Ecosystems conservation

Terrestrial Ecosystem Conservation and Restoration Analysis Forecasting

PHASE 5 PROJECT

By

Group 4

Business Overview

Challenge

Traditional environmental monitoring is costly, slow, and lacks scalability hence limited real-time data for land degradation, biodiversity loss, and climate change impacts.

Opportunity

Governments, conservation agencies, and policymakers need data-driven insights for decision-making. Exploring advanced remote sensing, GIS, and NLP can enhance monitoring efficiency.

Solution

Utilize kenya biodiversity shapefile ,Sentinel-2 imagery & environmental indices (NDVI, NDWI, BSI) for land cover analysis. Apply Natural Language Processing (NLP) to extract insights from environmental reports. Integrate spatial and textual data for comprehensive ecosystem monitoring.

Business Impact

✓ Improved decision-making for land use, conservation, and climate resilience.✓ Cost-effective & scalable environmental monitoring solution.

✓ Supports global sustainability goals (Kunming-Montreal GBF).

Business Understanding

Problem Statement

Biodiversity loss, ecosystem degradation, and ineffective conservation management threaten global environmental sustainability. Despite efforts to protect and restore ecosystems, the lack of data-driven decision-making hinders the ability to prioritize conservation actions, restore degraded lands, and monitor protected areas

General objective

Develop a data driven solution integrating spatial and textual data for environmental monitoring

Specific objective

1. To analyze land cover changes using Remote Sensing indices (NDVI, NDWI,BSI).
2. Using NLP to Extract Environmental Concerns and Conservation Strategies for Terrestrial Ecosystem Sustainability.
3. To integrate spatial and textual to support conservation efforts.

Data understanding

1. Remote Sensing Data: Sentinel-2 Imagery (European Space Agency - ESA):Downloaded from Copernicus Open Access Hub (https://scihub.copernicus.eu)Used for calculating NDVI, NDWI, and BSI to assess vegetation health, water bodies, and bare soil exposure.

2. Geospatial Data: Shapefile Data: Represents terrestrial protected areas and forest reserves. Used for spatial overlay analysis to understand land cover changes in protected zones.

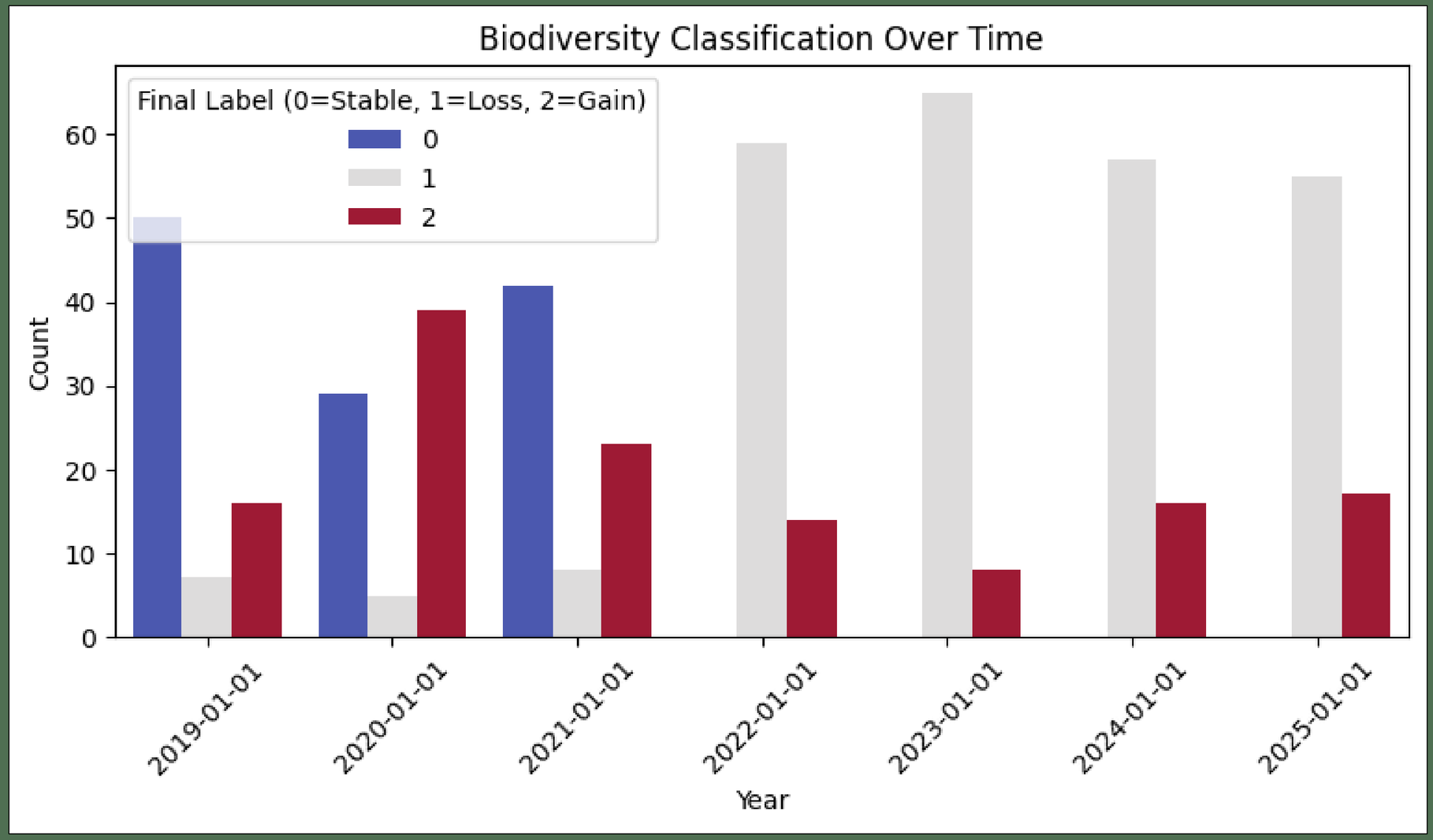
CSV Data Contains biodiversity and forest reserve information. .

