011.



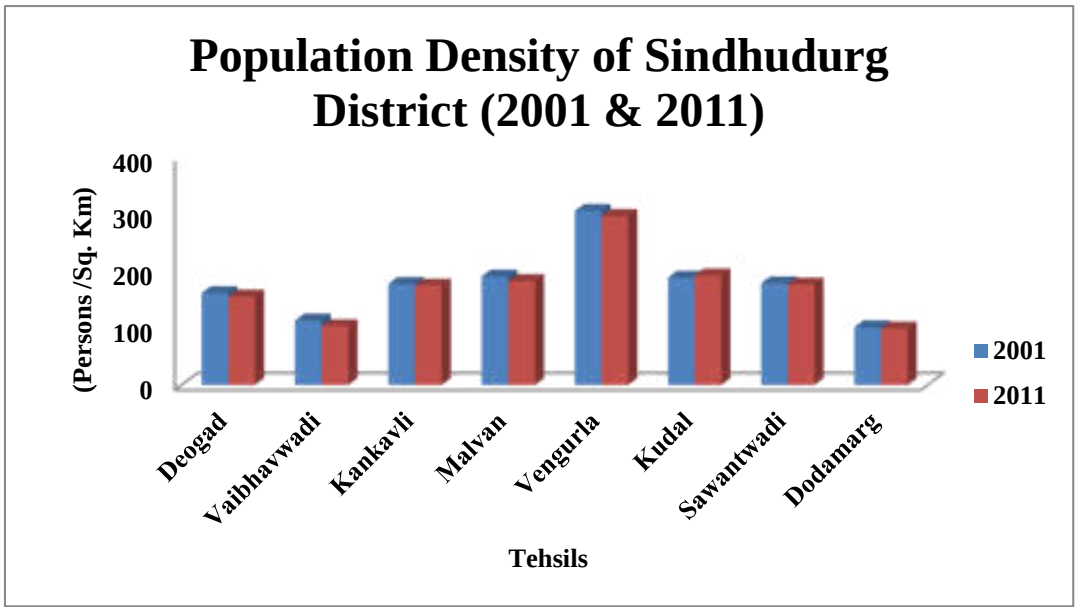
6.3 POPULATION DENSITY

Density of population gives the idea about where the population was concentrated in real world. As per the 2001 census average 177 and 172 population density was observed respectively. Highest population density was located in Vengurla tehsil in both the census year and lowest was in Dodamarg tehsil of Sindhudurg district.

Table-3. Sindhudurg District: Population Density, 2001 & 2011.

Sr. No.	Name of Tehsil	Density (Persons per Sq. Km Area)	
		Census Year 2001	Census Year 2011
1	Deogad	161	155
2	Vaibhavwadi	113	103
3	Kankavli	177	174
4	Malvan	190	182
5	Vengurla	305	296
6	Kudal	188	192
7	Sawantwadi	178	176
8	Dodamarg	101	99
	Average	**177**	**172**

Source: Census of India, District Census Handbook of Sindhudurg District 2001 & 2011.



6.4 LITERACY RATE

Literacy and educational attainment are the most powerful weapons of social change without which no society can break backwardness. It is a reliable index of socio-economic development and an important precondition for rural development [6]. The function of education is to teach one to think intensively and to think critically. Intelligence plus character – that is the goal of true education. The purpose of education is to replace an empty mind with an open one. Literacy is one the weapon of social development. Census of India gives the simple definition of literate population is people able to read and write with understanding any language 7 and above population is considered as literate population. Average 79.25 per cent Sindhudurg district population was literate in 2001 census and it increased 5 per cent and goes to the 84.59 per cent in 2011. According to 2001 census highest literacy was observed in Vengurla tehsil which was 85.12 followed that Malvan tehsil 83.11 per cent and lowest was in Vaibhavwadi tehsil which was 68.42 per cent. After the ten years the educational status and literacy scenario was changed because of parent's attitude towards the female education was changed therefore literacy rate increased about 5 per cent. As per the 2011 census highest literacy was observed in Vengurla tehsil which is 88.52 per cent followed that Malvan tehsil 87.96 near about 88 per cent and Sawantwadi tehsil 86.71 per cent was observed, lowest was in Vaibhavwadi tehsil 74.96 per cent respectively.

Table-4. Sindhudurg District: Literacy Rate, 2001 & 2011.

Sr. No.	**Name of Tehsil**	**Literacy (in %)**	
		Census Year 2001	**Census Year 2011**
1	Deogad	79.81	86.43
2	Vaibhavwadi	68.42	74.96
3	Kankavli	78.33	83.81
4	Malvan	83.11	87.96
5	Vengurla	85.12	88.52
6	Kudal	81.31	85.83
7	Sawantwadi	81.51	86.71
8	Dodamarg	76.37	82.57
	Average	**79.25**	**84.59**

Source: Census of India, District Census Handbook of Sindhudurg District 2001 & 2011.

