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GIS and Bhuvan Data as Tools for Agricultural Development and Economic Empowerment in Pune District

Sandhya Deshpande[1], Mukesh Shrimali[2]

[1]Pro.Sandhya Deshpande
Research scholar (Computer Engineering)
Pacific Academy Of Higher Education And Research
University Udaipur

[2]Dr. Mukesh Shrimali
Department Of Computer Science
Director,Pacific Polytechnic College,Pacific University India.

Abstract
This paper examines the use of Geographic Information Systems (GIS) and Bhuvan data to enhance agricultural development and drive economic empowerment in Pune District, Maharashtra, India. GIS technology has been instrumental in optimizing water management, land utilization, and crop management. Likewise, Bhuvan data plays a critical role in monitoring crop growth, identifying diseases, and evaluating land use patterns. These advancements contribute to improved crop yields and increased profits for farmers. The paper highlights the significant impact of GIS and Bhuvan data in promoting agricultural progress in Pune district and suggests that these tools could be effectively implemented in other regions to achieve similar benefits.

Objective:
1. To examine the role of Geographic Information Systems (GIS) combined with Bhuvan data in promoting agricultural development and economic empowerment in Pune District.
2. To explore the technical processes and methodologies involved in the application of GIS for agriculture.
3. To highlight the key benefits that GIS and Bhuvan data bring to agricultural practices in the region.
4. To identify and discuss the challenges associated with implementing GIS and Bhuvan data for agricultural development.

Technical Approach:
The technical approach for implementing Geographic Information Systems (GIS) in agricultural development and economic empowerment in Pune District encompasses several key steps:

1. **Data Collection**: The initial step involves gathering data from various sources, including Bhuvan, a web-based mapping tool developed by the Indian Space Research Organization (ISRO). The collected data should encompass information on land use, soil characteristics, climate, water availability, and crop yields.
2. **Methodology for Data Collection**: To facilitate GIS analysis regarding agricultural development and economic empowerment in Pune District, the following methods may be employed to collect data on land use, soil characteristics, climate, water availability, and crop yield:
3. **Land Use Land cover**: (LULC)To collect data on land use, remote sensing techniques can be employed. This involves analyzing satellite images to identify different land use types such as agricultural land, forest, urban areas, etc. Bhuvan data is used to obtain high-resolution satellite images of the study area.

LULC FOR PUNE DISTRICT:

Land Use Land Cover (LULC): Under the ISRO's National Natural Resource Census
A programme of Land Use Land Cover mapping on the 1:50,000 scale for the entire country has been taken up to study and understand the degree and magnitude of LULCchanges at every 5-year time intervals starting from 2005-06. For the current study,
LULC data for 2015-16 timeframe was used and feature level-2 classification covering
24 classes (Figure 3) is considered.
Foe pune district Highly Suitable
Area (HS)is 1766.51 sq.km
Moderate Suitable Area (MS)1845.92sq.km, Others/Not applicable area is 12043.26sq.km
Water erosion :for pune distinct in 2003 to 2005 is 23.18 sq.km

Soil Characteristics: Soil samples can be collected from different locations in the study area and analyzed in a laboratory for various parameters such as pH, organic matter content, nutrient content, etc. This information can be used to create a soil map of the area, which can help in identifying suitable crops for different regions.

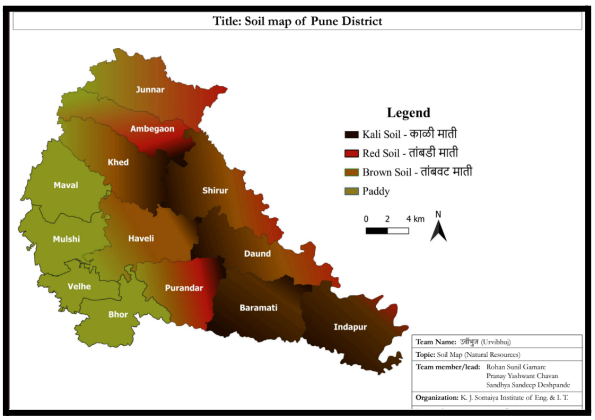


Fig.No. 1 Soil map of Pune District

Here are some soil characteristics of Pune district, as per the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP):

Soil Type and its Characteristics:

Red soils: Moderately deep to deep, well drained, highly weathered, acidic, low to medium fertility, suitable for dryland agriculture.