3. Textual Data (Natural Language Processing - NLP)Environmental Reports & Scientific Publications: (CIFOR-ICRAF and CBD).

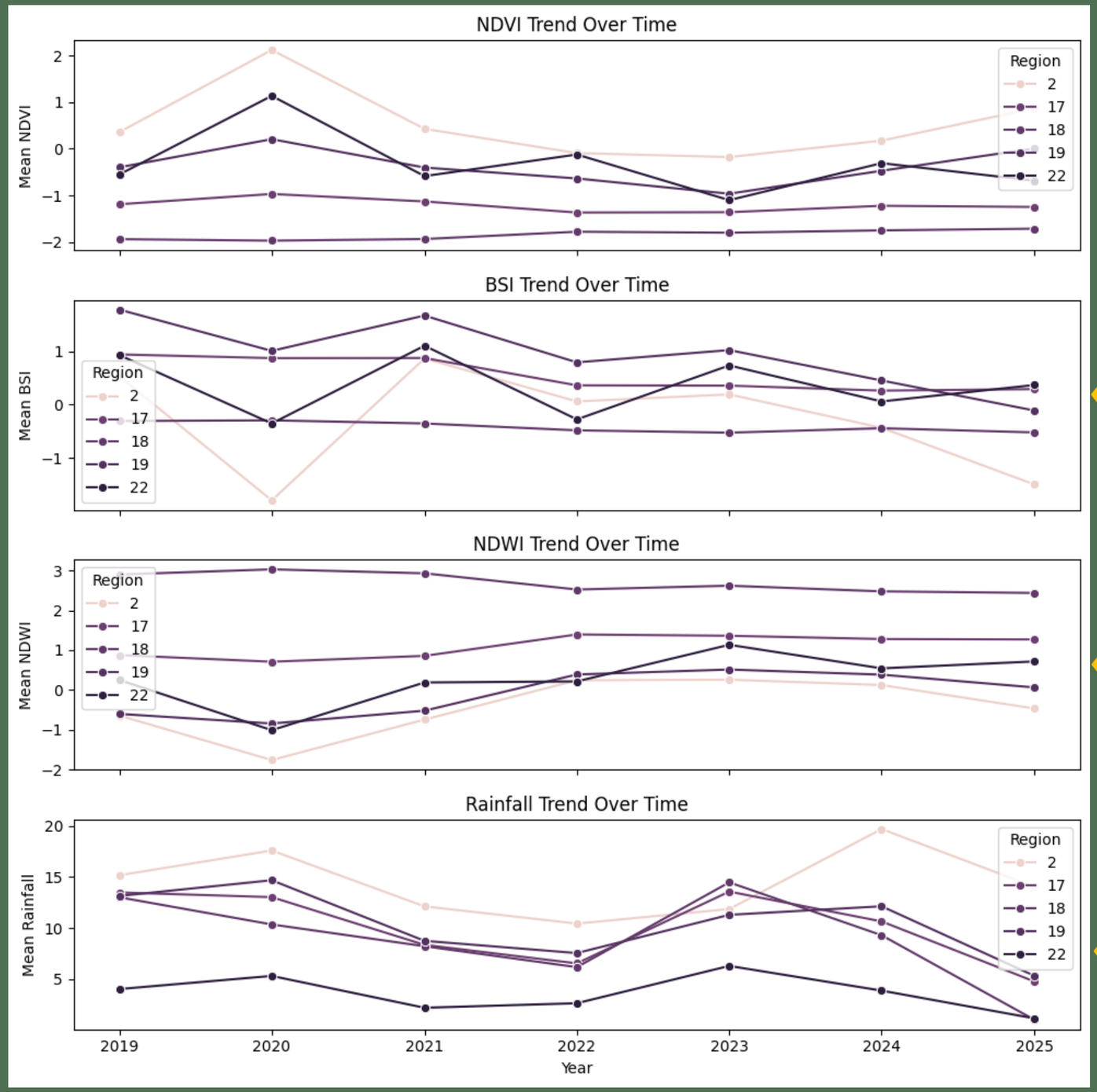
Data Collection → Data Preprocessing → Data Manipulation → Data Modeling → Data Deployment

Results

Land cover changes Results



The chart shows an increase in biodiversity loss in certain years, likely due to deforestation, habitat destruction, or climate change. Some areas exhibit gains, possibly from conservation efforts, while stable regions remain largely unaffected

