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ENVIRONMENTAL IMPACT ANALYSIS AND CLIMATE ACTION: A STUDY OF ADVANCED DECISION-MAKING TECHNIQUES FOR LAND USE AND URBAN DEVELOPMENT

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Abstract

Urban development zones and their climate exhibit cyclical changes throughout the year. Vehicular emissions, industrial activity, forest destruction, and dust storms contribute to climate change. The consequences of urban land use and transport system development, influenced by local environmental quality in general, and air quality in particular, are well-known and alarming. The increase in pollutants in the environment and the continuous rise in global temperature negatively affect human and animal health. Particulate matter with a cross-sectional diameter less than 2.5 µm (PM2.5) is a ubiquitous air pollutant released by biomass burning, vehicle and cooking exhausts, industrial processes, and non-exhaust sources. Due to its small size, PM2.5 can infiltrate both the upper and lower respiratory systems. The application of advanced decision-making tools is necessary to predict upcoming climate action and the increase in environmental degradation. This research analyses the application of machine learning techniques in assessing the impact of environmental change. Deploying different algorithms helped to predict concentrations of high-risk pollutants. Models were applied and compared based on various measures of model effectiveness. ML Model is applied to study pollutant concentrations like PM2.5, CO_2, and NO_2. To address emissions reduction needs for sustainable urbanization and improving air quality, innovative decision-making tools, closer to practice, are necessary. Environmental Impact Analysis will help achieve sustainability goals, such as Climate Action (SDG13) and Good Health and Well-being (SDG3).

Introduction

Rising growth of cities and industries become the cause of serious environmental problems like air pollution and rapid climate change. Smoke from cars, industrial wastes, trees cutting and even dust storms are making the climate pollute and increase the environmental temperature. Mostly harmful pollutants are particles with PM value 2.5 or above, CO_2 and NO_2 causes serious health problems, mostly lung and heart diseases. To resolve these problems, new technologies and techniques like Machine Learning (ML) help us to predict and analyze pollution levels and intensity, which help us to manage the health issues and predict better solutions. In this study, we analysis and compare the ML predictions to check how well they identify air pollution and become safer for human life for future generations.

METHODOLOGY

Environmental Impact Analysis and Climate Action: A Study of Advanced Decision-Making Technique for Land Use and Urban Development

STEP-BY-STEP EXPLANATION OF THE METHODOLOGY

1. Environmental data collection
Air quality data (PM2.5, CO_2, NO_2), satellite imagery, and urban Evolution records are Obtained for assessment

2. Environmental impact assessment
The Results is assessed to assess pollution Level, health consequences, and environmental risks.

3. Urban Policy Framework
The results are incorporated into urban planning strategies to reduce emissions and enhance land use efficiency.

4. Decision-making
Machine learning models are used to predict pollution levels and support policy decisions.

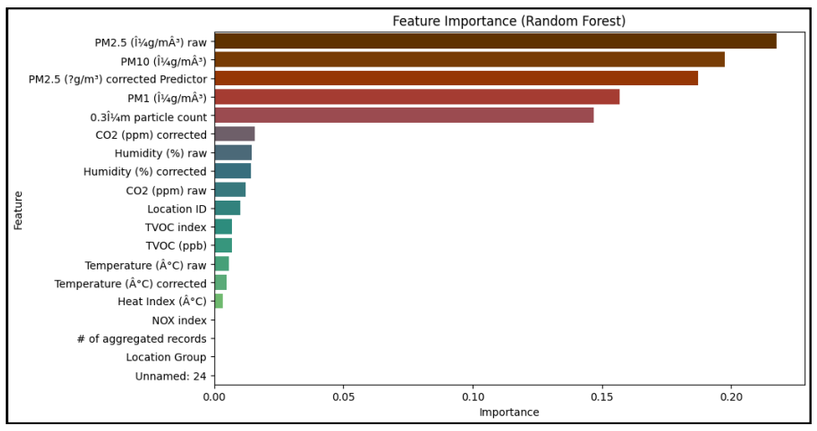
5. Land use and climate strategies
Sustainable Methods and climate Intervention plans are developed to make urban environments healthier and safer.