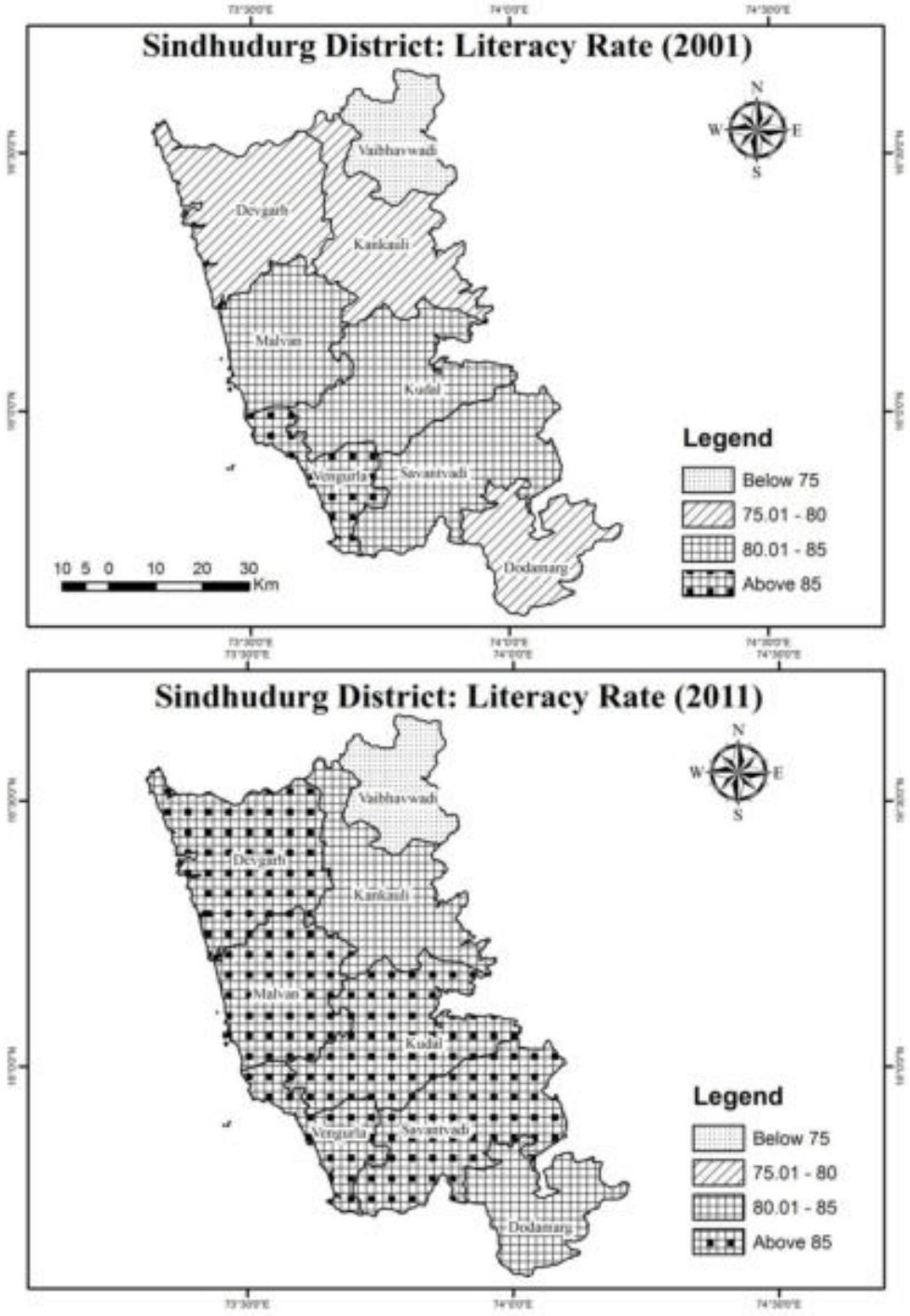


Figure-3. Sindhudurg District, Literacy Rate (2001-11).

6.5 OCCUPATIONAL STRUCTURE

The occupation of an individual refers to his trade or profession or type of work. The occupational structure of a community is the product of various socio-spatial and economic factors [6]. The occupation depends upon the degree of economic development and sophistication of a country. The occupational structure is essential to understand the Scheduled Caste and its distribution into various occupations as well as sex wise participation in different economic activities [2]. Business design is also an indicator of disparity in access to attractive jobs, mainly because it depends on the educational status of the individuals. But many people do not have access to education and are denied access to good jobs. One can see uneven access to the landing property in infrastructure. Family members who have more land than livelihoods do government and other types of white-collar jobs, and those who do not own land are forced to work on farm labor or farm fields [13].

Table-5. Sindhudurg District: Occupational Structure, 2001 & 2011.

Sr. No.	Category	Occupational Structure (%)	
		Census Year 2001	Census Year 2011
1.	Cultivators	46.67	36.05
2.	Agricultural Labours	19.48	23.54
3.	Household Industry	3.55	2.77
4.	Other Workers	30.31	37.65
	Total	**100**	**100**

Source: Census of India, District Census Handbook of Sindhudurg District 2001 & 2011.

In agrarian society most of the population was engaged in primary sector is basically agricultural activity. Census of India creates two broadly groups of occupational structure the first one is agricultural sector and second one is non-agricultural sector. In agricultural sector again two groups are there 1) Agricultural Labours 2) Cultivators. Most of the population in study area was engaged in Agricultural sector in 2001 about 66.15 per cent population falls in this category and remaining 33.85 per cent population was in non-agricultural sector. After the ten years scenario has been changed 59.59 per cent population in agricultural sector and 40.41 per cent in non-agricultural sector. Sindhudurg district benefited to the coastal line therefore, most of the coastal population engaged in fishing activity only.

