

Using Satellite Imagery, Real-Time Detection and Prediction of Agricultural Land Degradation due to Urbanization Intrusion

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Abstract— Since agriculture is the main source of food and other raw resources, it is regarded as the basis of all life. It is essential to the economic progress of the nation. Regrettably, a lot of our farmers still work their land the old-fashioned way. We should switch to more modern farming methods to replace these antiquated ones. Modern agriculture faces a number of difficulties, such as the rising demand for food brought on by the planet's population expansion, climate change, the depletion of natural resources, changes in dietary preferences, and safety and health concerns. Every year, urbanization destroys thousands of hectares of agricultural land around the world.

Index Terms— Image Processing, Deforestation, Machine Learning, Urbanization, Clustering.

I. INTRODUCTION

The rapid population expansion, the fact that human values evolve through time, and the inability to meet human production demands without modifying or converting land use/cover are all contributing factors to the deterioration of agricultural land. Urbanization and growth are needed, but it's also critical to protect land for agriculture, which is ultimately necessary for human survival.

Land degradation is undoubtedly one of India's most urgent environmental issues, with close to 30% of its geographic area already impacted. Even worse, nearly all Indian states have seen an increase in degraded land over the past 15 years, with the northeastern regions, which are rich in biodiversity, seeing the fastest growth. These specifics have been made public in the Indian Desertification and Land Degradation Atlas, which the Indian Space Research Agency released in August (ISRO).

The statistics, which cover the years 2018–19, also show how difficult it will be for India to meet its goal of neutralizing land degradation by 2030, which was proclaimed by the Prime Minister in September 2019 at the UN Convention to Fight Desertification.

According to a study of the ISRO data by Down to Earth, more than half of the country's degraded land is either rainfed cropland, which ensures the nation's food security, or forest land, which provides the best protection against climate change.

453 million people lived in 28 megacities in 2014, and 13 more megacities are predicted to appear in less developed areas by 2030.

It warns that between 2000 and 2030, worldwide urban land cover in biodiversity hotspots will rise by nearly 200%

as a result of urbanization.

II. LITERATURE SURVEY

Rapid urbanization is destroying our most productive farmland. Although commonplace in several places, in this one it represents a serious abuse of the country's scarce farmland. Using Landsat satellite pictures from 1987, 2001, 2015, and 2019, this study aims to measure agricultural land consumption by urbanization and anticipate the future pattern of this process in selected regions of governorates[1].

Changes in land use have resulted in a major dispersal of India's once-cultivated areas. Rapid urbanization has led to an even less amount of land suitable for farming. The percentage of land in India that is used for farming is just under 45 percent, while the percentage that is used for forests is just under 22 percent. By 2014, the built-up area on the outskirts of Bengaluru, as measured by Remote Sensing data, is expected to expand to a whopping 446.55 square kilometers[2].

Degradation of land caused by drought, overgrazing, and other factors is known as desertification. This report details the classification scheme, methods, and findings of a nationwide survey of the state of desertification and land degradation. It has been possible to decipher and map the most important land degradation processes using satellite data[3]. These processes include water erosion, vegetative degradation, wind erosion, salinization/alkalization, water logging, frost heaving, frost shattering, mass movement, and others.

The digitization of farming has led to the development of AI-powered tools for a variety of management tasks, all with the goal of extracting insights from the massive amounts of data now available. The application of machine learning, a branch of AI, offers great potential to address many issues related to the development of knowledge-based farming systems. By a comprehensive literature review using PRISMA guidelines[4] and a set of keywords centered around "machine learning," "crop management," "water management," "soil management," and "livestock management," this study hopes to shed light on the application of machine learning in agriculture.

The authors analyzed how predictions affect agricultural land management. Methods for forecasting farmland use were given special consideration. Extrapolation and modeling are two of the highlighted formalized approaches of agricultural land use predictions. The authors compared the strengths and weaknesses of different forecasting techniques and explored their potential for use in projecting future agricultural land usage. Predictions of agricultural land use in India are examined[5].

The semiarid district of Bellary, virtually in the geographical center of the Indian subcontinent, is prone to drought. In order to examine desertification processes, map the district's existing desertification status, and offer recommendations for reversing it, the district was selected as a pilot project under the United Nations Convention to Combat Desertification's (UNCCD) topic of monitoring and assessment. Degradation in the region was seen in rainfed and irrigated farmland, forest and scrub land, and mining activities[6].

III. PROPOSED SYSTEM

The best answer to a problem can be found through careful analysis. Analysis of a system is gaining an understanding of its current state, outlining its components and their functions, and assessing how well they meet user needs. It's a mindset that shifts how you approach issues within an organization and a toolkit of methods for getting things done. In system analysis, the feasibility study is crucial in establishing a point of reference for future work on the system's design and development.