Lateritic soils **:**Shallow to moderately deep, highly weathered, acidic, low fertility, prone to erosion, suitable for horticulture and forestry

Alluvial soils: Deep, well-drained, fertile, high water-holding capacity, suitable for irrigated agriculture

Black soils:Deep, moderately fertile, high water-holding capacity, prone to waterlogging, suitable for crops like cotton, wheat, and sugarcane

Hill soils:Shallow, rocky, well-drained, low fertility, suitable for horticulture and forestry

Saline and alkaline soils: High salt content, low water-holding capacity, unsuitable for cultivation.

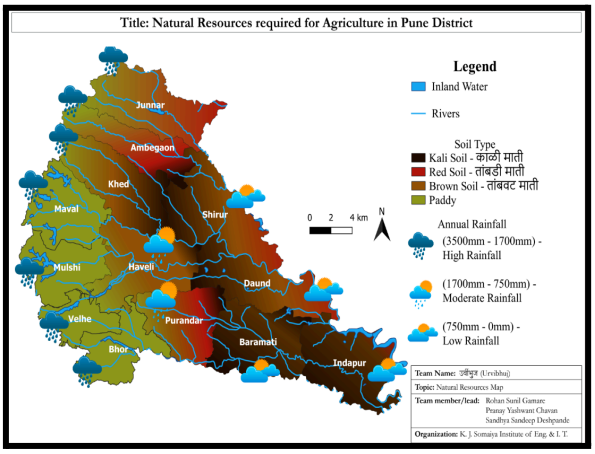


Fig. No. 2 Natural Resources required for Agriculture in Pune District

Here are some natural resources required for agriculture in Pune district:

Water: Adequate and reliable water supply is essential for agriculture. Pune district has several rivers, dams, and canals that provide irrigation water to crops.

Soil: A fertile and healthy soil is necessary for the growth of crops. Pune district has a variety of soil types that require different farming practices and management strategies.

Sunlight: Sunlight is essential for photosynthesis, which is the process by which plants produce energy. Pune district has a tropical climate with abundant sunlight.

Air: Plants require oxygen for respiration and carbon dioxide for photosynthesis. Adequate air circulation is necessary to prevent diseases and pests.

Biodiversity: A diverse ecosystem with a variety of plants, animals, and microorganisms is essential for healthy soil and sustainable agriculture. Pune district has a rich biodiversity, including several protected areas.

Fertilizers and Pesticides: In addition to natural resources, agricultural production may require the use of fertilizers and pesticides to improve crop yields and protect against pests and diseases.

Climate: Climate data such as temperature, rainfall, humidity, etc. can be obtained from various sources such as meteorological stations and weather forecasting agencies. The data can be used to analyze the impact of climate on agricultural production and identify areas with high potential for agriculture.

Water Availability: Data on water availability can be obtained from various sources such as groundwater surveys, surface water surveys, and irrigation department records. The data can be used to identify areas with water scarcity and develop irrigation systems to improve agricultural production.water shed body fr pune district can be found

Crop Yield: Crop yield data can be collected from various sources such as farmers' records, agriculture department records, and surveys. This data can be used to identify areas with low crop yield and develop strategies to improve production.

Biological diversity in pune district : Biological diversity in pune district an be collected from various sources such as farmers' records, agriculture department records, and surveys.here we collected data for total number of Dairy animals (2013-14) of Pune District and total number of