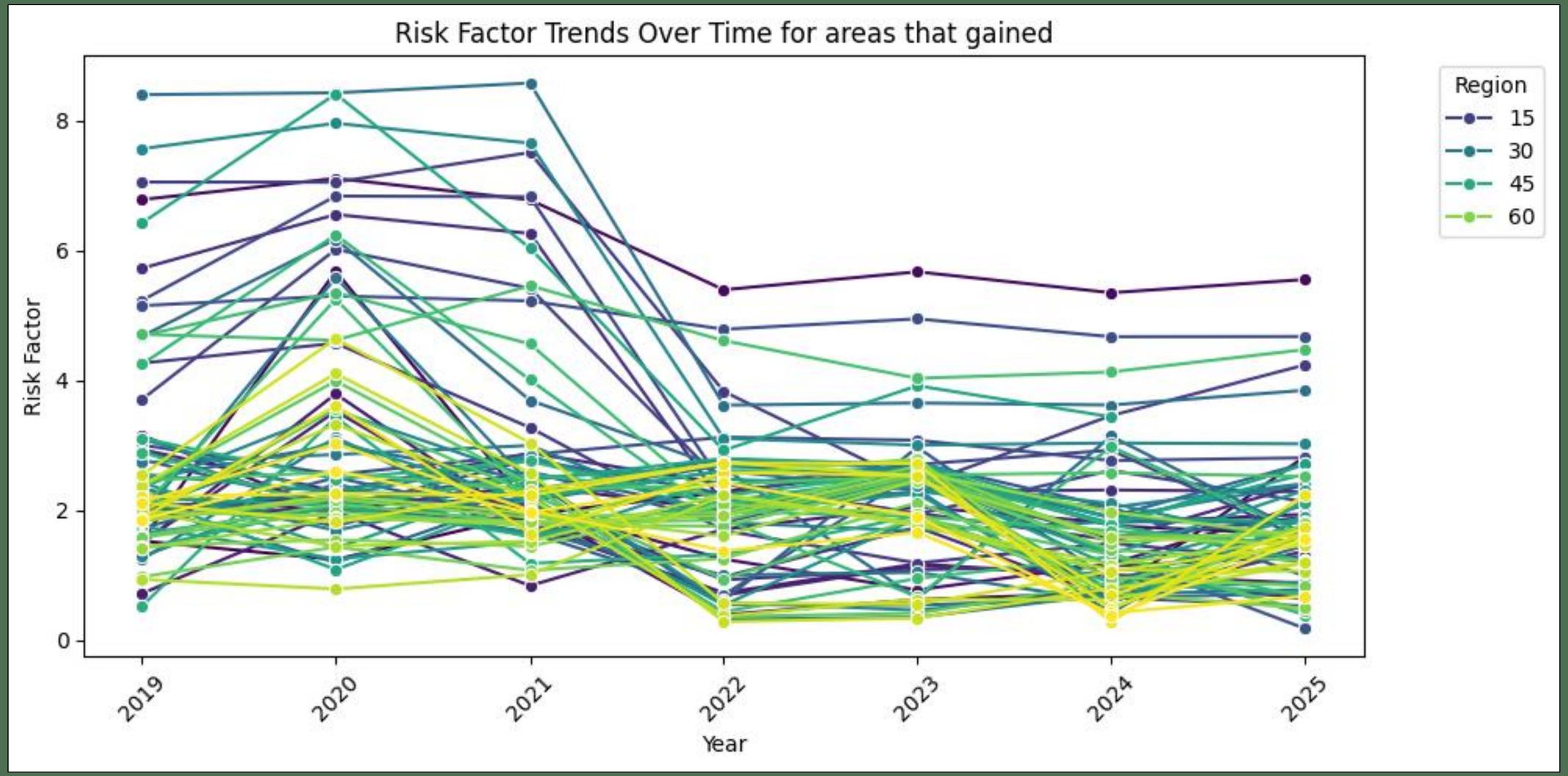


The NDVI trend highlights vegetation health, with variations indicating periods of greening or degradation across regions.

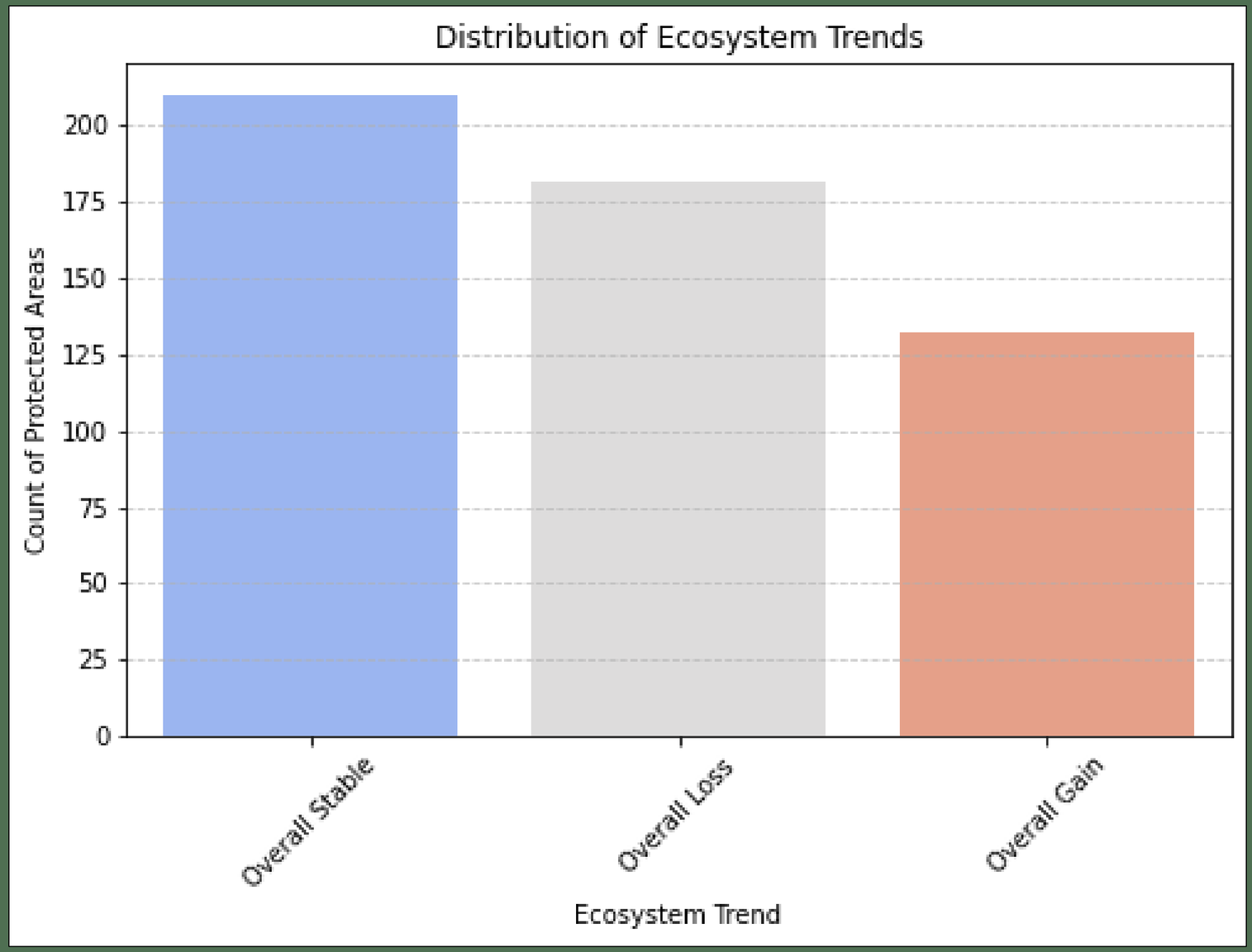
The BSI trend reflects changes in bare soil exposure, showing potential land degradation or recovery patterns.

