Drought:
Effects of Human Intervention in the Brazilian Amazon

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Abstract

This study presents a System Dynamics exploration into the multifaceted consequences of human intervention in the Brazilian Amazon. Focusing on the extensive deforestation for cattle farming and mono-crop agriculture, the paper critically examines the dichotomy between economic growth and the ensuing environmental degradation, particularly biodiversity loss and drought. The research illuminates how these ecological disruptions not only damage the forest ecosystem but also have profound effects on public health and societal well-being. By employing a robust System Dynamics model, the paper elucidates the complex feedback loops and interdependencies that characterize the Amazonian environment and its exploitation. This model serves as the foundation for an Interactive Learning Laboratory, designed to foster a deeper understanding of the Amazon's dynamics. The laboratory offers a platform for stakeholders to engage in exploration, discussion, and the collaborative design of more effective and sustainable policies. Ultimately, this work aims to contribute to the discourse on balancing economic development with environmental stewardship, seeking pathways towards the sustainable management of this crucial global ecosystem.

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Introduction

At the 2022 International System Dynamics Conference, an insightful paper titled "Dynamics of Human Intervention in the Brazilian Amazon" was presented. This pivotal work highlighted key effects and feedback loops resulting from the deforestation of the rainforest for agricultural and livestock purposes. It shed light on the consequential dynamics of deforestation and proffered strategic approaches to mitigate these effects, aiming to chart a course toward the sustainability of this vital ecosystem.

However, the original work did not delve into the critical aspects of reduced rainfall and its cascading effects on water bodies like rivers and lakes, nor did it consider the implications of water usage in agricultural practices. Building on this foundation, our new research seeks to expand the scope of analysis. We aim to integrate these overlooked elements, drawing on recent studies that have further unraveled the complexities of the Amazon's ecological balance.

In our new work, we aim to extend these bridges between past research and recent discoveries, seeking innovative pathways to sustain this indispensable system for humanity. By integrating these diverse but interconnected strands of research, we hope to contribute a more holistic understanding of the Amazon rainforest's sustainability challenges and solutions.

Problem Statement

Drought is a problem that is affecting various places around the world. Even though there are multiple reasons for it, we have focused on the drought present in the Brazilian Amazon. Expanding the structure of the system dynamics model presented at the International System Dynamics Conference 2022.

The previous model did not include the effects of the decrease in rainfall (which has decreased by 63% of the Amazon territory) on bodies of water, nor the rate of water use derived from intense agriculture. Nor its connections with the previous structure.

Methodological Approach

We decided to extend the past system dynamics model to reproduce the new reference modes. These modes of reference are born from the multiple reports found online about the drought in the Amazon.

The model is a generalization and simplification of these mental models. It was built thinking about how structures are interconnected and generate certain behaviors.

The CLD in Image 1 represents the complete dynamic hypothesis that we have modeled.