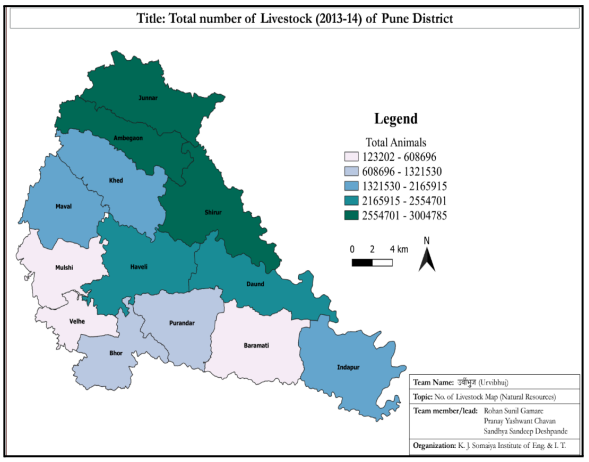


Fig.No.3 Total number of Livestock (2013-14) of Pune District

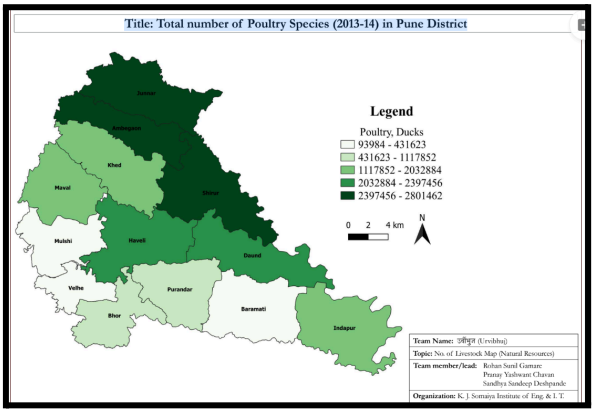


Fig.No.4 Total number of Poultry Species (2013-14) in Pune District

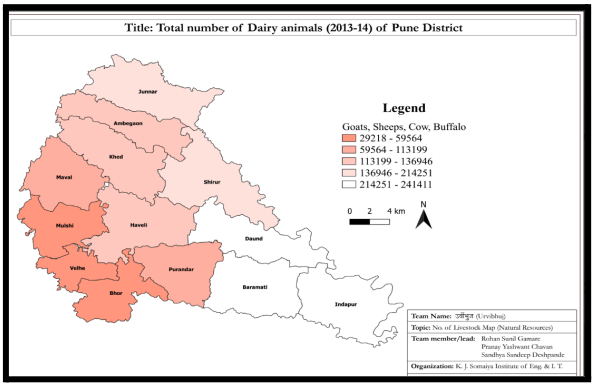


Fig.no. 5 Total number of Dairy animals (2013-14) of Pune District

Population of city :Data on Population of city can be obtained from various sources such as election committees surveys,