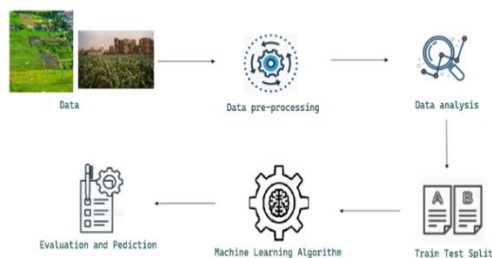


Fig 1. Architecture of proposed system

Depending on what was found in the preliminary research, the survey is being expanded into a full-fledged feasibility study. A "FEASIBILITY STUDY" evaluates a system proposal based on how well it would function, how it would affect the organization, how well it would meet needs, and how efficiently it would use available resources. There are a total of eight stages to a feasibility study: (1) putting together a team and selecting a leader;

(2) listing possible alternatives for the proposed system; (3) conducting the analysis; and (4) making any necessary adjustments.

Certain features of the proposed system should be identified and defined.

Learn how each system stacks up in terms of performance and cost efficiency.

Data on the effectiveness and price of weight systems.

Choose the system that you think is the best possible option.

Draft and submit to management the project's concluding directive.

Economics, technology, and social acceptability are the three pillars upon which a feasibility study rests.

A. Existing System

India's economic foundation rests on the success of its agricultural sector. However agricultural land and significance are declining for a variety of reasons. Efforts to improve farming practices and preserve farmland are the subject of a great deal of study and investigation. For identifying soil/seed/crop quality, weed detection, predicting deforestation rate, etc., we have come across machine learning methods like Artificial Neural Network (ANN), Convolution Neural Network (CNN), K-Nearest Neighbor (KNN), and Random Forest Regression. These frameworks serve as the foundational concepts for evaluating farmland.

The chosen research used a wide variety of ML methods (abbreviations are provided). Each study's preferred and most commonly utilized ML algorithms. These methods are summarized as belonging to one of eight ML model families. Identifies the top performing ML models as a means of summarizing the state of affairs and showing progress in a manner analogous to. Figure 8 shows that Artificial Neural Networks (ANNs) were used in over half of the investigations (51.8% to be exact) since they produced the greatest results from ML models. Furthermore, most research across all categories found that ANN models performed better. Similar to the biological neural networks that make up the human brain, ANNs may learn from examples taken from data describing a physical occurrence.

In contrast to traditional machine learning methods, ANNs have the unique ability to learn the interrelationships between dependent and independent variables, allowing them to mine meaningful insights from statistical samples. The capacity of ANN models to deal with noisy data, which is frequent in agricultural measurements, is just one example of the advantages they can provide. Some of the most often used ANNs are Deep Neural Networks (DNNs), which have several hidden layers between the input and output layers. Unsupervised, semi-supervised, and supervised DNNs all exist. Convolutional Neural Networks (CNNs) are a popular type of DNNs because, unlike conventional neural networks, the neurons in their layers can be arranged in three dimensions. In reality, CNNs were shown to be the algorithms that produce the best results across all categories, with nearly half of the individual proportion of ANNs being CNNs. Recent research, such as the one conducted by Yang et al., have emphasized the success of CNNs in the field of image detection.

Machine learning has a wide variety of uses in the farming industry. Crop, water, soil, and livestock management are the four main areas covered. Most articles were about crop management (61% of the total), which was further broken down into subtopics including yield prediction, disease detection, weed detection, crop recognition, and crop quality.

B. Proposed System

Farmers and society as a whole have suffered tremendous losses as a result of urbanization encroaching on once-productive agricultural land. Degradation of farmland due to increased urbanization is now recognized as a pressing issue.

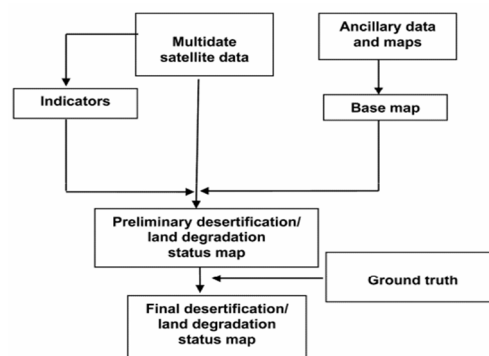


Fig 2. Process to identify the land degradation

Farming provides a majority of people's food and income. There's also great significance for the country's progress. Thus, it is crucial to study, analyze, and monitor their rates in order to keep the appropriate balance between them. We hope to use Machine Learning to examine historical and current satellite photos of a region, deduce the current rate of agricultural land degradation due to urbanization, and then anticipate the degradation of agricultural land due to urbanization. These evaluations and forecasts can raise public consciousness, allowing more informed decision-making and the avoidance of unfavorable outcomes.