7. CONCLUSION

In the foregoing analysis, it is endeavored to look into the spatial distribution, sex ratio, and literacy rate, density of population and occupational structure of this Sindhudurg district population and has also attempted to examine their spatio-temporal changes and development, which have taken place during 2001-11.The present study has aimed to explain the distribution patterns of population in Sindhudurg district of Maharashtra state. This has been analyzed with the help of

some physical and economic factors. Population is unevenly distributed throughout the region. In some parts, a dense concentration is found while in others it is found very sparse. This variation is mainly associated not only with the physical characteristics but also with the economic set up of the different parts of the study area. Sex ratio is one of the well-known indicators for social well-being and social development, in the state of Maharashtra Sindhudurg tehsil leading front in this category because of the male-female ratio of this district is more than 1000 therefore, this tehsil having good social as well as economic development during the 2001-11 period of time.

In the literacy category more or less all the tehsils in Sindhudurg district having more than 80 per cent literacy as per the 2011 census only the tehsil Vaibhavwadi having 74.96 per cent literacy rate so many reasons behind that, undulating topography, scheduled tribe population, hilly region, inaccessible area, less transformational facilities and many other things are responsible for this condition. Remaining seven tehsils having good literacy both in male and female category was observed during the time period. Where the highly urbanized population their high population density was located. Vengurla, Malvan and Kudal are the best examples for high population density in Sindhudurg district because of urban centers, commercial complex, Maharashtra Industrial Development Corporation (MIDC) educational hubs are the pull factors in above tehsil results high population density was observed.Occupational structure of the population gives the idea or information about how much economic development has been taken place. Where the maximum populations are engaged in non-agricultural activity there, high percentage of economic growth is seen. But in study area more than 50 per cent overall population was indicated in the field agricultural sector. Little bit scenario of this district has been changed in the entire category which has taken into consideration.

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The Spatio-Temporal Analysis of Economic Status of Population in Rural-Urban Fringe Area of Kolhapur city

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ABSTRACT
For more than three decades, India has experienced tremendous urbanisation and an increase in urban population. Large cities, which absorb a larger share of the urban population, are benefiting more from India's urbanisation. Due to this, these cities are also growing spatially, and many of the places on their periphery (or those close to the city boundary) are now being impacted by urban expansion and development. The rural-Urban fringe area is a complex area where we find both urban and rural environments, and it is mixed in economic activity and social activities. This is the zone that is the bridge between the city and the surrounding villages. Therefore, it plays an important role in the development process. Therefore, it is necessary to analyse It shows unique characteristics as most of the population is engaged in primary, secondary, and tertiary activities. It provides economically cheaper infrastructure facilities because this area is in a rural zone, but it has the feel of an urban area. This is the area that also provides primary products like milk, vegetables, etc. to the city and plays a role as a market for city products and services. Therefore, an attempt has been made to assess the spatio-temporal change in economic activities in the fringe area.

KEYWORDS
Rural-Urban fringe, Spatio-Temporal change, occupational structure, economic activity.

…….

1. INTRODUCTION

Urbanisation In India and other developing nations, there has been rapid urban development as a result of population growth, immigration, and economic expansion. There is a definite tendency towards greater urbanisation occurring all throughout the world [1]. As of 2001, there were 6.1 billion people living in the world. According to

the UNFPA, that number would rise to 7.8 billion by 2025 and 9.3 billion by 2050 as a result of a significant rise in the population of developing nations [2, 3]. Large cities in India are taking up a larger part of the urban population than other cities, which is another factor in the country's uneven urbanisation. Large cities are growing spatially as a result, frequently well outside the urban boundaries. As a result, these cities have evolved into city-regions, with some rural communities now being influenced by metropolitan areas. Urban sprawl on a large scale and changes in urban land use are consequences of cities growing in all directions [4]. The spatial pattern of such changes is far more obvious in rural or periphery urban areas than in the urban core [5, 6]. Due to this, the city's periphery now boasts the most dynamic landscape. The term "fringe" is significant in the contemporary era of urban growth because it is subject to information about fringe.

The rural-Urban fringe of the city is a significant area because it shows both urban and rural characteristics [9, 10]. This area is a blend of both zones, and this shows mixed land use. People use their own vehicle or public transport to make their daily trips to perform their jobs from this zone to the central city area, where their offices and economic institutions are generally located. Therefore, the role of the fringe is land uses that bind together town and village everywhere, and "there is the absence of a clear break" [7, 8]. Thus, the urban fringe is a marginal area for both the city and others sides. n India, rural areas are engaged in agriculture-based activities, but metropolitan cities are engaged in tertiary and large-scale secondary activities [13]. But small cities like Kolhapur are the cities that show both cultures, like rural areas based on some agro-based industrial sectors, and the culture of urban areas as developing small-scale industries. In this combination, the fringe of any city plays an important role. Because it connects the city with the rural areas and combines both rural and urban activities.t provides agricultural products to the city easily as well as human resources [11, 12]. It provides low-rent accommodation compared to the city, and people from it can use facilities in the city. Therefore, this area plays an important role in the city's development. Therefore, an attempt has been made to analyse the economic status of this fringe of Kolhapur.