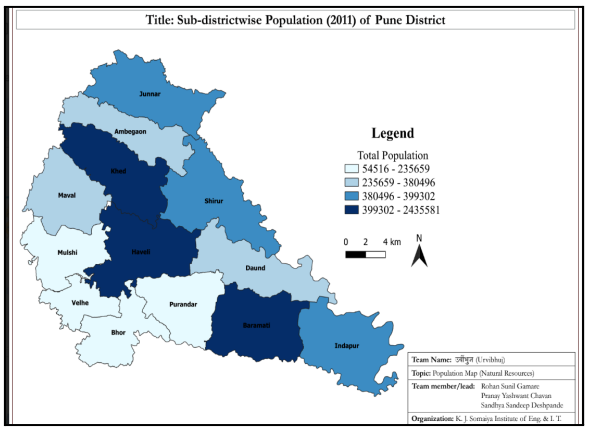


Fig.no. 6 Title: Sub-districtwise Population (2011) of Pune District

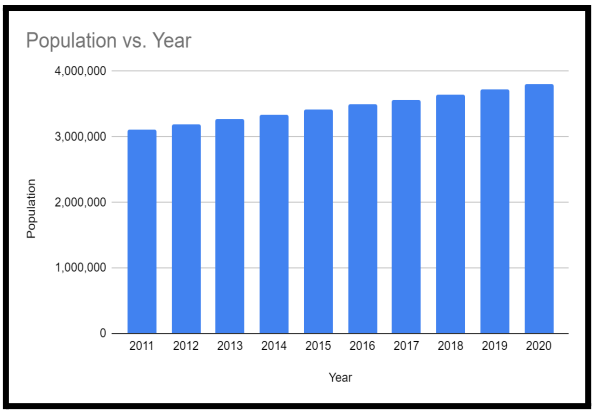


Fig No. 7 Pune district population 2011-2020

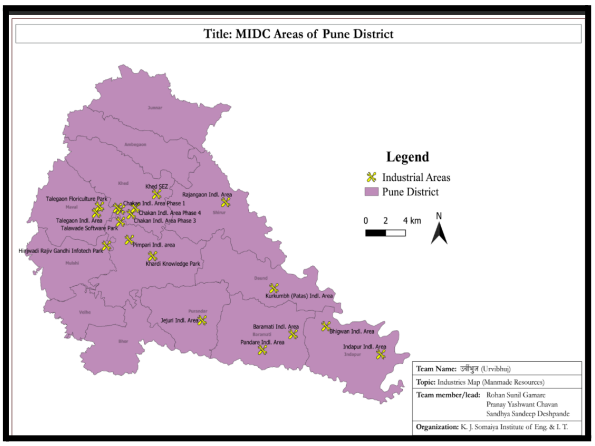


Fig.No. 8 MIDC Area of pune district

This map is generated from ISRO vedas and bhuvan data Maharashtra Industrial Development Corporation (MIDC) - They have information about industrial operations in the Pune district's MIDC area.

Government of Maharashtra, Directorate of Economics and Statistics - This institution may have statistical data on many socio economic elements of the Pune district.

Census of India - The Government of India's census statistics can provide useful demographic and socioeconomic information about the Pune district.

OGD Platform India - This is a platform that delivers various datasets provided by the Government of India, including statistical data on various regions.

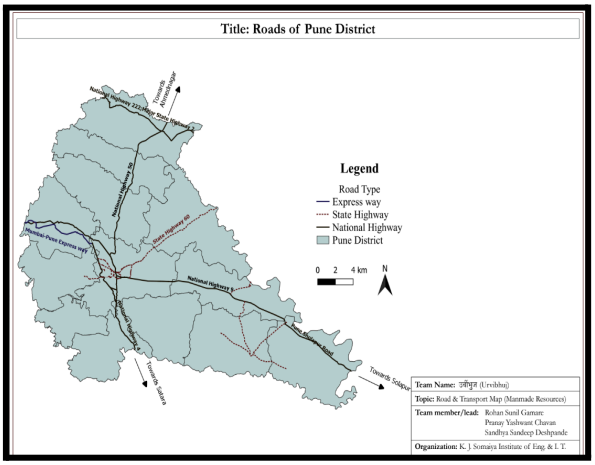
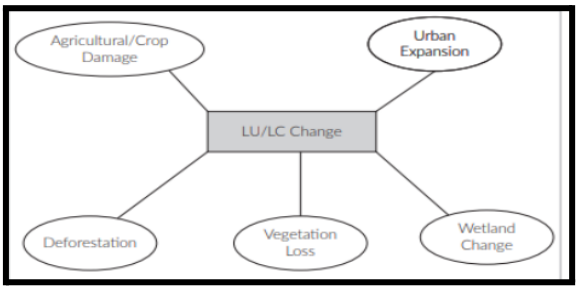


Fig no. 9 Title: Roads of Pune District

This map is referred to as The National Remote Sensing Centre (NRSC), a subsidiary of the Indian Space Research Organisation (ISRO), is one source of such data. The National Reconnaissance Satellite Centre (NRSC) produces satellite images and remote sensing data for a variety of uses, including land use and land cover mapping.



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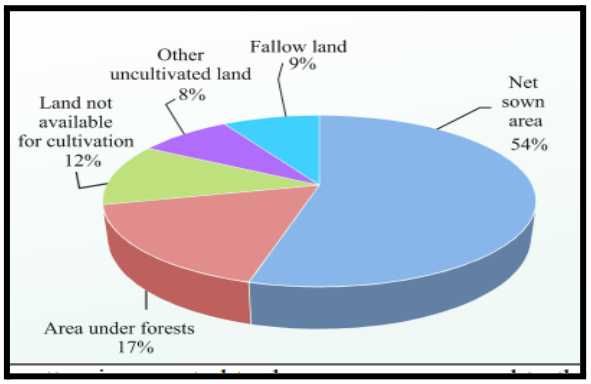

Figure No.10 land utilization in state 2019-20

Rainfall in pune district :The statistical data on rainfall in Pune district from 2011 to 2021, which is the latest year for which the data is available.this map is generated from This map is generated from ISRO vedas and bhuvan data.