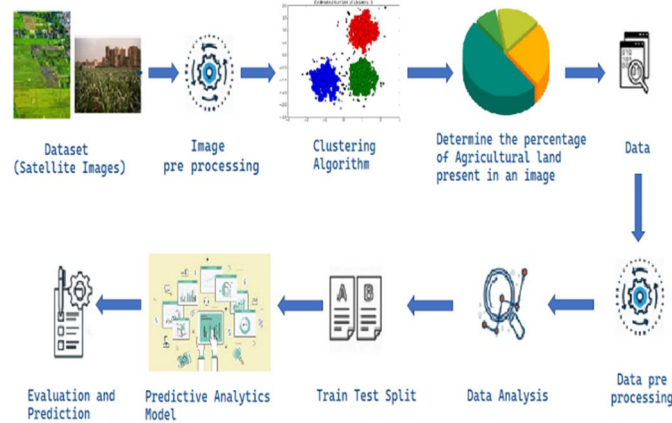


Fig 3. Methodologies used in the identification of the land degradation

Clustering difficulties in machine learning can be solved with the help of the Unsupervised Learning algorithm K-Means Clustering, which divides the unlabeled dataset into distinct groups. Here, K specifies the required minimum size of the initial set of clusters.

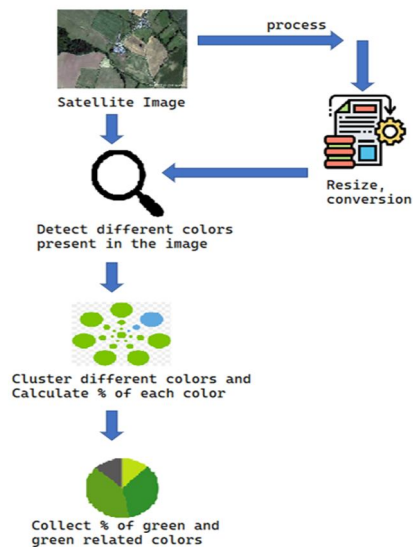


Fig 4. Calculation of agricultural land

It aids in analyzing the land's productivity before urbanization intrusion so that the loss of the productive land can be prevented by selecting the unproductive area for urbanization, hence reducing the loss that can occur.

IV DESIGN

The resolution of an input image determines how it is processed by a computer. The height, width, and depth it perceives will be determined by the image resolution. Example: a matrix with dimensions of 6 by 6 by 3 for the RGB color space and a matrix with dimensions of 4 by 4 by 1 for the grayscale image.

Next, a machine-learning method is selected and constructed to categorize unknown feature vectors based on a large database of feature vectors with known classifications using the features (processed data) obtained in the

previous phase. Among the many possible algorithms with which to accomplish this goal are the Bayesian Net, Decision Tree, Genetic Algorithm, Closest Neighbor, and Neural Network, to name a few of the more well-known ones.

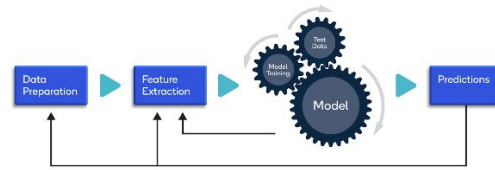


Fig 5. Machine Learning Image processing work flow

V EXPECTED RESULT

Even though agriculture's share of national income has decreased, the sector remains vital due to its importance in employment, food security, and budgetary allocation. The potential farmlands need to be preserved and protected in light of the expanding population. Building upwards should be encouraged. If the government is serious about preventing further agricultural land from being lost, it must ensure that development projects take place on land that is not suitable for farming, tighten zoning regulations, and implement new policies.

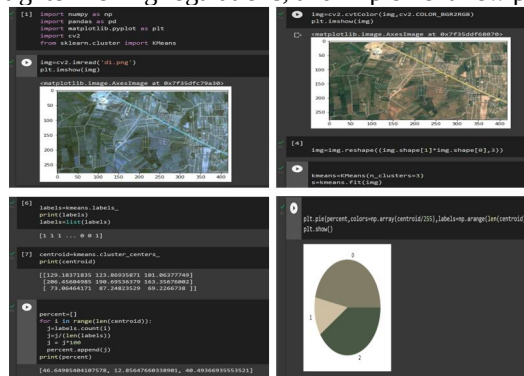


Fig 6. A Case study – Shirimpura (2002-2022)

Farmers who own arable land should be financially rewarded for not selling it for urban sprawl. Get the right statistics out of satellite images for accurate land use forecasting. Future decline in farmable land predicted for a specific region. In addition, the Government should make and impose such policies strictly to increase agricultural land area in the country and for maintaining balance in different types of land uses.

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