2. OBJECTIVE

To study the spatial-Temporal analysis of the economic status of the fringe area of Kolhapur city.

3. DATA COLLECTION AND METHODOLOGY

This paper is based on secondary data from 1981–2011 in the District Census Handbook. Here, data regarding occupational structure for 20 villages from the fringe

area is considered for analysis. Appropriate techniques are used to analyse and represent the data.

4. REVIEW OF LITERATURE

Dr. Javed Ahmad Tali, Divyas, and Asima Nusrath (2014) A literature survey of the rural-Urban fringe Dynamic change Rural-Urban change of the city characteristics of social, economic, and demographic change Rural-Urban change in land use pattern Use ARC GIS and Remote sensing mapping to monitor the dynamic nature of Rural-Urban fringe areas. Various problems in this region include sprawl and the deficiency of various services like water supply, health, entertainment, etc.

Romachandran and B. Srivastava (1974) define Delhi's rural-urban periphery. The metropolitan area in his book, Ramachandran provided five variables for defining the boundaries of Bangalore's and Delhi's rural urban fringes. 80 (a) A population density of at least 400 people per square kilometre; (b) Population growth in the previous decade of at least 40%; (c) A female to male ratio of at least 800; (d) A percentage of workers engaged in non-agricultural activities of at least 50%; and (e) The outer limit of city bus services or local train services. The aforementioned method has drawbacks because the parameters change depending on regional differences.

B.P. Mishra's (1980) "The Concept of Rural-Urban Fringe" and "The Rural-Urban Fringe: Its Concept and Importance in Planning" highlighted the logical ambiguity of the phrase "rural-urban fringe." He claims that the disputed administrative term "rural-urban fringe" is unapproved and unconstitutional. He talked about a lot of the essential factors that need to be considered when dealing with the delineation of the rural-urban fringe.

5. STUDY AREA

Kolhapur is an inland city located in south-west Maharashtra state. The geographical area of the fringe area is about 122.13 sq. km, and the population of the fringe area is 2,01,328 as per the 2011 census. Kolhapur is the headquarters of the district. It is located between 16^0 42’ North latitude and 74^0 14’ East longitudes at an altitude of 650 metres above mean sea level. The city of Kolhapur is located on the right bank of the Panchganga River. The fringe area comprises about 20 villages. These are located on the boundary of the city. The following table shows the population of villages located in fringe areas.

6. RESULT AND DISCUSSION

Table No. 1 Total Population of fringe area (1981-2011)

Sr. No.	Village	1981	1991	2001	2011
1	Shiye	4421	5566	8307	9503
2	Bhuye	5018	2566	2781	2744
3	Nigave Dhumala	4630	5464	6101	6898
4	Wadange	9148	10740	11846	13507
5	Chikhali	4606	4501	5728	6301
6	Ambewadi	1507	2002	2077	2203
7	Shinganapur	7686	3722	4911	7570
8	Nagdewadi	0	2010	3449	4981
9	Balinge	1709	3023	3828	5158
10	Padali Kh.	2929	3569	4297	5408
11	Wadipir	1214	1553	1893	2376
12	Kalambe_T_Thane	3939	6561	8734	10138
13	Pachgaoan	2016	5069	11991	22353
14	Morewadi	885	2525	4539	7222
15	Ujaiwadi	1098	2113	4750	9075
16	Sarnobatwadi	1244	1648	2586	3722
17	Uchgaon	7417	14790	22548	31238
18	Gandhinagar	10767	6561	12374	12601
19	Shiroli	11069	16854	21671	29707
20	Gokul Shirgaon	1844	3154	7505	8623
	Total Population	83147	103991	151916	201328

Source: District census handbook of Kolhapur [3]

The above table shows the population of fringe areas in the last 4 decades. It shows growth in population in almost all villages. Some of the places are villages only on paper. But they have developed into urban areas like Pachagaon, Sarnobatwadi, and Gandhinagar. Therefore, here it shows massive population growth at these places in the fringe area.