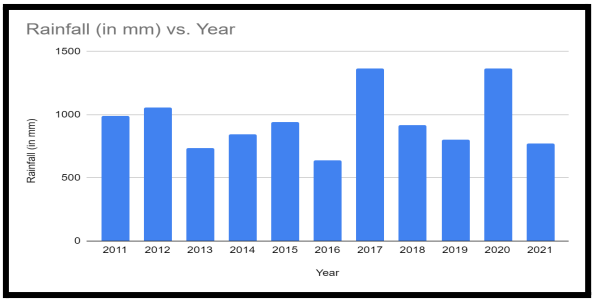

Fig.No. 11 Rainfall in pune city from 2011-2021

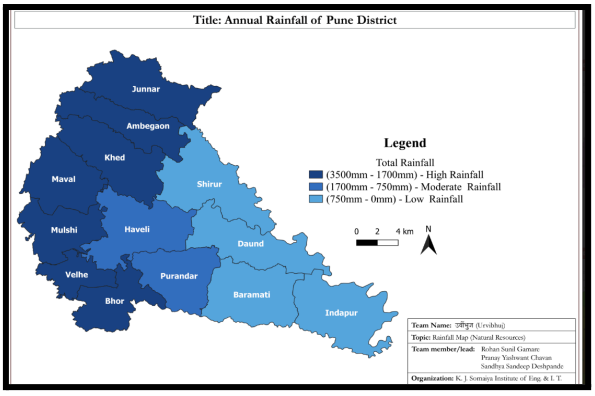

Fig No.12 Rainfall in pune district taluka wise

This map is generated from ISRO vedas and bhuvan data.Junner ,ambagaon,khed, maval,mulshi,velha bhor taluka having 3500 mm to 1700mm having very high rainfall .
Haveli and purandar have moderate rainfall in the range 1700mm to 750mm and Shirpur,daund,baramati,indapur having low rainfall in the range 750mm to 0mm.

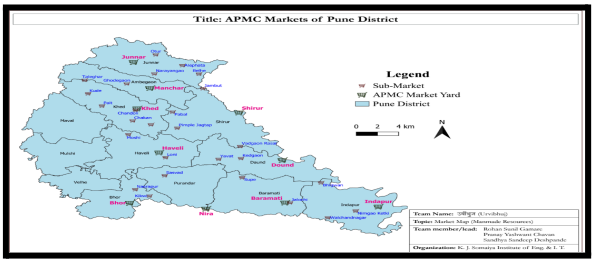

Fig.no.13 Title :APMC Markets of Pune District

Department of Agricultural Marketing establishes Agricultural Produce Market Committees (APMC) under Maharashtra Agricultural Produce Marketing (Development & Regulation) Act, 1963 and provides infrastructure for sale of agricultural produce so that farmers get adequate price of their agricultural produce and are protected from exploitation by traders and middlemen by offering low prices. In all 306 APMCs and 623 sub yards have been established in the State. Number of direct marketing licenses issued upto January, 2022 was 1,400. Apart from these, 68 private market licenses have been issued. The quantity and value of arrivals in all APMCs of the State are given in Table no.---

Quantity & value of arrivals in all APMC of the State		
year	Quantity (Lakh MT)	Value (₹Crore)
2018-19	207	49,100
2019-20	214.7	57,936
2020-21	174.9	50,795

There are a total of 16 APMC markets in Pune district. The list of these markets along with their location is as follows:
Pune APMC Market - Gultekdi
Junnar APMC Market - Junnar
Narayangaon APMC Market - Narayangaon
Shirur APMC Market - Shirur
Manchar APMC Market - Manchar
Baramati APMC Market - Baramati
Lonavala APMC Market - Lonavla

Saswad APMC Market - Saswad
Velhe APMC Market - Velhe
Pimpri-Chinchwad APMC Market - Moshi
Pimpalgaon APMC Market - Pimpalgaon
Chakan APMC Market - Chakan
Khed APMC Market - Khed
Daund APMC Market - Daund
Indapur APMC Market - Indapur
Jejuri APMC Market - Jejuri

The APMC markets in Pune district handle various agricultural produce such as fruits, vegetables, grains, pulses, spices, etc. The statistical data on the trade and transactions of these markets is collected and maintained by the respective APMC committees.

