Problem Chosen	2023 MCM/ICM Summary Sheet	Team Control Number
A		2302480

Small fungi plays a big role in carbon cycle

summary

Carbon cycle draws more people's attention recent years due to the climate change and greenhouse effect. One of the major component in this cycle is the decomposition of plant material and woody fibers. Among several factors, fungi plays a key role in decomposition process. In order to find out what determines the decomposition speed of fungi and what is the interaction among different kinds of fungi, we establish several models to examine.

To find out the relationship between decomposition rate and the key two factor(the growth rate of fungus and the range of fungus' tolerance to moisture), we build **XXXXX model**. We found out that there is a positive relationship between the growth rate and the decomposition. By contrast, a negative correlation was found between the range of fungus's tolerance to moisture. After incorporating the interactions between different types of fungi, we found out XXXX.

The interaction between various kinds of fungus will cause different results. In short-term, because there is sufficient nutrient in the environment , there is no obvious interest conflict between groups of fungus. However, as the time goes by, the nutrient will decrease to an extent that it can't support all fungus to survive. In this case, we will use **XXXXX model** to solve this problem. We will also examine its sensitivity to rapid fluctuations in the environment and its overall impact.

Different fungi has different functions to degrade the wood. In that case, the combination of fungus will have an impact on the speed of decaying given certain temperature and moisture. We will apply our model built before to analyze the relative the advantages and disadvantages for each species and combinations of species likely to persist. Also we will consider different kinds of environment including arid, semi-arid, temperate, arboreal, and tropical rain forests.

Key words: Sensitivity analysis

Contents

1 Introduction

1.1 Problem Background

Carbon cycle is the process in which carbon atoms continually travel from the atmosphere to the Earth and then back into the atmosphere. The balance of carbon cycle is critical for the live beings on the earth. There are several tunnels for carbon to back into the atmosphere, among which the decomposition of wood plays an important part.

Wood decay is caused by any species of fungus that digests moist wood, causing it to rot. The decomposition speed of different fungus is determined by both intrinsic (e.g., tree species properties) and environmental (e.g., temperature, moisture) factors. Among the associated organisms, wood decay fungi are essential and extremely important, being the only forms of life capable of degrading wood to its initial constituents.

Figure 1: Brown-rot fungi at 400X

What's more, the interaction between different kinds of fungus also will change the speed of decay rate.With the climate change, the environment where fungus live will also change, which will impact the overall efficiency of the carbon cycle system. According to the type of decay they cause, wood decay fungi can be classified into white-rot fungi, brown-rot fungi, and soft-rot fungi. The detailed of interaction must be examined.

1.2 Problem restatement

- Build a mathematical model to find out decomposition speed in the situation where several species of fungi are exist at a given temperature and district in certain district.
- Find out what will happen when fungus are interacted in short-term and long-term.
- Examine the different kinds of combinations of species and its advantages and disadvantages in different environment(arid, semi-arid, temperate, arboreal, and tropical rain forests).
- Analyzing the sensitivity of our model in rapid fluctuations and changing atmospherical trends.

1.3 Our approach

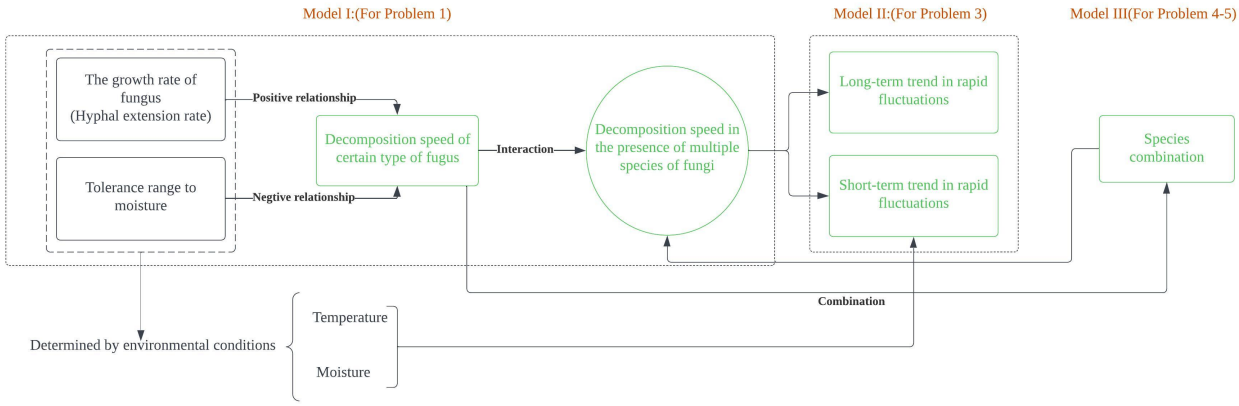

Figure 2: The framework of our article

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2 Assumptions

Assumption 1:

Justification:

Assumption 2:

Justification:

Assumption 3:

Justification:

3 Notations

Table 1: Notation

Symbols	Definition	Unit
T	Temperature of the environment	°C
		Unit
		Unit
		Unit
		Unit
		Unit
		Unit
		Unit
		Unit
		Unit
		Unit

4 The Data

4.1 Data collection

We collect relevant data for our model building.

Table 2: Data source

Database	Database websites	Data description

4.2 Data Processing

5 Model I: Decomposition rate and the existence of multiple species of fungi

The decomposition rate is determined by several environmental factors and characteristics of fungi. Among these, the most factors are temperature and moisture. The majority of fungi are mesophiles, and grow at temperatures in the range of 5-35 °C, which optimum temperatures for growth between 20 and 30 °C. In contrast, the sensitivity of fungi to moisture has huge differences. Different fungal species have different tolerances to moisture and some will grow at lower moisture levels. Moreover, the rate will not only be affected by the behaviour of a single fungi, but also be determined by the interactions of different species of fungi.

5.1 model

5.2 Conclusions

6 Model II:

In Model I, we analyze the relationship between decomposition rate and multiple fungi. However, the behaviour and interaction will be different against time due to the limited resource and external environment. In short-term, because there is sufficient nutrient in the environment , there is no obvious interest conflict between groups of fungus. However, as the time goes by, the nutrient will decrease to an extent that it can't support all fungus to survive. In that case, there will be competition among species and reach a balance in the long run. We will use X model to solve this problem.

6.1 model

6.2 Sensitivity analysis

6.3 Conclusion

7 Model III: Fungus combination model

Competition does exist among different kinds of fungus. However, the suitable combination of them may result in different situations. There are variable kinds of fungi which has different method of decaying. For example, white-rot fungi mainly secrete cell oxidases for delignification while brown-rot fungi can degrade cellulose and hemicellulose.

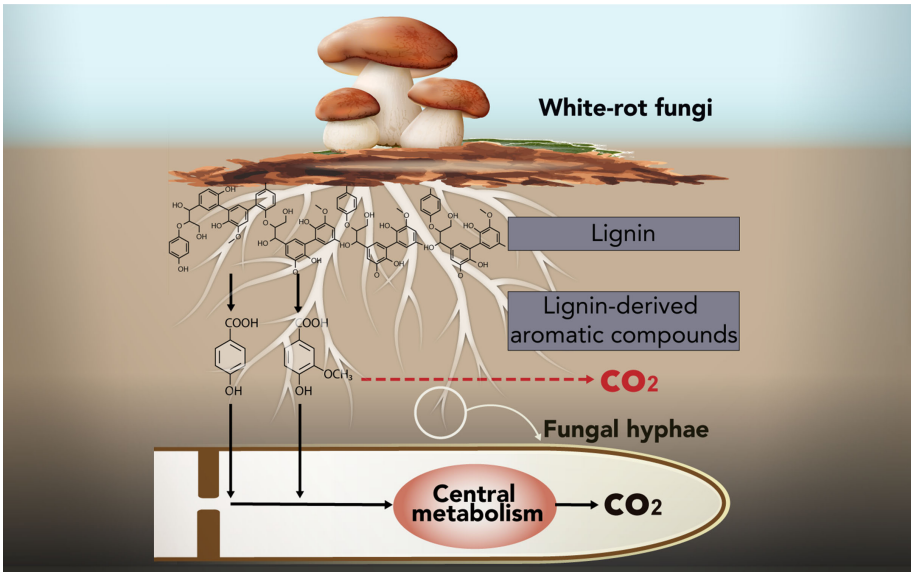

Figure 3: White-rot fungi

In that section, we will analyze the relative the advantages and disadvantages for each species and combinations of species likely to persist. Also we will consider different kinds of environment including arid, semi-arid, temperate, arboreal, and tropical rain forests.

7.1 Introduction of model III

8 Conclusion

8.1 Result of Problem I & II

8.2 Result of Problem III

8.3 Result of Problem IV

8.4 Result of Problem V

References

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