6.1 Decadal Population in Fringe Area From 1981 to 2011

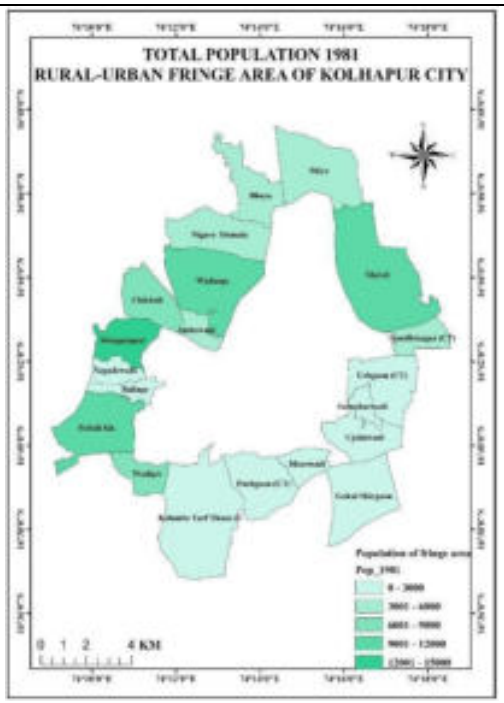


Figure-1

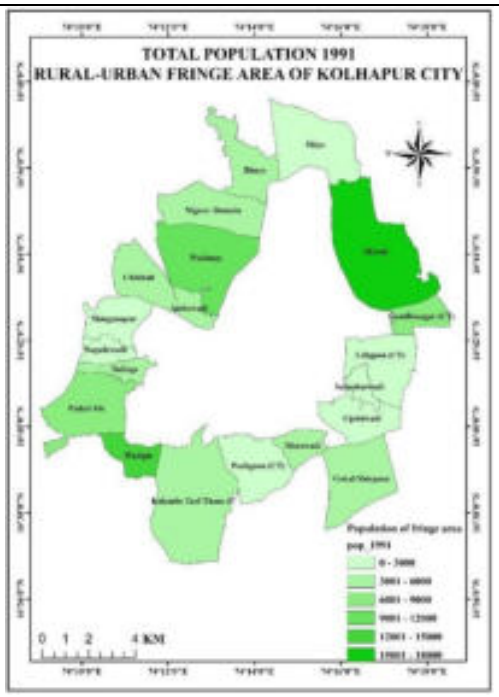


Figure-2

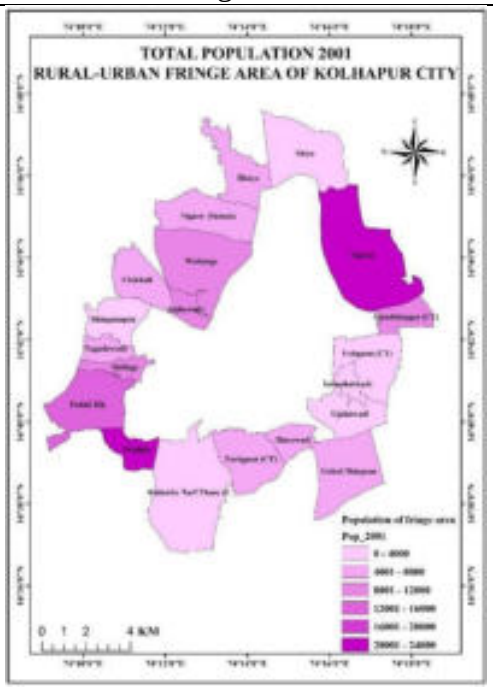


Figure-3

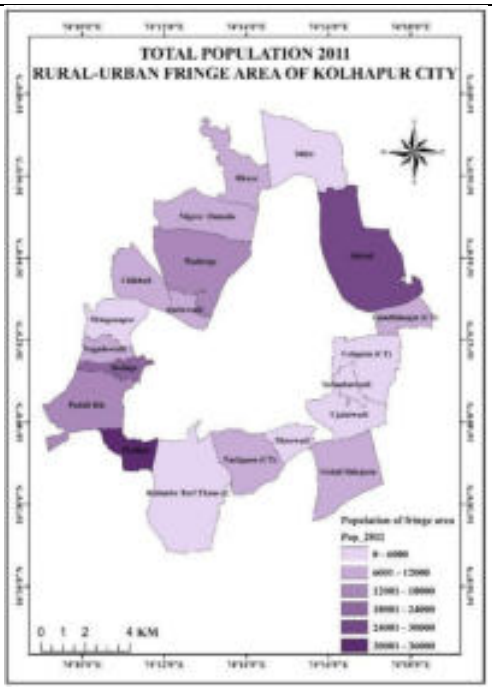


Figure-4

The above maps show clear-cut growth in population in four decades, mostly in a few areas that are very close to urban areas like Pachgaon, Saranobatwadi, Uchgaon, and Gandhinagar.

6.2 Spatio-Temporal Variations in Occupational Structure of Fringe Area

The population structure engaged in occupations shows the economic status of that place. Therefore, occupation is structured to assess the economic status of the fringe area.

Table No.2 Percentage of Occupational Structure of Population 1981-2011

		1981			1991		
Sr. No.	**Village**	**Primary**	**Secondary**	**Tertiary**	**Primary**	**Secondary**	**Tertiary**
1	Shiye	67.61	1.11	31.28	69.24	24.91	5.85
2	Bhuye	67.57	7.47	24.96	76.64	16.57	6.79
3	NigaveDhumala	87.61	1.19	11.21	75.68	16.83	7.49
4	Wadange	52.19	1.84	45.97	57.48	25.43	17.09
5	Chikhali	81.37	0.64	17.98	70.81	19.55	9.64
6	Ambewadi	42.63	4.38	53.00	40.50	38.02	21.49
7	Shinganapur	56.59	0.68	42.73	61.87	27.54	10.58
8	Nagdewadi	0.00	0.00	0.00	71.24	15.57	13.19
9	Balinge	59.18	2.73	38.09	42.52	29.73	27.75
10	PadaliKh.	82.75	1.94	15.31	78.81	13.22	7.97
11	Wadipir	73.15	0.69	26.16	64.44	26.44	9.12
12	Kalambe-T Thane	34.60	1.45	63.95	36.24	40.94	22.82
13	Pachgaoan	52.89	1.65	45.45	21.73	49.45	28.82
14	Morewadi	27.55	4.53	67.92	16.25	50.63	33.12
15	Ujaiwadi	54.75	0.00	45.25	28.77	46.66	24.57
16	Sarnobatwadi	62.95	1.59	35.45	45.37	33.01	21.63
17	Uchgaon	43.38	1.32	55.30	25.39	47.91	26.70