Agro Ecological zone of pune district.

Agro-Ecological Zones of Pune District: Agro-Ecological Zones (AEZ) are zones with similar physical, climatic, and biotic features that are utilized to construct agricultural strategies and plans for long-term agricultural development. Pune district, in the Indian state of Maharashtra, is classified into four agro-ecological zones based on meteorological and soil characteristics:

Western Maharashtra plateau: This zone, which encompasses the middle and western parts of the Pune district, has a semi-arid climate with moderate rainfall. Sugarcane, jowar, bajra, and groundnut are the principal crops farmed in this zone.

The eastern Maharashtra plateau has a sub-humid climate with moderate rainfall and encompasses the eastern parts of the Pune district. Rice, jowar, bajra, wheat, and barley are the principal crops farmed in this zone.

.This map is generated from ISRO vedas and bhuvan data

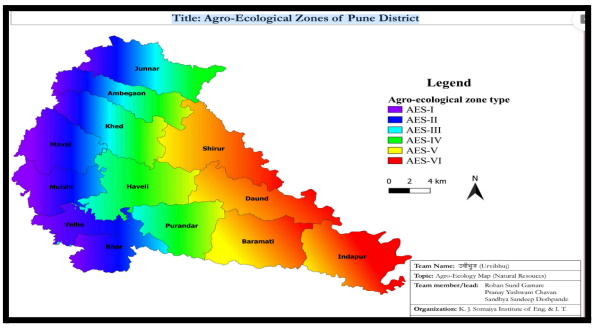

Fig No. 14 Agro-Ecological Zones of Pune District

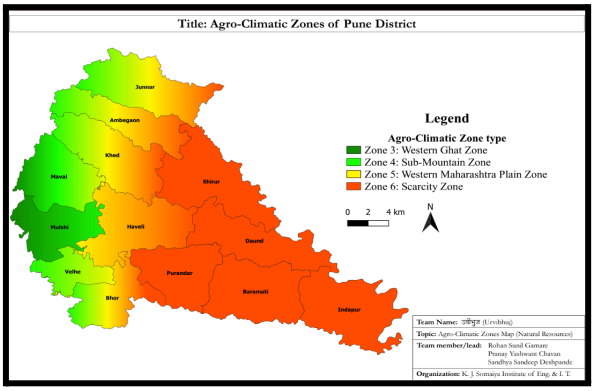

Fig.no. 15 Agro climate zones of pune district

Agro climate zones of pune district This map is generated from ISRO vedas and bhuvan data.Agro-climatic zones are places with distinctly different climate and soil conditions, which in turn determine the types of crops that can be grown there and the methods used to cultivate them. The climate and soil features of the Pune district, in the western part of Maharashtra state in India, have led to its division into three agro-climatic zones:

The Western Plateau, which includes the heart and west of the Pune district, enjoys a semiarid environment with average annual precipitation. Sugarcane, groundnuts, jowar, and bajra are the four main crops farmed in this area.

Sub-humid climate with moderate rainfall characterizes the Eastern Plateau, which encompasses the eastern parts of the Pune district. Soybeans, jowar, bajra, wheat, and rice are the main crops cultivated here.

Humid and rainy, the Coastal Zone includes the westernmost parts of the Pune district's coastline. Coconuts, paddy, and areca nuts are the main agricultural products in this area.