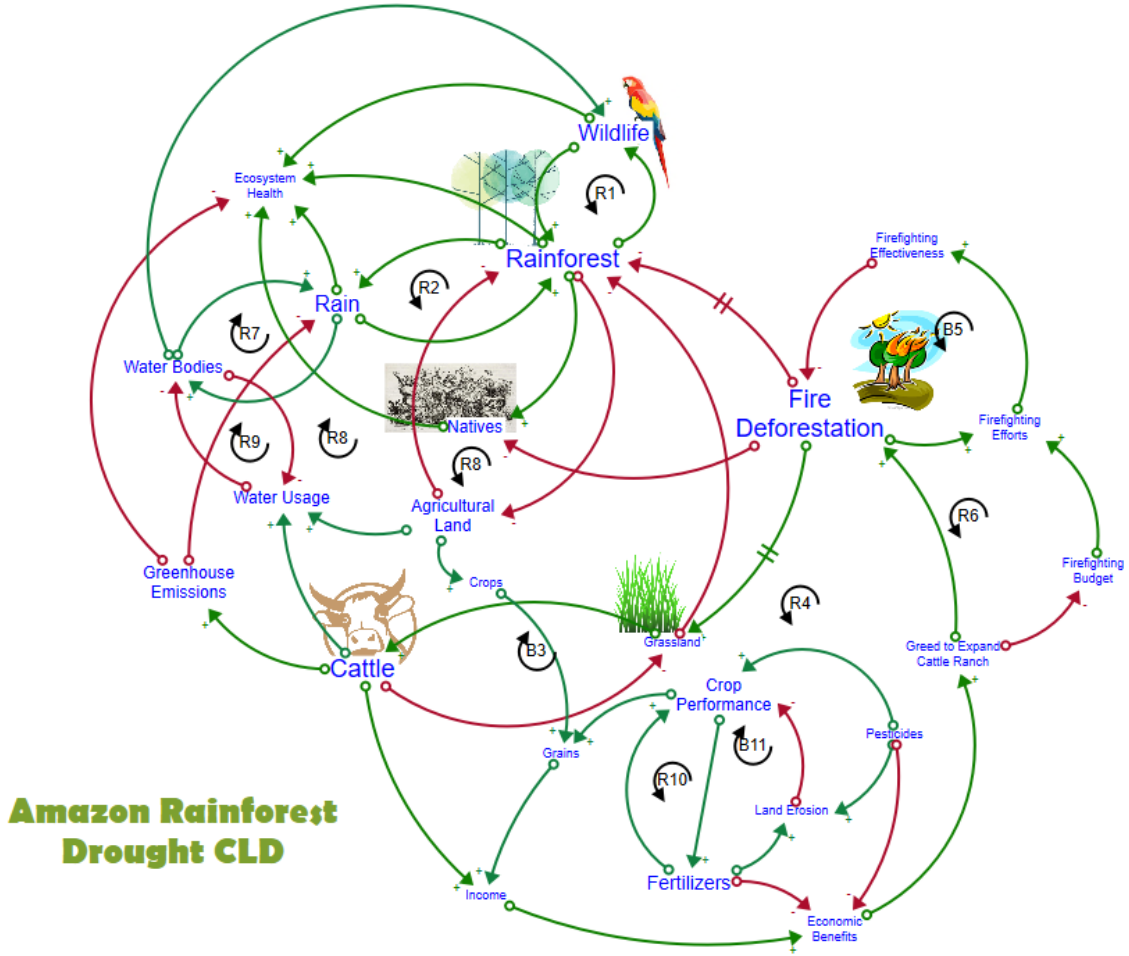


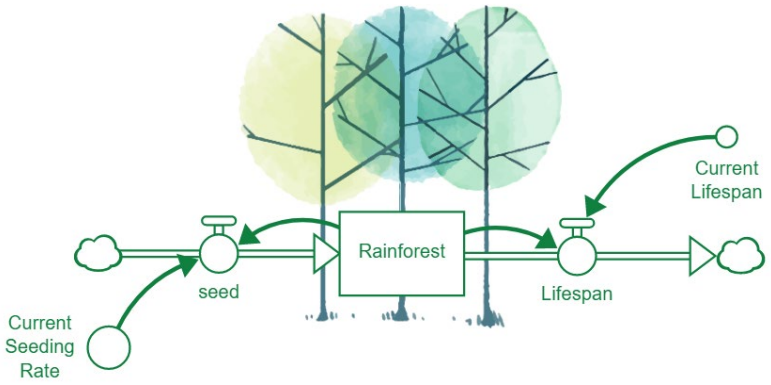
Image 1: CLD of the Amazon Rainforest Drought

Methodological Approach

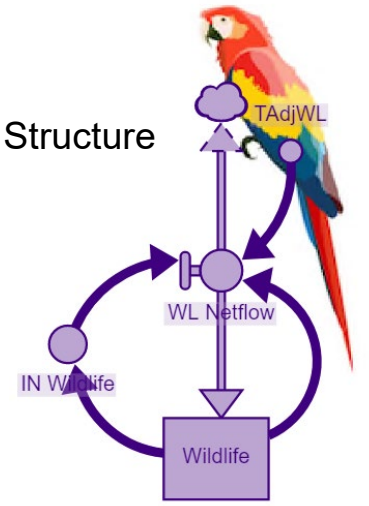
Their structures are basically of two types: 1) limits to growth structure, 2) goal seeking structure. That when interconnected form the basic dynamics of the mental model. Examples in image 2: LTG and GS structures.