The NDWI trend tracks water availability, helping assess drought conditions and wetland changes.

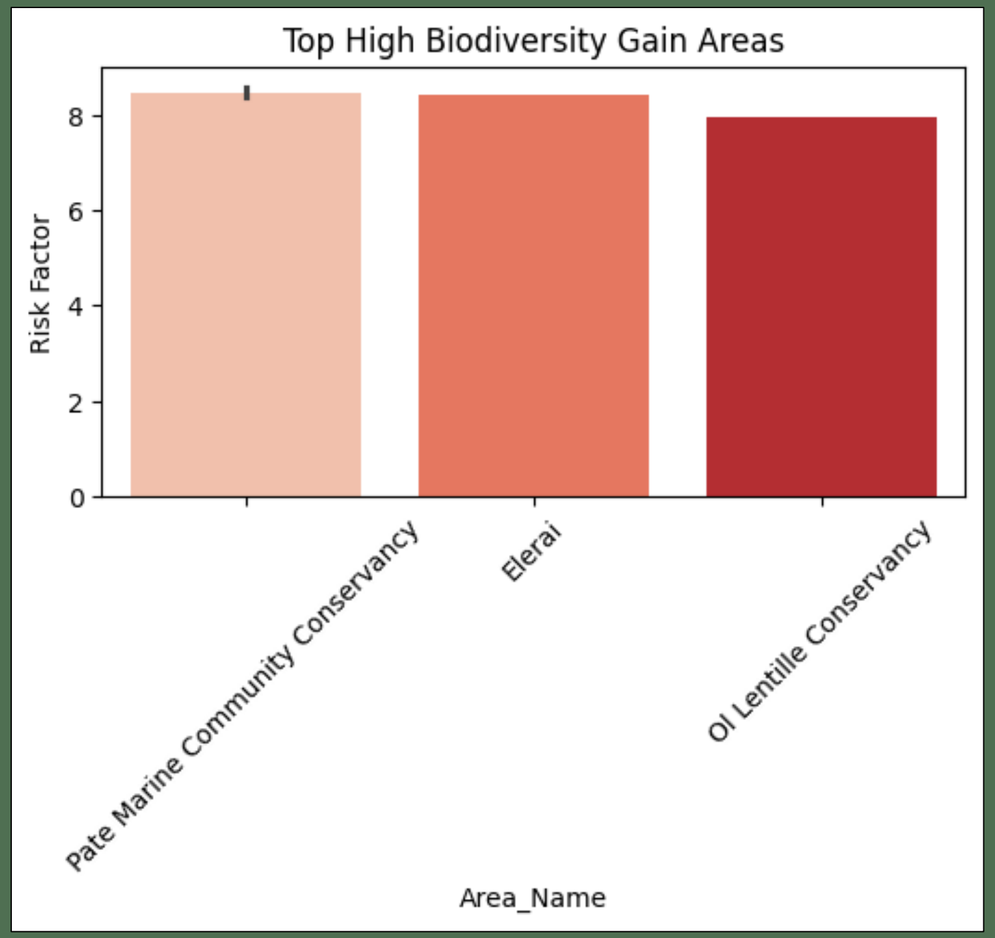
The rainfall trend illustrates precipitation patterns, influencing vegetation growth and ecosystem stability.