The climate, soil types, and agricultural practices of the area are all explained by the district of Pune's agro-climatic zones. Farmers and policymakers alike rely on this data when deciding which crops and farming techniques to implement. It helps in designing agricultural policies and programmes that meet the demands of individual regions. Pune district's agro-climatic zones are described by the Government of Maharashtra's agricultural extension services and the Department of Agriculture.

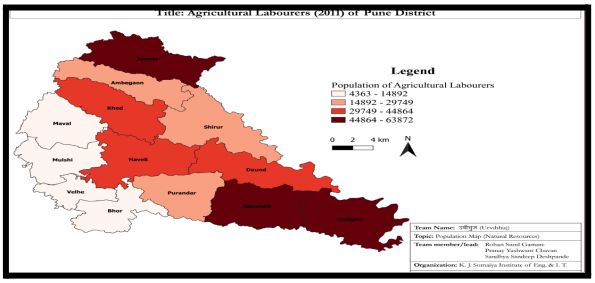

Fig no16 Agriculture labors of pune district

Agriculture laborers of pune district : According to the Census of India 2011, agriculture is the main occupation in Pune district, with 43.5% of the working population engaged in

agricultural activities. However, this percentage has been declining over the years due to industrialization and urbanization.
Here is some statistical data on agriculture labor in Pune district from the Census of India 2011:

Year	Total Working Population	Agriculture Labor	Percentage of Agriculture Labor
2011	4,157,291	1,809,998	43.5%

Table no. 2 statistical data on agriculture labor in Pune district

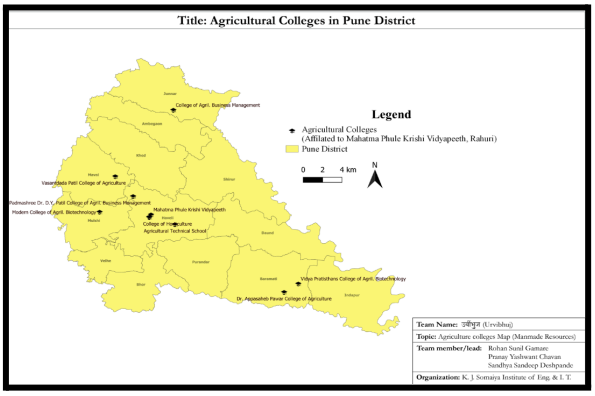

Fig no. 18 Agriculture college in pune district

Once the data is collected, it can be integrated into a GIS database and analyzed using various GIS tools and techniques to identify areas with high potential for agricultural development and economic empowerment. The results of the analysis can then be visualized using maps and other visualizations to communicate the findings to stakeholders.by using bhuvan data we find different types of map we prepared .
After collecting data we are able to generate the map on total 13 title

sr.no.	Title of map
1	Total number of Livestock (2013-14) of Pune District
2	Agro-Ecological Zones of Pune District
3	APMC markets in Pune district.
4	Annual Rainfall in pune district taluka wise
5	Roads of Pune District
6	MIDC area of pune district

7	Sub-districtwise Population (2011) of Pune District
8	Total number of Dairy animals (2013-14) of Pune District
9	Total number of Poultry Species (2013-14) in Pune District
10	Total number of Poultry Species (2013-14) in Pune District
11	Soil map of Pune District
12	Agro climate zones of pune district
13	Agriculture labors of pune district

Table no.

Water Availability: Data on water availability can be obtained from various sources such as groundwater surveys, surface water surveys, and irrigation department records. The data can be used to identify areas with water scarcity and develop irrigation systems to improve agricultural production.

