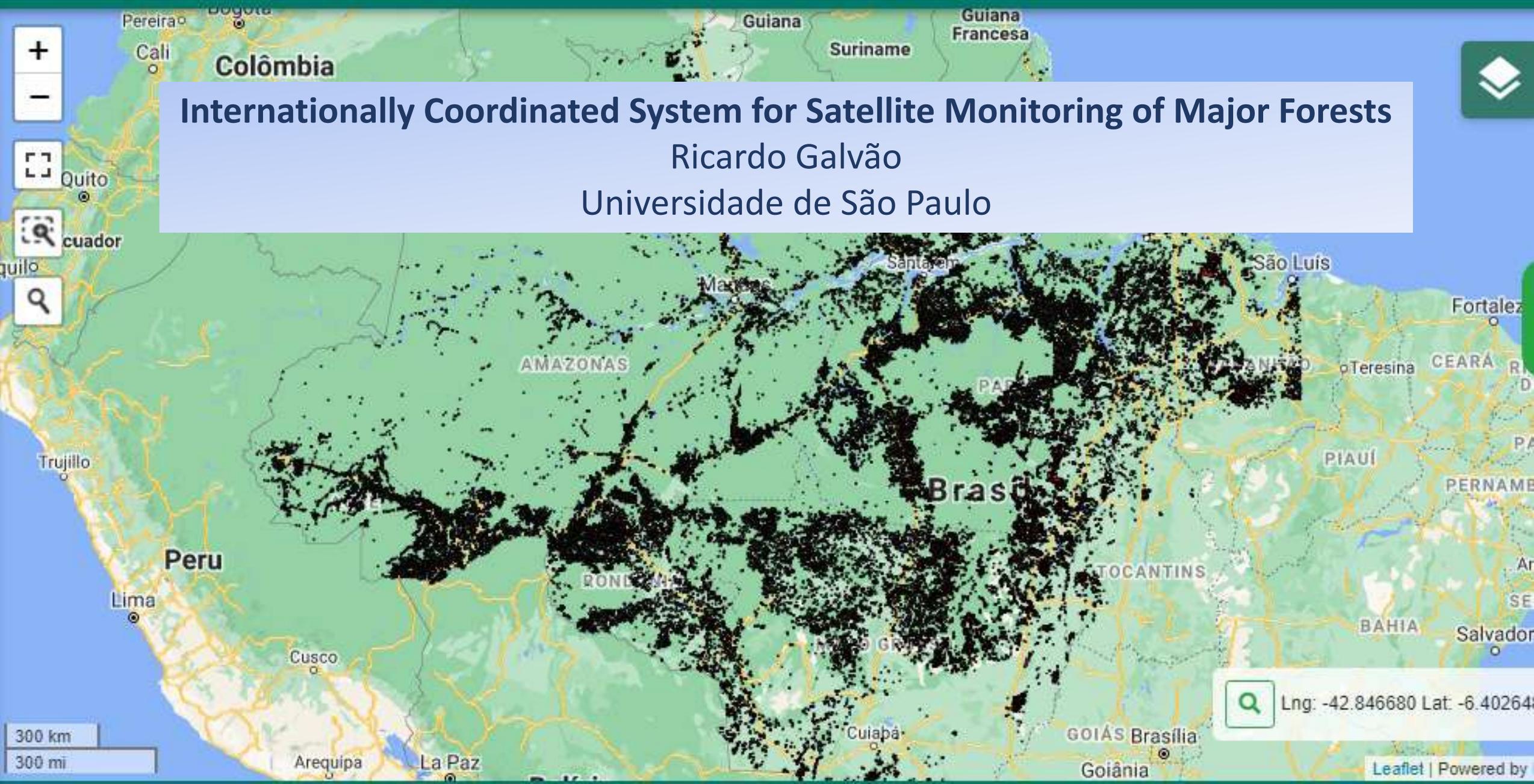


Internationally Coordinated System for Satellite Monitoring of Major Forests

Ricardo Galvão

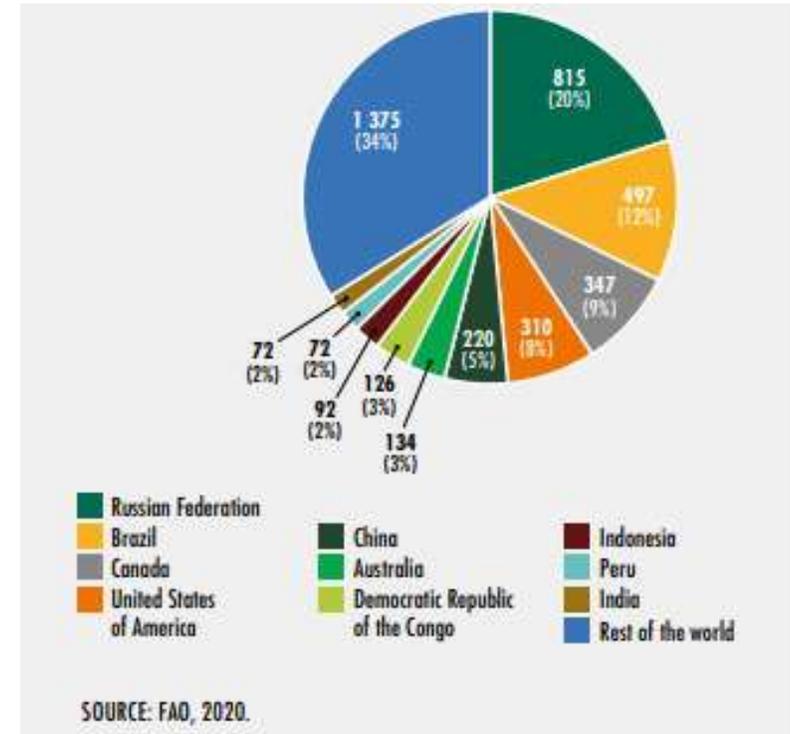
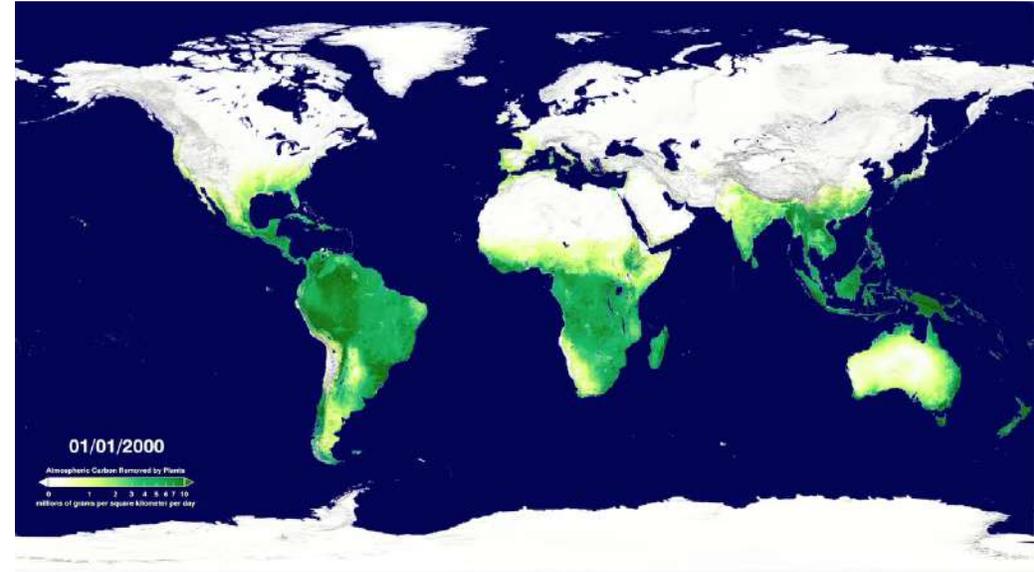
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- The role of forests in capturing and storing carbon and mitigating climate change is of ever-increasing importance.
- Forests currently cover 30.8 percent of the global land area, 4.06 billion hectares, but are not equally distributed around the globe.
- For decades, the only institutional effort to generate global forest measurements has been the inventory assembled by FAO/UN. Nations self-report their forest inventories and differ in how they define forests as well in their deforestation monitoring systems.

• For establishing effective global policies to reduce emissions from deforestation and forest degradation (REDD+), an internationally coordinated forest monitoring system must be implemented.