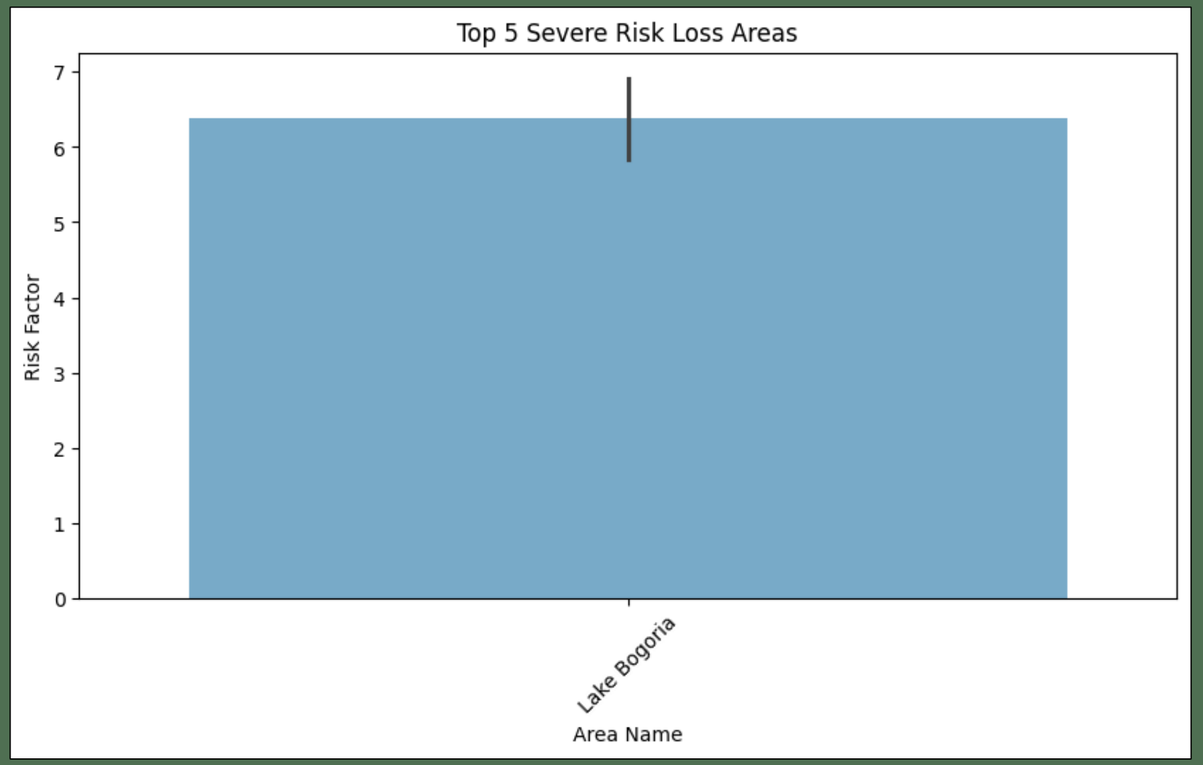
The chart visualizes risk factor trends over time for areas that experienced biodiversity gains, highlighting regional variations. This insight helps assess emerging threats and supports targeted conservation planning.



The chart illustrates the distribution of ecosystem trends, showing variations in protected area conditions over time. Understanding these trends helps guide conservation strategies and prioritize ecosystem restoration efforts