RESULTS & ANALYSIS

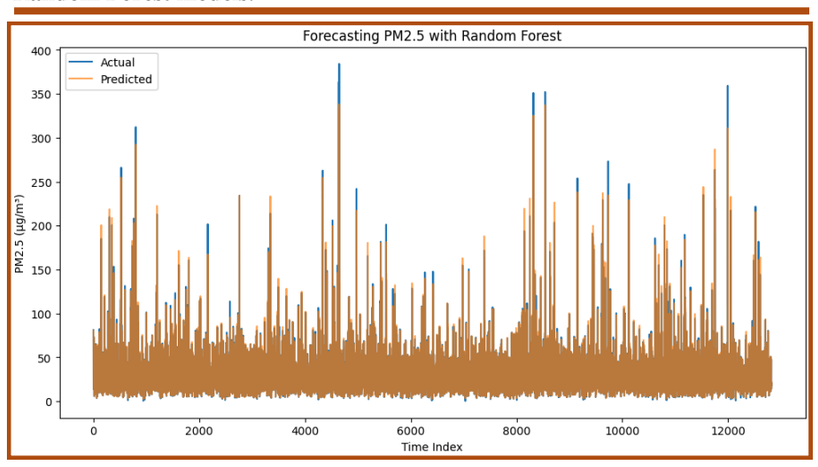
MODEL PERFORMANCE METRICS SUMMARY

Metric	Value
Training R^2	0.982
Validation R^2	0.989
Training RMSE	2.92
Validation RMSE	2.18
Training Entries	29791
Validation Entries	12924
MAPE	4.9%

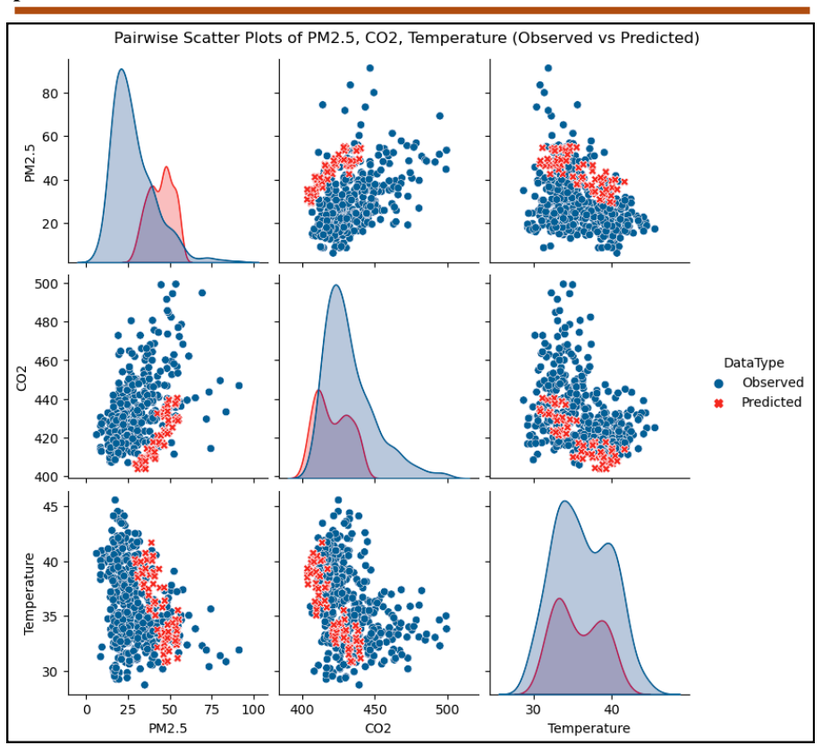
The model achieved excellent accuracy with $R^2 \approx 0.98$–0.99, low RMSE (2.92, 2.18), and MAPE of 4.9%, demonstrating strong reliability on both training and validation data.



This analysis demonstrates that PM 2.5, PM 10 and PM 1 are high intensity features while others variables, temperature, humidity shows less intensity in Random Forest models.



A more accurate and stable prediction model known as Random Forest Algorithm helps us to identify the PM 2.5 effects, showing more accuracy in prediction the trend of PM 2.5.



The scatter plots demonstrate that prediction values and actual values of PM 2.5, CO_2 and temperature are closely related. The red points (predicted) and blue points (measured) almost overlap and matched, which shows that the model is working properly in identifying the valid patterns.

THEME

This study contributes with SDGs (Sustainable Development Goals) introduced by United Nation. The analysis results support Good Health and Well-Being (SDG-3) by managing the health problems caused by harmful air particles and it supports Sustainable Cities and Communities (SDG-11) by introducing sustainable plans and techniques. It also links with Climate Action (SDG-13) in controlling the emission of harmful gases. Indirectly it contributes to Life on Land (SDG-15) by safeguarding the habitat of living organisms from industrial wastes and deforestation

CONCLUSION

1. Machine learning (ML) predictions are beneficial in predicting the harmful effects of air pollutants, such as PM2.5, CO2, and NO2.

2. The results show that ML algorithms simplify the process of identifying air quality and techniques to reduce air pollution.

3. Machine Learning predictions helps us in designing and make a good choice for decision makers to keep the cities unpolluted and beautiful for living..

4. This analysis assists the worldwide struggle in managing Climate Action (SDG-13) aligned with Good Health and Well-Being (SDG-3).

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