Problem Chosen	2024	Team Control Number
A	MCM/ICM Summary Sheet	2411262

Rapid Bushfire Response for Emergency Response

Summary

How to respond and deal with fires in time when they occur is a question worth thinking about. This paper provides a fire response plan for Victoria through the rational deployment of EOC, drones and forward teams.

In Task 1, the paper establishes the area safety evaluation model with fire frequency, size, and recent fire situation as indicators to classify the danger levels of different areas in Victoria. Then, we confirm that drones should provide different services for high- risk and dangerous areas. In order to increase the service capacity, we optimize both capacity and cost. For capability, we make the average response time of SSA drones to high-risk areas as short as possible, and reserve as many SSA drones to dangerous areas as possible. For cost, we quantify the demand for SSA drones in terms of fire acreage, and take into account the rounds and the attrition rate of drones. We also consider the mix between SSA drones and radio repeater drones, and calculate the number of repeater drones using a greedy mix-based maximum number solving algo- rithm. The total cost is calculated and finally the quantity optimization model based on the maximum mix rate and minimum cost is obtained.

Keywords: safety factor; commensurable; signal-to-noise ratio; Niche width;
Population interactions

Contents

1 Introduction

1.1 Problem Background

Plants of different species possess varying susceptibilities and abilities to resist drought. Extensive observations have indicated that the species richness of plant communities significantly impacts their ability to adapt to water scarcity over the long term. Communities containing a larger number of species tend to exhibit higher resistance to drought stress in subsequent generations, whereas those with fewer species exhibit lower resistance. Thus, analyzing the association between drought adaptability and the number of species in plant communities is critical for their survival over extended periods.

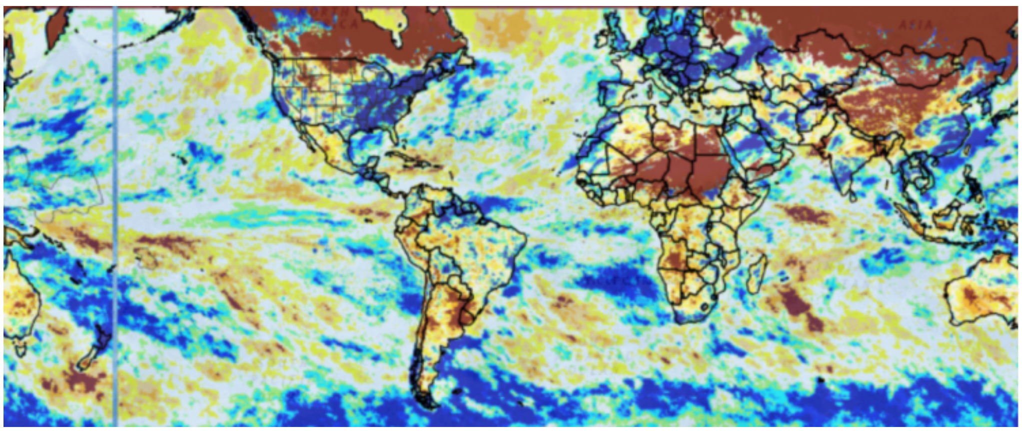

Fig. 1. World drought situation from NIDIS

1.2 Restatement of the Problem

- Develop a model to predict the evolution of plant communities under various irregular weather cycles and consider the interactions between species.
- Determine the minimum number of species required for the community to benefit and the impact of increased species numbers on the community.
- Analyze the effect of species type on community evolution.
- Discuss the impact of the greater or less frequency and width of drought.
- Analyze the impact of other factors such as pollution and habitat reduction on the model.
- According to the model, determine what should be done to ensure the long-term viability of a plant community and the impacts on the larger environment.

1.3 Our Work

To sum up the full article, we

- Develop an ecological niche model considering uncertain weather cycles to simulate plant community evolution. The model accounts for species interactions and successional processes based on inter-species competition, and establishes competition matrices to describe population interactions within the community.

- Use the model to determine the minimum number of species required for a community to benefit from increased species numbers. The model considers the ecological niche width of each population under uncertain drought conditions, using differential equations based on the Beverton Holt and Lotka Volterra equations.

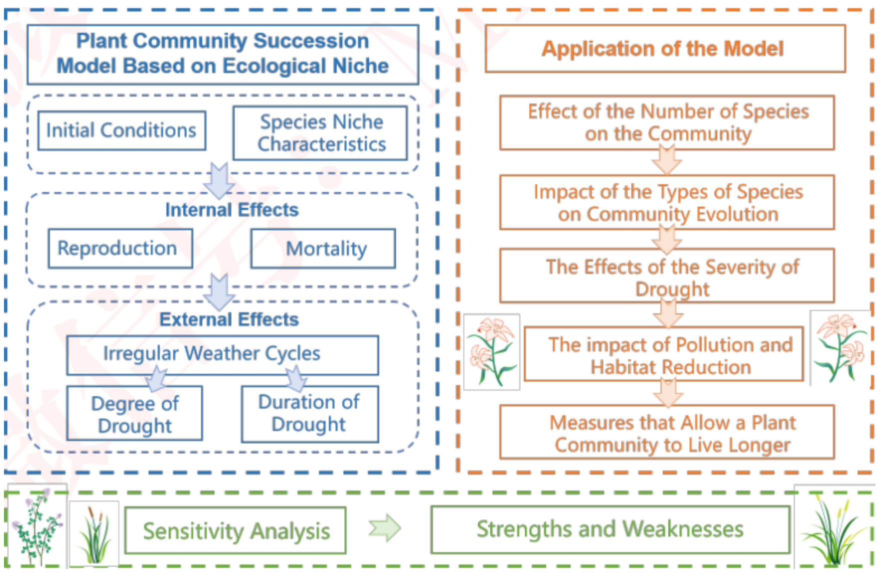

Fig. 2. The flow chart of our work

2 Assumptions and Notations

2.1 Assumptions

To simplify the problem and make it convenient for us to simulate real-life conditions, we make the following basic assumptions, each of which is properly justified.