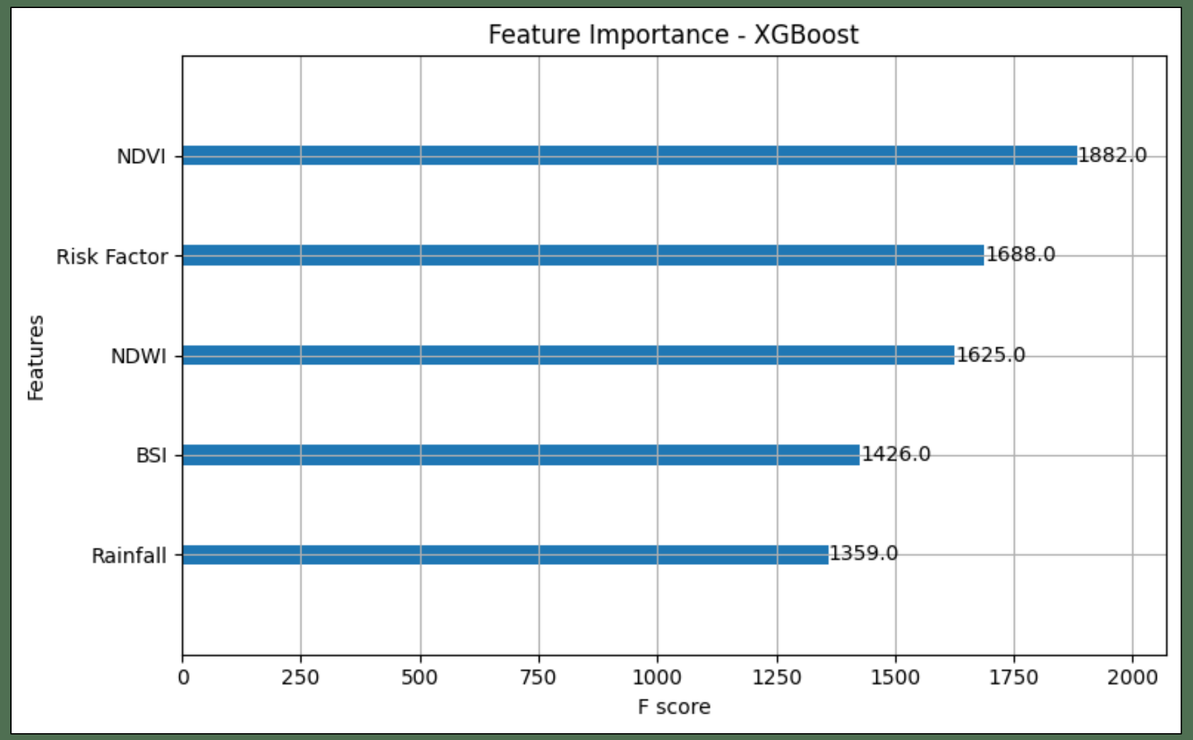


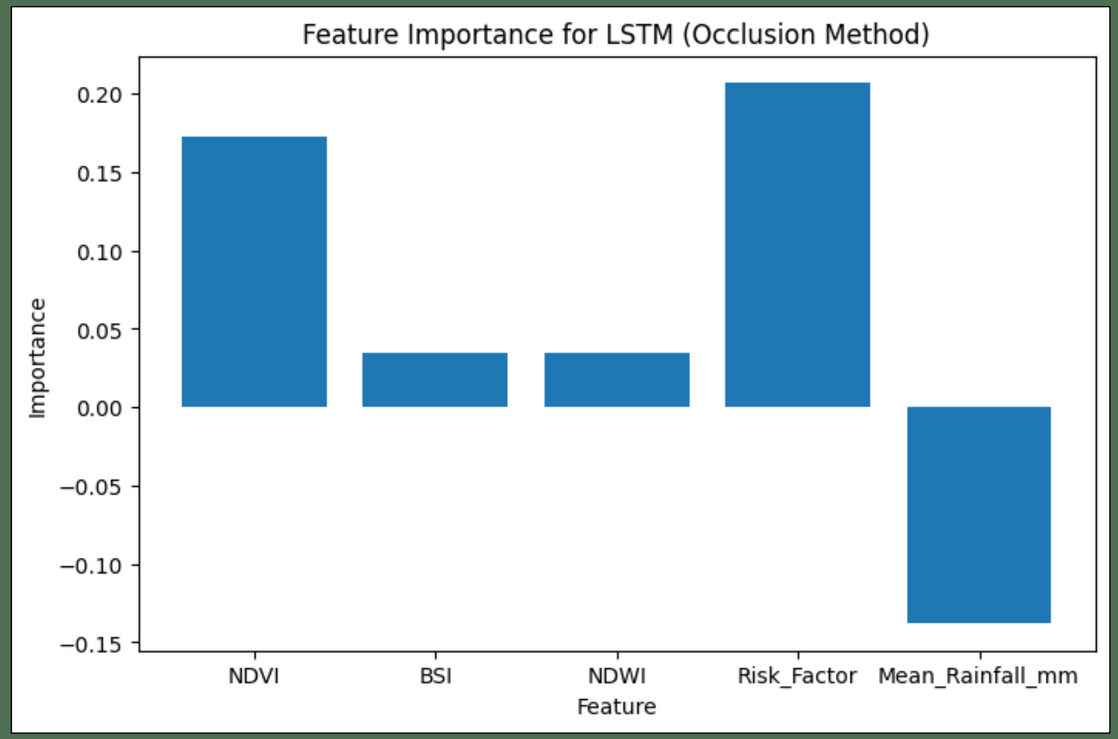
This chart highlights the top five areas with high biodiversity gain, indicating regions with significant conservation potential. Understanding these high-gain areas helps in developing targeted strategies to sustain and enhance biodiversity resilience.



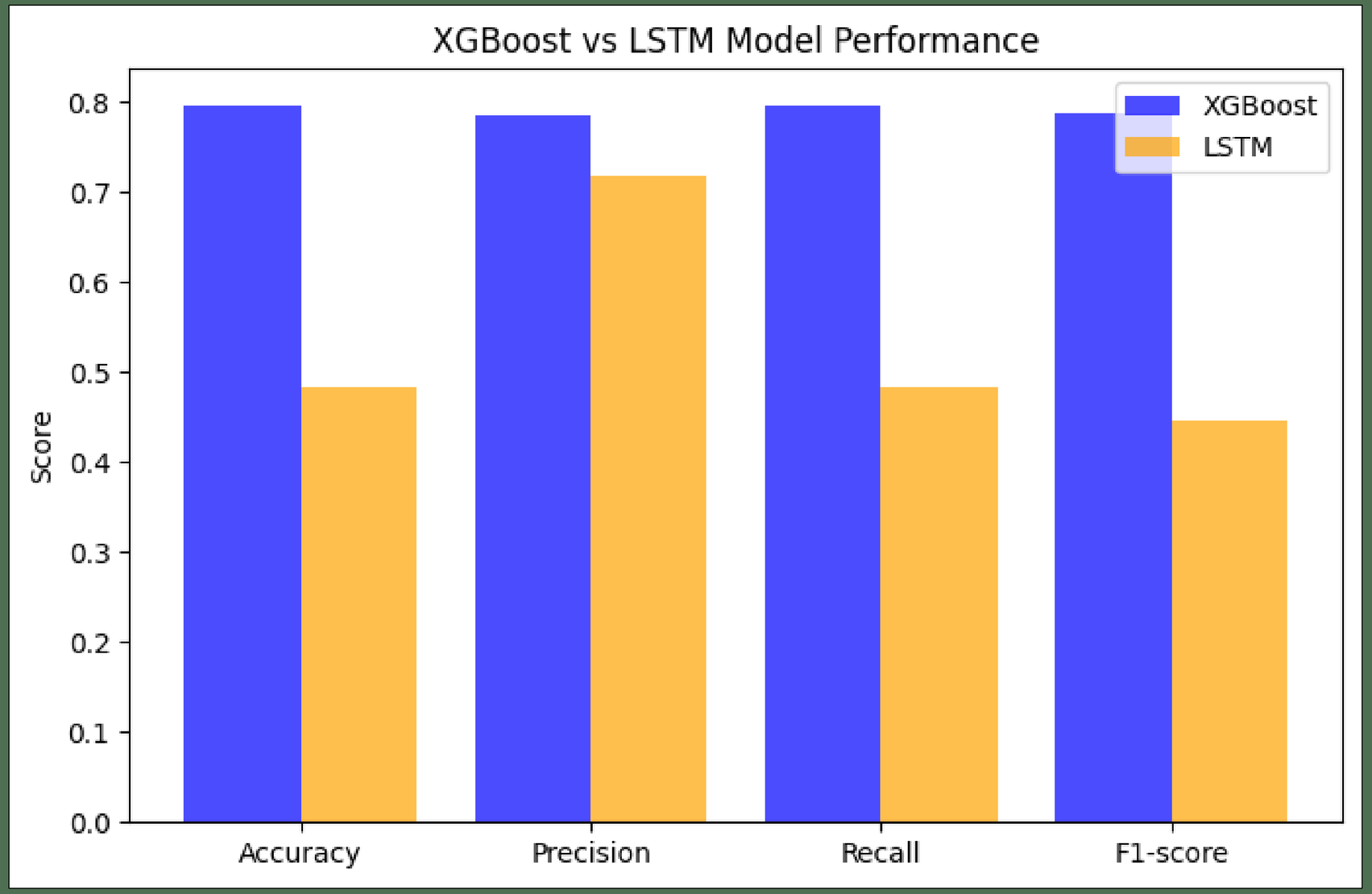
The bar chart highlights the protected area with the highest severe risk loss, emphasizing regions that require immediate attention. By analyzing risk factors across different locations, we can prioritize mitigation strategies to reduce potential losses effectively.