18	Gandhinagar	2.09	3.87	94.04	36.24	40.94	22.82
19	Shiroli	55.25	2.67	42.07	53.36	32.56	14.07
20	Gokul Shirgaon	54.80	0.18	45	91.21	55.11	9.07

		2001			**2011**		
Sr.No.	**Village**	**Primary**	**Secondary**	**Tertiary**	**Primary**	**Secondary**	**Tertiary**
1	Shiye	32.82	2.29	64.90	36.64	2.58	60.79
2	Bhuye	72.32	6.92	20.76	60.60	3.93	35.47
3	NigaveDhumala	78.45	1.56	19.99	64.33	1.70	33.97
4	Wadange	43.43	2.87	53.70	37.87	1.97	60.16
5	Chikhali	56.16	2.45	41.39	51.90	2.57	45.53
6	Ambewadi	24.26	6.10	69.64	20.48	4.28	75.23
7	Shinganapur	50.74	3.11	46.15	32.38	2.77	64.85
8	Nagdewadi	47.65	2.42	49.93	33.09	1.49	65.42
9	Balinge	29.79	4.39	65.82	19.86	2.07	78.07
10	PadaliKh.	68.48	3.36	28.16	64.29	2.84	32.87
11	Wadipir	42.42	2.86	54.71	32.35	1.01	66.64
12	Kalambe-T-Thane	21.54	1.79	76.67	19.42	2.02	78.56
13	Pachgaoan	7.35	4.88	87.76	3.54	4.76	91.69
14	Morewadi	1.83	3.29	94.88	1.66	5.38	92.96
15	Ujaiwadi	7.27	6.02	86.71	1.83	2.24	95.93
16	Sarnobatwadi	19.26	1.79	78.95	14.38	0.79	84.83
17	Uchgaon	13.21	2.54	84.25	11.13	2.97	85.90
18	Gandhinagar	0.72	4.19	95.08	0.42	2.61	96.97
19	Shiroli	35.12	8.40	56.47	25.67	5.02	69.32
20	Gokul Shirgaon	14.90	3.78	65.10	8.97	2.50	78.06

Source: District census handbook of Kolhapur

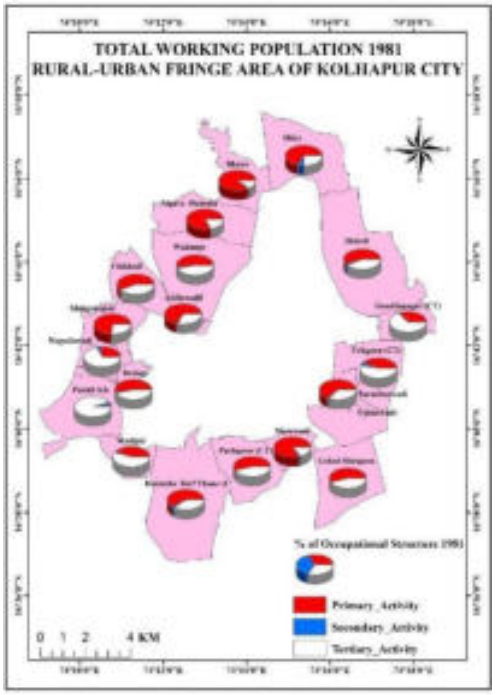


Figure-5

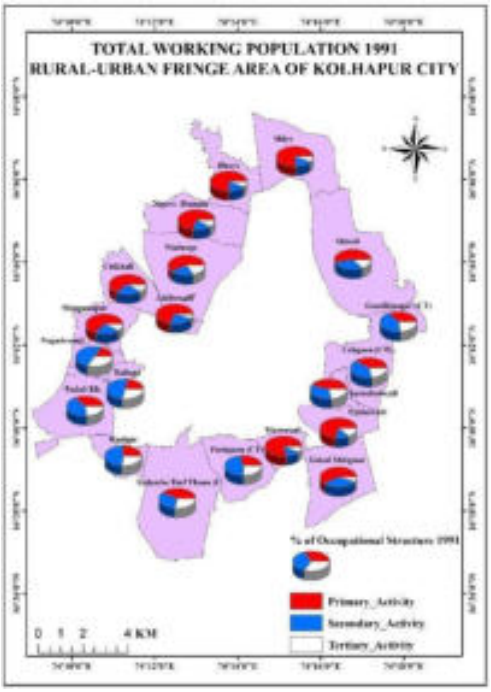
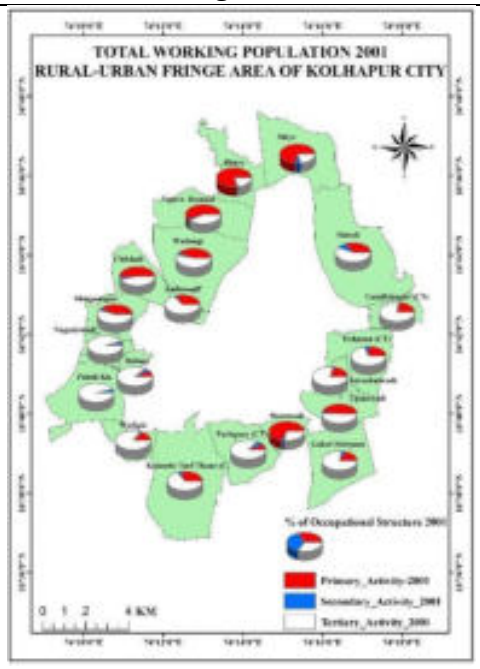