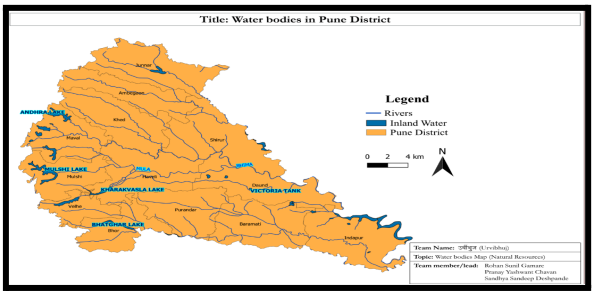

Fig.no.17 Water bodies in pune district

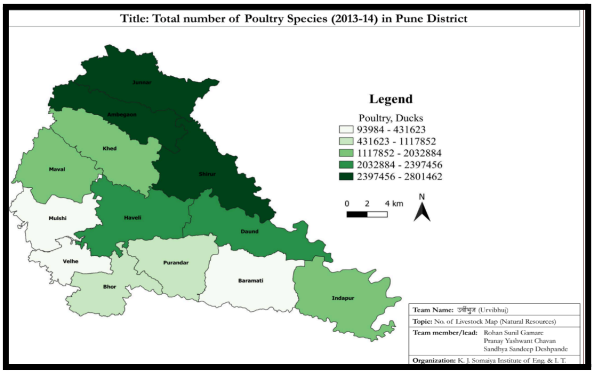

Fig.no.19 Total number of Poultry Species (2013-14) in Pune District

Data Integration: The next step is to integrate the collected data into a GIS database. This involves organizing the data into layers and assigning attributes to each layer. The GIS

database should be designed to allow for the analysis of various factors affecting agricultural development and economic empowerment.

Analysis: The GIS database can then be used to analyze various factors affecting agricultural development and economic empowerment in Pune district. For example, the database can be used to identify areas with high potential for agriculture, areas with low crop yield, and areas with water scarcity. This analysis can help in the identification of suitable crops for different regions and the development of irrigation systems.

Visualization: The GIS database can also be used to create visualizations that help in the communication of the results of the analysis. For example, the database can be used to create maps that show the distribution of different crops in the district, the areas with high potential for agriculture, and areas with water scarcity.

Benefits and Challenges:

The use of GIS for agricultural development and economic empowerment in Pune district has several benefits. First, it allows for the identification of suitable crops for different regions, which can help in the optimization of agricultural production. Second, it allows for the identification of areas with water scarcity, which can help in the development of irrigation systems. Third, it allows for the identification of areas with high potential for agriculture, which can attract investment and promote economic development.

However, there are also several challenges associated with the use of GIS in agricultural development and economic empowerment. One of the main challenges is the availability of accurate and up-to-date data. Another challenge is the technical expertise required for the implementation of GIS. Finally, there is a need for adequate funding and support from the government and other stakeholders to ensure the sustainability of the GIS-based approach.

Conclusion:

In conclusion, the use of GIS for agricultural development and economic empowerment in Pune district using data from Bhuvan has great potential to improve agricultural productivity, promote economic development, and empower the local population. However, there are several challenges that need to be addressed to ensure the success and sustainability of this approach. Adequate funding, support, and technical expertise are critical for the successful implementation of GIS in agricultural development and economic empowerment in Pune district.

Future scope:

Decision Support Systems can be vastly improved by including machine learning algorithms and IoT (Internet of Things). Algorithms trained by machine learning can sift through mountains of data in search of useful patterns and trends that may then be used to inform inferences and guide decisions. Connected sensors, automated weather stations, and other IoT nodes can provide farmers with timely data on weather and other environmental factors.

Decision Support Systems using machine learning algorithms and IoT can be created in the context of agricultural development using GIS and Bhuvan data to provide farmers with

individualized guidance on crop selection, planting time, irrigation, fertilizer application, and pest and disease control. To help farmers better prepare for irrigation and planting, machine learning algorithms can examine weather records and make forecasts. In a similar vein, IoT gadgets may track soil moisture levels and offer real-time guidance on when and how to water plants.

It is also possible to utilize machine learning algorithms to create predictive models that can assess market demand, predict crop yields, and detect disease outbreaks. These models can aid farmers in making profitable decisions on crop selection and marketing approaches.

In general, using machine learning algorithms and the Internet of Things (IoT) in Decision Support Systems can help farmers make decisions based on data that is relevant to their unique situation. This has the potential to boost agricultural output, income, and long-term viability.

Decision support systems can benefit greatly from the incorporation of machine learning algorithms and Internet of Things (IoT) devices by offering real-time insights, predictive analytics, and automated monitoring. The combined effort has the potential to enhance agricultural productivity and sustainability by providing farmers with access to useful data from GIS and Bhuvan Data.

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