Data Modelling results



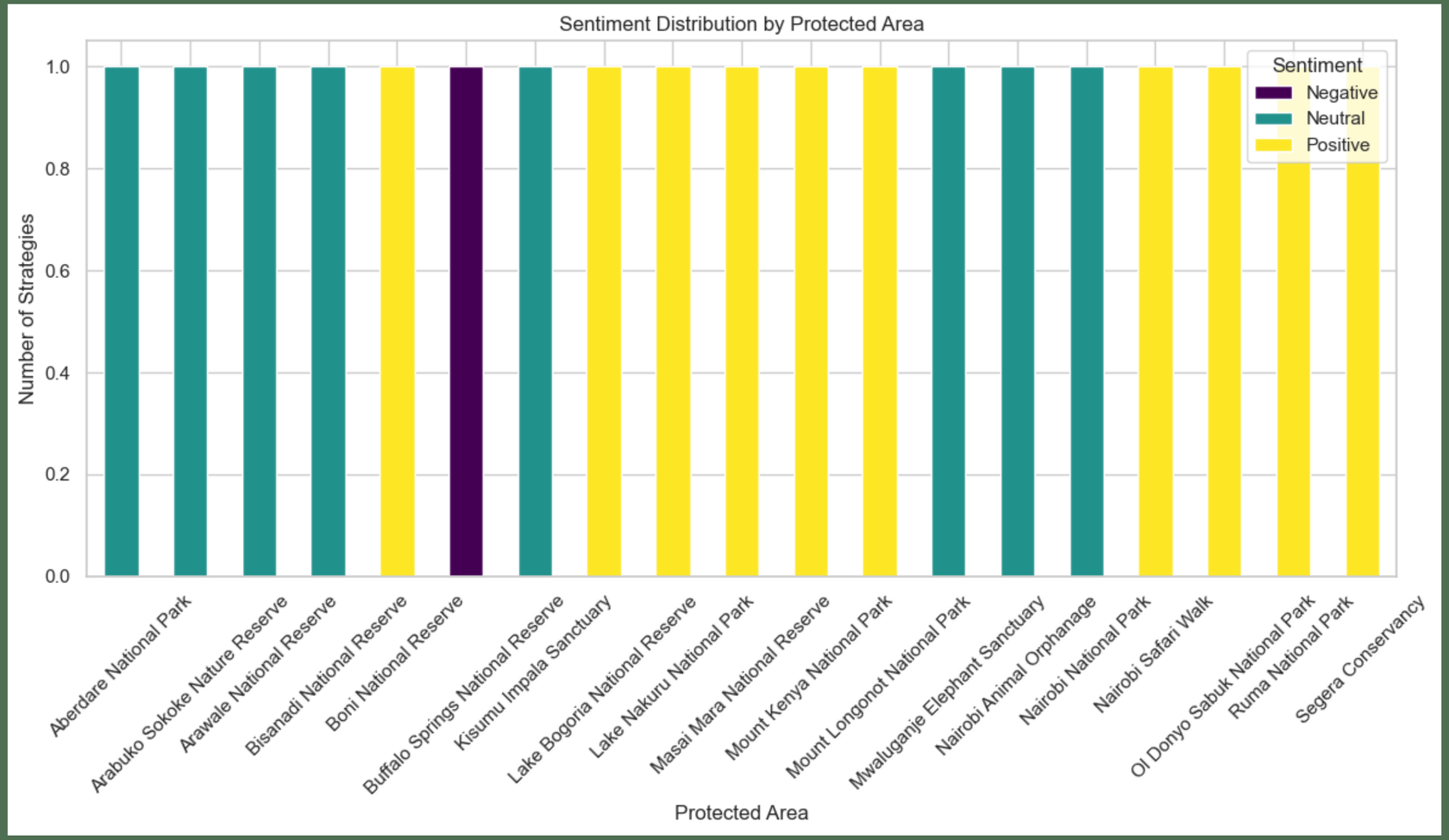


The feature importance analysis from both XGBoost and LSTM highlights NDVI, BSI, and NDWI as key variables in predicting ecosystem risk. Understanding these contributions enables data-driven decision-making for conservation, land management, and effective ecosystem monitoring.