Figure-6



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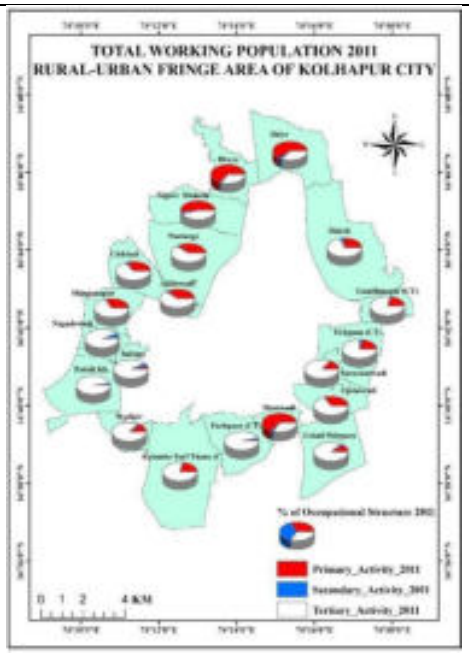

Figure-8

6.2.1 Primary Activity

For the period of the last thirty years, i.e., 1981–2011, the occupational structure and economic status of rural-urban fringe areas have been analysed. In 1981, The population of fringe areas was overwhelmingly engaged in primary activities. The Shiye, Bhuye, Shiroli, Ujlaiwadi, Morewadi, Wadange, Shignapur, and Chikhali villages show more than 60% of people engaged in the primary sector. But in the next two decades, agriculture activities have shifted to non-agriculture activities in the fringe area, and primary activities have shifted to secondary and tertiary activities.

6.2.2 Secondary Activity

After the MIDC area development at Shiroli and Gokul Shirgaon villages, it created jobs in the industrial sector in nearby villages; therefore, the population here has been shifted from primary activities to secondary activities, especially in the industrial sector. Even people started working in the construction business as workers.

6.2.3 Tertiary Activity

In the 2001 census, construction activity shifted to tertiary activity, and the number of people working in transportation also increased. Because of these two reasons, the population in tertiary activity has increased. Most of the fringe population engages in tertiary activities like transportation, communication, shops, hospitals, etc.

6.3 Spatio-Temporal Change in occupational structure of Fringe Area

Table No.3 Percentage of occupational change of economic status of fringe area

		Change (2001-1981)			**Change (2011-2001)**		
Sr. No.	**Village**	**Primary**	**Secondary**	**Tertiary**	**Primary**	**Secondary**	**Tertiary**
1	Shiye	-34.79	1.17	33.62	3.82	0.29	-4.11
2	Bhuye	4.74	-0.55	-4.19	-11.71	-2.99	14.70
3	Nigave Dhumala	-9.16	0.37	8.79	-14.11	0.14	13.98
4	Wadange	-8.76	1.03	7.73	-5.56	-0.90	6.46
5	Chikhali	-25.21	1.80	23.41	-4.27	0.13	4.14

6	Ambewadi	-18.37	1.72	16.65	-3.77	-1.82	5.59
7	Shinganapur	-5.86	2.43	3.42	-18.36	-0.34	18.69
8	Nagdewadi	-	-	-	-14.55	-0.93	15.49
9	Balinge	-29.39	1.66	27.73	-9.93	-2.32	12.25
10	Padali Kh.	-14.27	1.42	12.85	-4.19	-0.51	4.70
11	Wadipir	-30.72	2.17	28.56	-10.07	-1.85	11.92
12	Kalambe-T-Thane	-13.06	0.34	12.72	-2.12	0.23	1.89
13	Pachgaoan	-45.54	3.23	42.31	-3.81	-0.12	3.93
14	Morewadi	-25.72	-1.23	26.95	-0.17	2.08	-1.92
15	Ujaiwadi	-47.48	6.02	41.46	-5.44	-3.78	9.22
16	Sarnobatwadi	-43.70	0.20	43.49	-4.88	-1.00	5.88
17	Uchgaon	-30.17	1.23	28.94	-2.08	0.43	1.65
18	Gandhinagar	-1.37	0.32	1.05	-0.31	-1.58	1.89
19	Shiroli	-20.13	5.73	14.40	-9.46	-3.39	12.84
20	Gokul Shirgaon	-39.9	3.60	20.10	-5.93	-1.28	12.96