- Estimated forest stock of carbon: $862 GtC$ [Y. Pan *et al*; Science 333, 988 (2011)]
tropical forests: 55% boreal forests: 32% temperate forests: 14%
 - Primary forests have higher carbon stocks because most living biomass carbon is found in large, old trees, and in undisturbed soil stocks and peat.
 - The goal to limit global warming to less than $2^{\circ}C$ requires atmospheric concentration $n_{CO_2}/n_{air} \leq 450 ppm$; it has already reached $400 ppm$. Loss of the world's forest by 2100 would emit enough CO_2 to increase its concentration by $50 \rightarrow 100 ppm$.
 - A halt to deforestation and forest degradation alone would reduce emissions by $1.4 GtC/year$. Furthermore, allowing logged forests to regrow and age could remove $1 \rightarrow 3 GtC/year$ of CO_2 from the atmosphere [R.A. Houghton; Carbon Management 4, 539 (2013)].
- Therefore, a well coordinated, effective, comprehensive, and properly supervised scheme to monitor deforestation and forest degradation, with fast enough response to allow swift actions by international organisms, must be implemented.



- *“To measure forests worldwide, satellite imagery is a practical necessity. The greatest strengths of satellite-based measurements are their unparalleled, unbiased measurements, their monthly to daily frequency, and—above all their synoptic nature.”* [M. Fagan and R. de Vries; RFF Report (2009)].
- Remote sensing of forests began in 1972, with the launch of Landsat. The relevant techniques have immensely advanced since then, using both passive (optical) and active (radar and lidar) sensors and cutting-edge methods of image processing [V.Maus *et al*; IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 9, 3729 (2016)].
- Currently, *“there are an estimated 713 active nonmilitary earth observation satellites in orbit, 75% of which were launched within the past five years. These satellites are now capturing imagery of Earth with unprecedented temporal, spatial, and spectral frequency.”* [M. Burke *et el*; Science 371, eabe8628 (2021)].
- Forest monitoring by satellites is employed by many countries and institutions, but still not in an integrated and internationally coordinated arrangement.

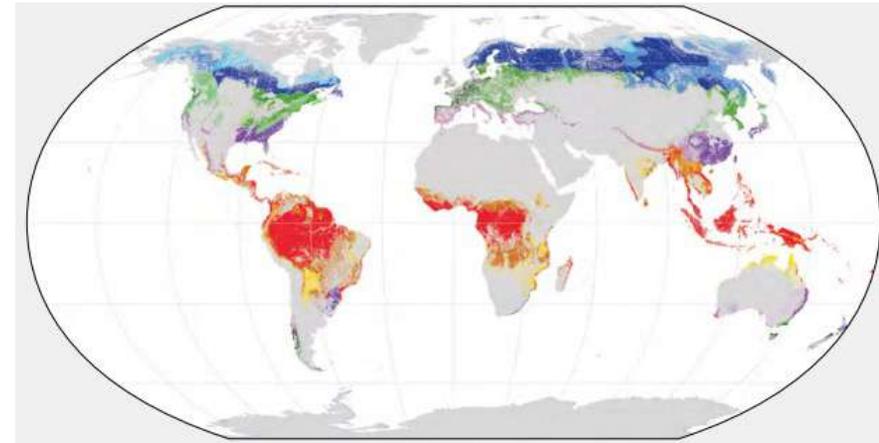


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- Definition on which systems should be used and how forest data should be monitored, reported, and verified [J. Lynch *et al*; Nature 496, 293 (2013)].
- The international system should not only provide reliable and open data on annual deforestation and forest degradation, but also implement an early warning mechanism, along the lines of the Brazilian systems PRODES and DETER.

<http://urlib.net/rep/8JMKD3MGP3W34R/443H3RE?ibiurl.backgroundlanguage=pt-BR>

- The system could be based mostly on medium resolution and large swath sensors, like those of Landsat 5, and AI data processing, but with reliable image calibration, expert validation, and high-capacity data storage.
- A modern constellation of equatorial orbit satellites with should be implemented to improve frequency.



The most effective way to implement this system seems to be through a dedicated international institution with delegation from the UN