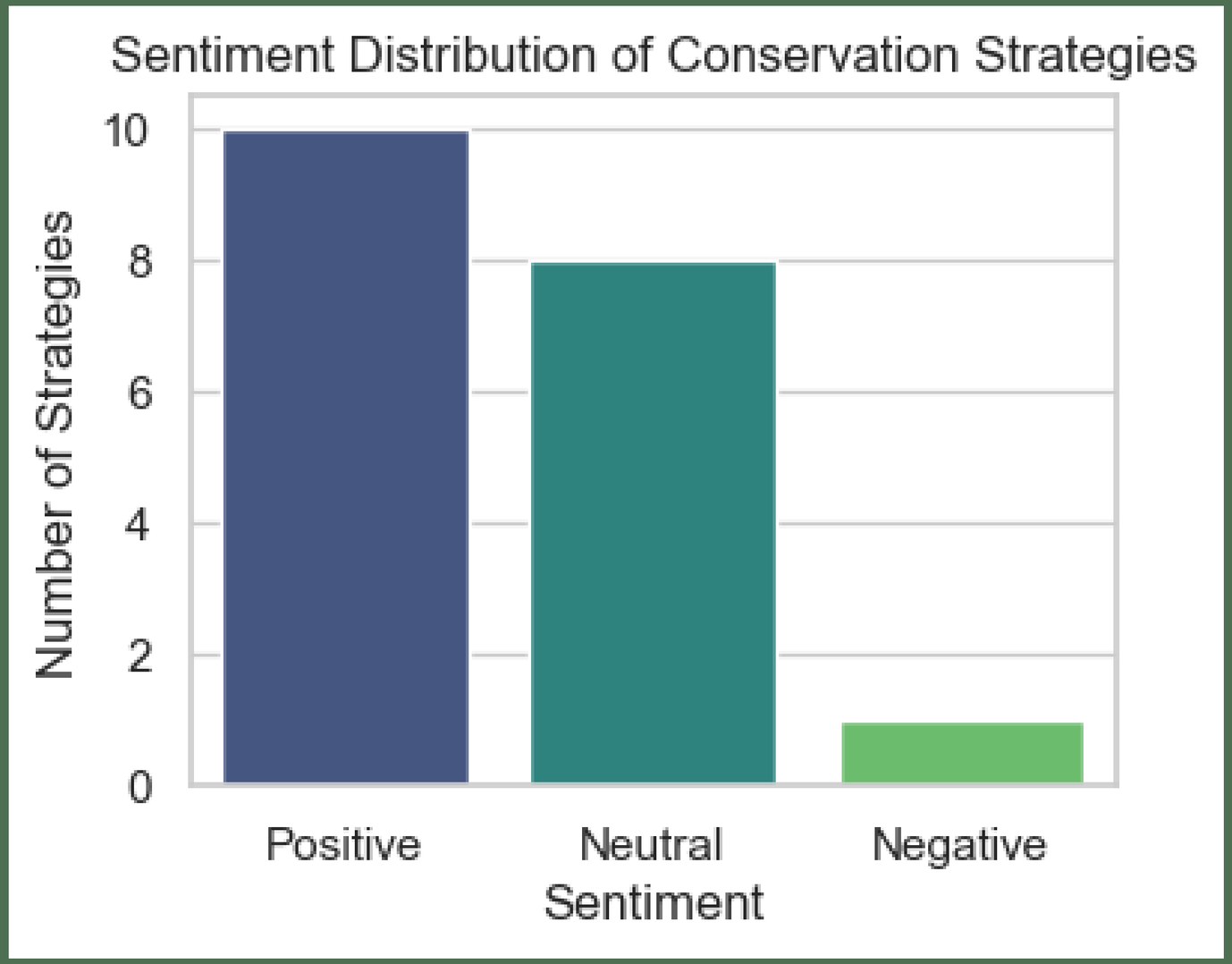


The comparison of XGBoost and LSTM performance across key metrics highlights differences in predictive accuracy, precision, recall, and F1-score.This analysis helps in selecting the most suitable model for ecosystem risk assessment, balancing interpretability and predictive power.

NLP Results



The stacked bar chart visualizes the sentiment distribution across different protected areas, showing how conservation strategies are perceived in each location. This helps identify areas with predominantly positive sentiments, as well as regions where negative sentiments may indicate challenges requiring targeted interventions.



The bar plot visualizes the distribution of sentiment labels associated with conservation strategies, highlighting whether the analyzed texts express positive, neutral, or negative sentiments. This helps in understanding public perception, policy effectiveness, and areas needing improvement in conservation efforts.

Conclusion

Conclusion from the Ecosystem Trend Analysis

The dataset reveals that 210 areas remain stable, while 182 areas have experienced ecosystem loss, and 132 areas have shown gains. Stability is the most common trend, indicating that many protected areas have remained unchanged. However, ecosystem loss exceeds gains, highlighting ongoing environmental degradation in some regions. Although some areas show improvement, the overall trend suggests that conservation efforts may be necessary to counteract ecosystem decline and promote environmental recovery.

Conclusion (NLP Analysis Findings)

Public sentiment analysis indicates negativity around land degradation and positivity toward conservation efforts, with media coverage significantly influencing public awareness and policy discussions on environmental issues. Environmental challenges vary by region, highlighting the need for localized conservation strategies, while NLP effectively extracts trends, enabling data-driven decision-making for environmental management.

Challenges

1. Data Quality & Availability – Incomplete or low-resolution satellite images and inconsistencies in textual data affect analysis accuracy.
2. Computational Limitations – Processing large-scale geospatial and NLP data requires high-performance computing resources.
3. Cloud Cover & Seasonal Variations – Frequent cloud cover in some regions affects remote sensing data reliability.
4. Model Generalization – Machine learning models may not generalize well across diverse ecosystems due to varying environmental conditions.
5. Stakeholder Adoption – Limited technical expertise and resistance to new data-driven approaches can hinder implementation.

Recommendations

- ✓ Strengthen Conservation Efforts: Prioritize conservation in areas with high ecosystem loss by implementing targeted restoration programs.
- ✓ Enhance Remote Sensing Monitoring: Utilize Sentinel-2 imagery and environmental indices (NDVI, NDWI, BSI) for continuous monitoring of land cover changes.
- ✓ Improve Data Integration: Combine remote sensing and NLP insights for a more comprehensive understanding of environmental trends.
- ✓ Leverage Public Sentiment Data: Use NLP analysis to identify regions where conservation awareness campaigns can have the most impact.
- ✓ Support Policy Development: Provide data-driven recommendations to policymakers based on observed environmental trends and sentiment analysis.
- ✓ Encourage Community Participation: Engage local communities by incorporating their feedback and concerns from analyzed text data.

Closing

QUESTIONS AND CALL TO ACTION

Biodiversity conservation is essential for our planet's future. Everyone must take action now to protect and preserve our natural environments.