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Space as a tool to foster climate mitigation and adaptation: Using the Amazon RainForest region of Brazil as a case study

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Abstract

Two issues that face the largest tropical rainforest on Earth (Amazon Rainforest) are highlighted as follows: Wildfires and Deforestation, both of which affect the biodiversity, global climate, and weather patterns, and contribute to the depletion of assets in medicine, agriculture, and other key industries. Amazonia Mission was then initiated to consolidate Brazil's knowledge in the integral development of a space mission using satellites. The Amazonia Satellite provides remote sensing data in image format, in order to monitor deforestation, water reservoirs, natural and cultivated forests of the Amazon region, and also diversified agriculture throughout the national territory.

Introduction

Figure 1: Brazil’s Amazon rainforest suffers deforestation due to wildfire spread

Brazil is a country on a continental scale, with more than 8.5 million km^2. Its territory comprises different ecosystems, a diversified agricultural system, and complex hydrological, geological, and topographic systems. There is a permanent need to monitor all of these objectives, especially two of them: ecosystems and agriculture [2].

Brazil's natural vegetation is very diverse. Only two ecosystems - Tropical Forests and Cerrados (Savannah) - cover more than half of the country's territory. The biggest tropical forest in Brazil is the Amazon Rainforest, it is also the world’s largest intact forest.

The Amazon rainforest plays a crucial role in the South American climate because of its effect on the regional hydrological cycle. According to Rhett (2020), the Amazon rainforest is believed to host 40,000 species of plants, 390 billion individual trees, 2.5 million species of insects, and 2,000 species of mammals and birds, at least half of which live in the forest canopy. Among many key ecosystem services, medicinal bioprospecting linked to ethnobotanical studies has achieved important findings in drugs for the treatment of cancers and associated diseases [3].

The forest interacts with the atmosphere to regulate the humidity inside the basin. Humidity is transported to the Amazon region by trade winds from the tropical Atlantic. After the rain, the rainforest produces intense evaporation and recycling of moisture, and then, much of that evaporation returns to the Amazon region in the form of rainfall [8;5].