The model is generic, in the way that it can reproduce behaviors of other rainforest that have similarities.

Limits to Growth Structure



Goal-Seeking Structure



Results

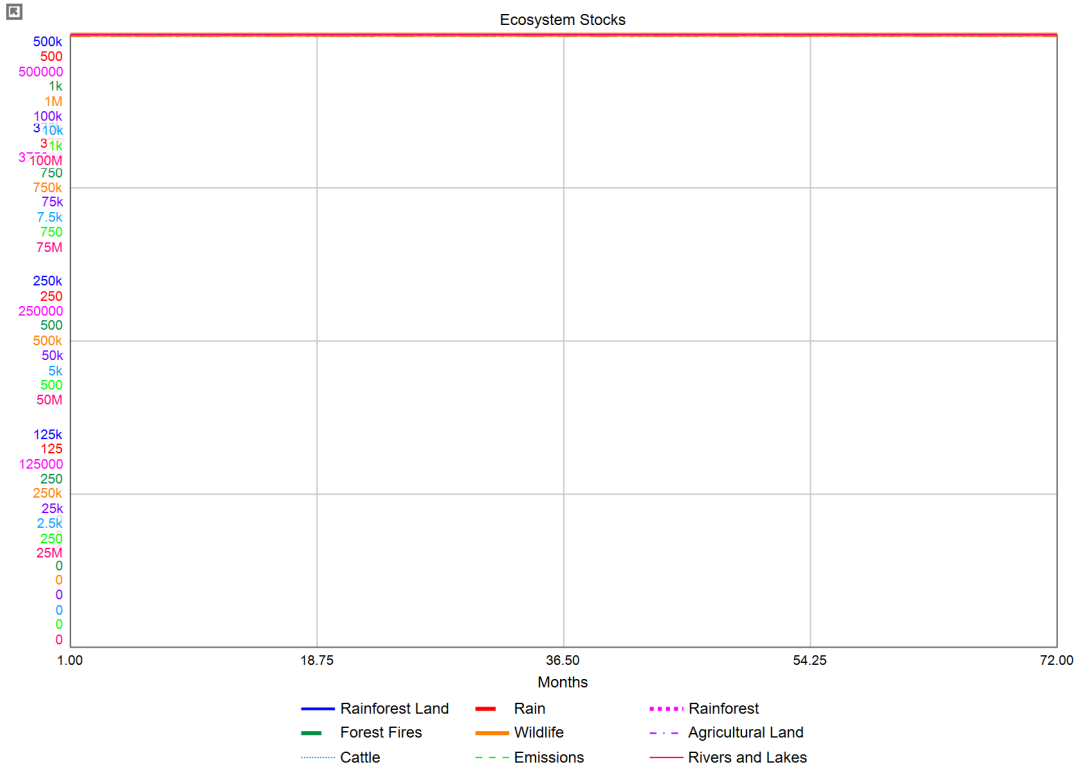


Image 3: BOTG Stable State run

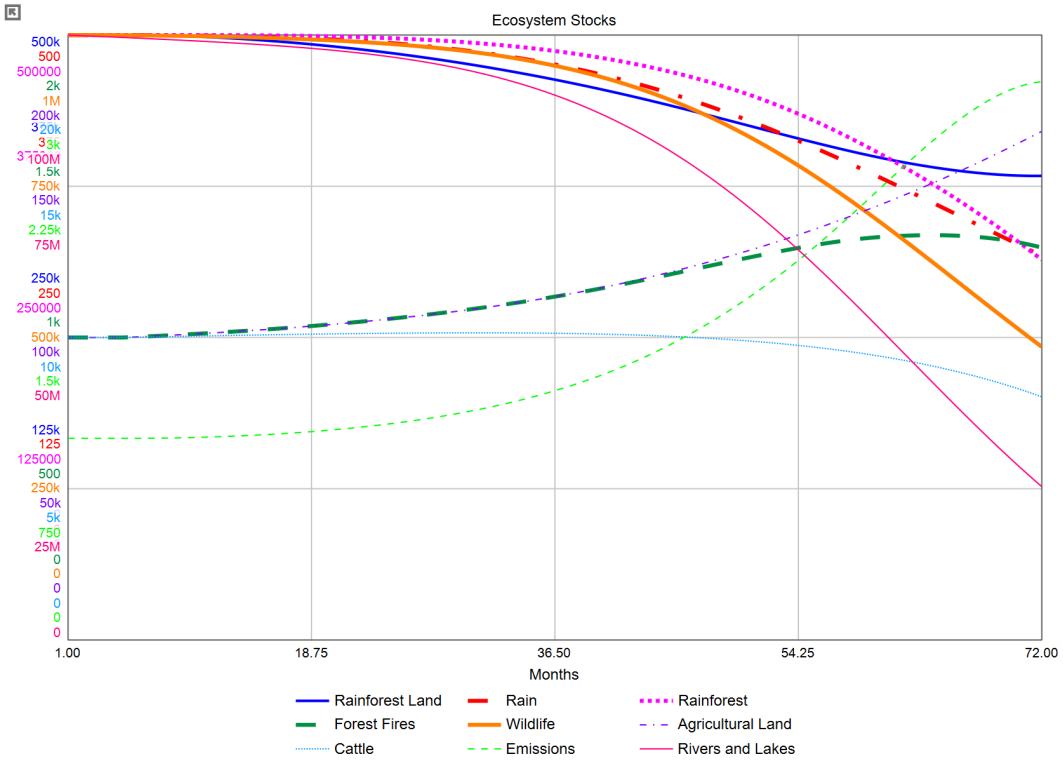


Image 4: BOTG Exploring Deforestation

Considerations

Our model is intended to allow exploration of this complex system to better understand the interconnections between various situations.

It can even be better supported by validating the science behind each of the parameters it contains.

It allows us to better understand what policies we can apply to improve the general performance of the Amazon, but above all, design policies to lead it to sustainability. Many lives depend on it.

Contribution

We consider this work to be an original contribution to System Dynamics and Systems Thinking as it creates a bridge to the past to obtain insights and better understand our present. In addition, it offers a mechanism to experiment with which the public can better understand their role in a in helping the environment to survive; however, this tool will be available until the conference as an Interactive Learning Laboratory.

For the scientific community in general, it provides a ray of hope, since what System Dynamics offers is not only simulation, but also being able to bring to life the knowledge available in literature and help humanity to solve the biggest issues of our lifetime.

Conclusions

We have successfully improved a quantitative model that behaves like the real-world and reproduces the effects described therein. At the same time, it plays a Stable State when no lever is on. Its structure presents consistency in its units of measurement.

We need to explore the model a little further to understand strategies to mitigate the effects deforestation and find policies to build resilience in our natural systems.

With the current model are building a Learning Laboratory to facilitate experimentation and find the best strategies, as well as explore new scenarios such as starting with a system out of balance.

Next Steps

We would like to present this work as a Poster and demonstrate its usability with an Interactive Learning Laboratory. Our Learning Lab enables users to experiment with the Amazon, and to adapt initial conditions to other regions. We believe that this tool can help create awareness and ignite discussion to solve this situation.

We cannot share the Online Interface at this time due to Blind Peer Review policy, as it shows author names in the web address.

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