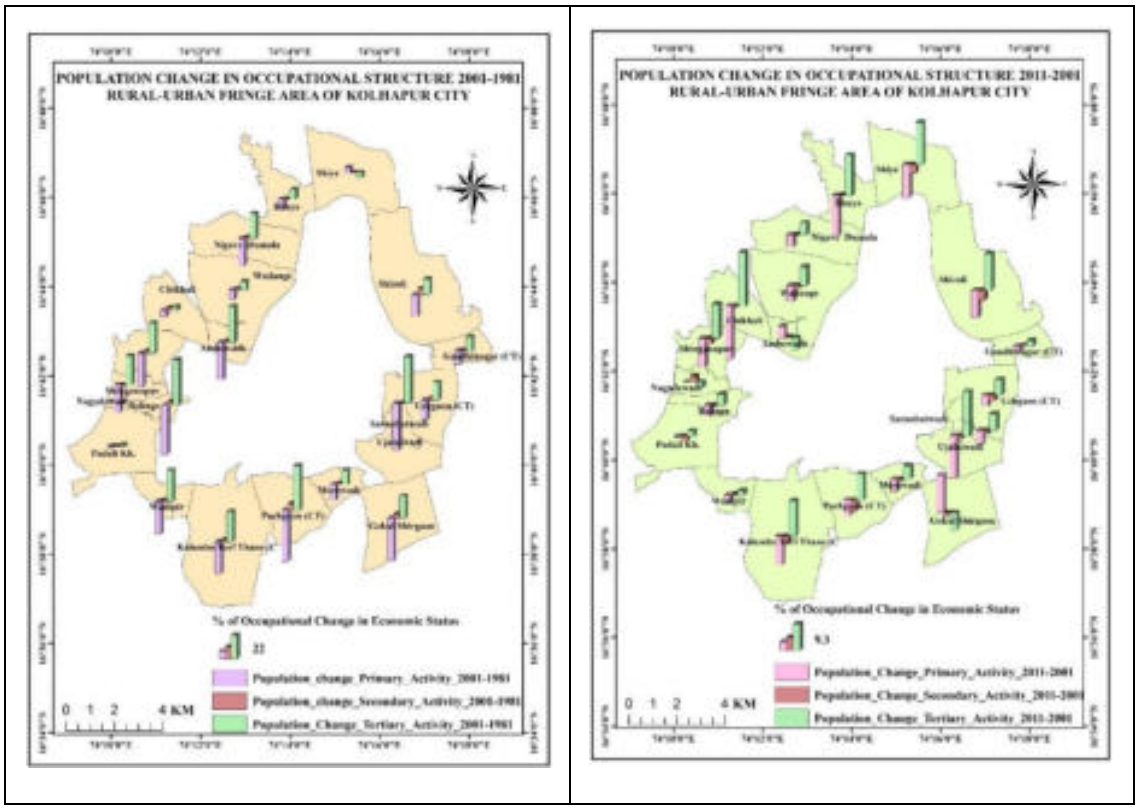

Figure-9 Percentage of Occupational Change 2001-1981

The above table and figure show the change in occupational structure from 1981 to 2001 and from 1981 to 2011 in the fringe area. It shows the highest change in Panchagaon, Ujalawadi, Uchagaon, Shiroli, Sarnobatwadi, Morewadi, and Wadipir. This area is near the city and doesn't have a river in between, and mostly, this area is as good as the city area; therefore, more agricultural land has been converted to residential and commercial purposes. Mostly, it is observed in the Panchagaon, Morewadi, and Sarnobatwadi areas. Shiroli is a MIDC area; therefore, agricultural land here has been converted into the industrial sector. Ujalawaiwadi is coming on either side of the highway. Here, more land is converted to residential purposes because the rate of land conversion is low compared to other areas, as well as because the airport is also developed. Therefore, land under agriculture is reduced here. Other areas of land under agriculture are available, but people from these areas are coming into industries and also for construction and transportation businesses; therefore, they have shifted from primary to secondary and tertiary. In Morewadi, Ulawaiwadi, Pachgaon, Uchgaon, and Wadipir, the residents are living only there because the living costs are low, they have large land areas to construct bungalows, and they have the facilities of villages, but they are working in the city.

7. CONCLUSION

- The Fringe area plays an important role in the economy of the city and provides infrastructure and land for commercial as well as residential purposes.
- Mostly fringe areas like Shiroli and Gokul Shirgaon are developed as MIDC areas; therefore, they provide job and business opportunities to people who live in the city as well as in surrounding villages. Because of this, most of the population from the fringe and nearby villages is shifted from agriculture to the non-agricultural sector.
- Even private international and English-medium schools are established in fringe areas. Because they are getting enormous space and a calm and quiet environment.
- Showrooms of vehicles, furniture, and go-downs are also established in the fringe area, and the reason is the space they are getting here and the low cost of land and maintenance.
- People who work in the city live in fringe areas, mostly in areas that don't have river boundaries, like Morewadi, Uchgaon, Saranbotwadi, and Ujalaiwadi, because they are getting land at a low rate and getting the facilities of villages and an environment that is good.
- Even hospitals and educational institutions are establishing themselves in this fringe area, like Bawada.
- All these aspects show that the fringe area is truly a bridge between the city and surrounding rural areas. But here, facilities like roads and transportation should be increased. Even this can be considered a transition zone; therefore, taxes and rules must be mixed from city and rural areas.

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