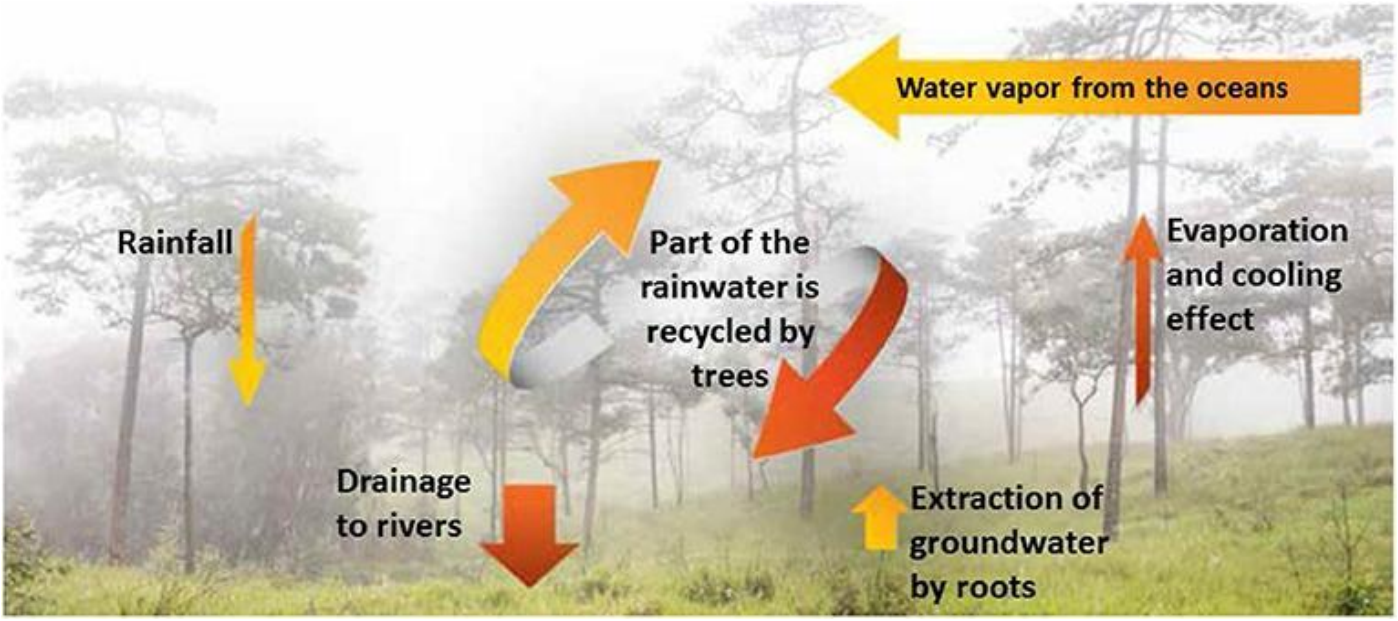

Figure 2: Regional water cycle in the Amazon Rainforest

Cloud cover such as smog restricts the system to identify deforestation. There is evidence that the area of deforestation is shrinking; thus, to monitor these areas, remote sensing systems with higher spatial resolution are required. Scientific studies conducted in Brazil (INPE, INPA, USP), [9] with international collaboration, show that the Amazon rainforest plays a crucial role in the climate system, helping to direct the atmospheric circulation in the tropics by absorbing energy and recycling approximately half of the regional rainfall [7].

No challenge poses a greater threat to our planet and to future generations than climate change. The reduction of forest affects the transport of atmospheric humidity to other regions by means of atmospheric circulation mechanism. Concerned that the activity of deforestation is affecting Amazonian biodiversity and causing climate change to be at its tipping points, [9;2] scientists propose to harness the resources within the collection of ecosystems that compose the Amazon ecosystem into net generators of high-value products,

towards a forest-biodiversity economy that values renewable natural resources, biological and biomimetic assets, environmental services and biodiverse molecules and materials [2].

The idea is to expand already successful initiatives such as using space extensive technological investment, skills, and capacity development for mitigation and adaptation to the climate change challenges.

Climate mitigation of Amazon Rainforest using Space Tool

Climate change is already happening and producing impacts, and the greater the warming, the greater the future impacts and risks that humanity will face, including the possibility of irreversible damage to ecosystems, biodiversity, agricultural production, and the economy and society in general.

The idea of taking actions that will effectively limit the outcomes of climate change is known as Climate Mitigation [1;4]. Deforestation can be reduced by a variety of means, including command-and-control programs using inspections, various kinds of integrated development projects aimed at channeling labor and capital resources to sustainable land use in deforested areas [9;5].

The government of Brazil and other agencies have made great efforts to monitor the aforementioned issues of the Amazon rainforest. One of these initiatives is DETER (Deforestation Detection in Real-Time). [9] DETER is a satellite-based system, which monitors and demonstrates the trend of deforestation rates in the Amazon rainforest. This system (as a space tool) is an important alert tool for monitoring and controlling deforestation, especially for the Brazilian Amazon [5;7].

Another space operational program dedicated to monitoring deforestation in the Amazon region is PRODES (Measurement of Deforestation by Remote Sensing) [9]. This system is based on Landsat data and aims to measure the deforested area using satellite data.

The usage of DETER and PRODES as a Space Tool by the Brazillian Space Agency in monitoring the activity of deforestation in the Amazon Rainforest [9;8], as an effort to reduce or prevent increased climate change is a typical example of Space as a tool to foster Climate Mitigation. Climate Mitigation will help build a more resilient society, no doubt about that.

Climate Adaptation of the Amazon Rainforest using Space tool

Over time, global climate change has lead to increased temperatures and changing rain patterns in the Amazon, which has undoubtedly affect the region's forests, water availability, biodiversity, agriculture, and human health.

The agricultural system requires high-intensity remote sensing monitoring [4]. The intense and diversified agriculture gives Brazil an important role as a food supplier in the world. Some of the main products in this sector are coffee, soy, sugar cane, corn, cotton, and citrus, in addition to cattle.

The main agricultural calendar in Brazil coincides with the rainy season, therefore with a high probability of cloud cover [8;6]. As such, optical remote sensing data obtained from the Amazonia satellite is required as an operational base for these agricultural applications [9].

The effects of climate change are already being felt, and there is a need for quicker and comprehensive adaptation [6]. For the Amazon rainforest, the climate adaptation actions involve using the spectral and radiometric resolution data from the Amazonia satellite to understand the vegetation phenomena including chemical, structural, and humidity.

This strategy is a perfect example of space as a tool that will help foster the focus on developing and rolling out adaptation solutions to help reduce climate-related risk, increase climate protection and safeguard the availability of fresh-water.

Conclusion

Since Brazil has a long history and commitments to keep monitoring its vast forested territories and large agricultural activities, there is a need to continue providing adequate precision of the spatial resolution of the remote sensing data. As such, both deforestation and agriculture can be assessed quantitatively. In general, the scope of satellite data applications is broader than its primary mission. The data from the Amazonia satellite has been used to serve other applications, such as monitoring coastal zones, water reservoirs, natural and cultivated forests.

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