- **Assumption 1:** The number of species in the plant community will not increase. Justification: We assume a closed system where no new species are introduced or can colonize the plant community.

- **Assumption 2:** Species don't mutate but the population and the resources it controls change over time.
Justification: The timescale of the study is relatively short, and genetic changes and mutations that could lead to ecological changes are assumed to be negligible.

- **Assumption 3:** The competitive or mutually-beneficial relationship between species in a community remains the same.

2.2 Notations

Symbol	Description
C	Competition matirx of species
L	Niche width od specise
Γ	Species sensitivity to drought
$l_i(t)$	Niche width of the i-th species at time t
$b_i(t)$	Increase in niche width of
$d_i(t)$	fraction of niche width of the i-thh
$\sigma_i(t)$	Gaussian white noise for unpredictability
$K(t)$	Niche width of a community at time t

3 Model I: Plant Community Evolution Model

Ecological niche refers to a species's position in a community in terms of its functional relationships and roles with related species, considering time and space. Niche width is an indicator of the diversity of resources used by organisms [1]. The wider the niche width of a species, the less specialized it is, and the stronger its adaptability to the environment.

3.1 Model Overview

Ecological niche model describes plant community based on inter specific interactions[2]. According to the ecological niche model, each species occupies a specific ecological niche with particular resource utilization strategies and environmental adaptability. The model considers species interactions through resource competition and cooperation.[3]

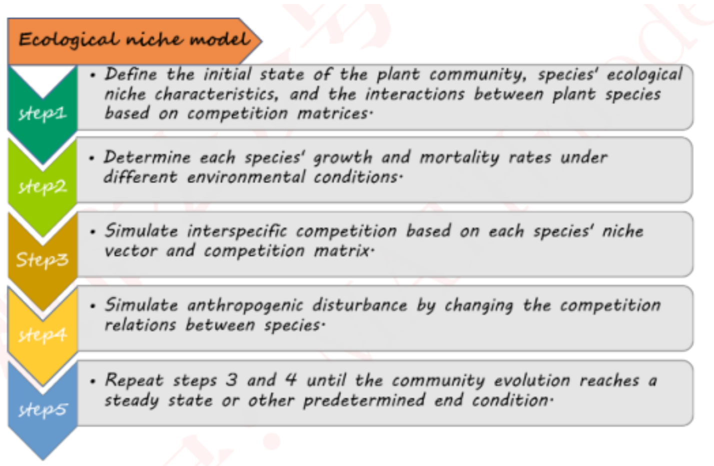

Fig. 3. Steps of the ecological niche model

The evolution process of community-based on niche model is shown in 4

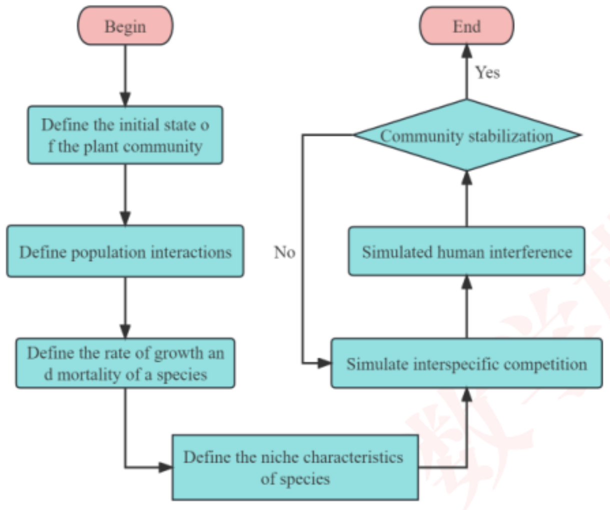

Fig. 4. The evolution process of community

3.1.1 More Sub-details I

test

3.1.2 More Sub-details II

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3.2 Factors/Development of the model

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3.3 Factors/Development of the model

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4 Model II: XXXXXX

PRE-DISCRIPTION OF THE MODEL. SOME FIGURES AS WELL.

4.1 Factors/Development of the model

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4.1.1 More Sub-details I

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4.1.2 More Sub-details II

BALABALA

4.2 Factors/Development of the model

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4.3 Factors/Development of the model

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5 Application of Models

CHOOSE CERTAIN REGION TO UTILIZE THE MODELS ABOVE.

6 Sensitivity Analysis

NECESSARY SENSITIVITY ANALYSIS HERE.

7 Model Evaluation and Further Discussion

7.1 Strengths

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7.2 Weakness

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7.3 Further Discussion

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References

[1] Anuj Mishra, N. V. Krishnendu, and Apratim Ganguly. Unveiling microlensing biases in testing general relativity with gravitational waves, November 2023.

[2] Amit Jit Singh, Ivan S. C. Li, Otto A. Hannuksela, Tjonnie G. F. Li, and Kyungmin Kim. Classifying lensed gravitational waves in the geometrical optics limit with machine learning, October 2018.

[3] https://www.ligo.org/science/Publication-O3bLensing/index.php.

Appendices

Appendix A First appendix

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CODE1
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