Rainforest **reconnaissance**

Professor Oliver Phillips stresses the critical state of the world's tropical forests, and why constant, effective monitoring of their dynamics is more crucial than ever

Your current project is a five-year interdisciplinary programme that aims to construct a Pan-Tropical Observatory to explore forest response to global change. Why is an international 'observatory' of forest dynamics so important?

The most exceptional thing about tropical forest ecosystems is their biodiversity; however, they also have huge planetary influences through the water and carbon cycles. These forests are changing fast – one-fifth of the Amazon rainforest has been destroyed, while just one-fifth of tropical Asian forests remain. Rapid climate changes coincide with massive removal of vegetation, so we have no past analogue to guide us as to what to expect. We can only understand the true nature of tropical forest change by observing these ecosystems carefully and consistently from space and the ground. For space-based observations there are satellites, whilst for the latter we need a global ecological observatory.

At what stage is this project currently?

The Pan-Tropical Observatory is growing; with more than a hundred collaborators worldwide we now have almost 500 plots being monitored. We are also undertaking detailed measurements of soils, photosynthesis, litterfall and other key carbon cycle processes in dozens of nations across the world. The challenge of detecting and understanding change in the data grows with time as the climate shifts.

Could you recap the most significant findings of your research in the Amazon following the 2005 drought?

Almost the entire world's terrestrial carbon sink occurs in forests (sequestering some 2.5 billion tonnes each year – equivalent to the fossil fuel emissions of the US and Western Europe combined), and half of that is in the tropics. However, just as forests slow climate change by absorbing carbon dioxide, if the climate becomes less hospitable they release it. The potential impact of such a reversal was realised after the 2005 drought. Results at a local level weren't dramatic, but because the Amazon covers such a large area, small impacts scale up to tens of millions excess tree deaths – enough to release a billion tonnes of carbon. This confirms the risk of climate change to forests and vice versa.

Climate change and associated drought pose a great threat to forests. What changes do you expect to occur in forests during times of drought?

While tropical plants are benefiting from increased carbon dioxide, they are also being exposed to higher temperatures due to its role as a greenhouse gas, which may, over time, win out over the growth boost. The events of 2005 taught us that if climates move beyond thresholds optimal for tree growth, rather than stabilising the climate by taking up more carbon, forests can have destabilising effects – potentially releasing large amounts of carbon into the atmosphere. Tropical forests are tremendously complex, so we must take measurements in many places in order to identify the impacts of drought and warming.

The research you carried out in 2005 was facilitated by the Amazon Forest Inventory Network (RAINFOR), a project that you coordinate. How will you draw on this experience to support the establishment of the Pan-Tropical Observatory?

RAINFOR has been a powerful template for similar research networks developing in Africa and Asia. Together, these now contribute to the Pan-Tropical Observatory. The long-term success of the Observatory will depend on each of these continental networks remaining vibrant hubs of research and training in their own right. A big challenge with such geographically dispersed teams is maintaining consistency, communication and standards. Valuing people and helping them develop and learn as individuals is vital to sustaining a team's energy.

What is the potential for data consolidated by these networks to influence policy at an international level?

The discovery of a large carbon sink in the remaining tropical forests has major policy relevance because it strengthens the case for including the conservation of undisturbed forests in strategies to combat climate change. Beyond carbon, our data are being used in other forest management and policy contexts, such as helping foresters decide how fast timber trees can grow, and helping conservationists map patterns and priorities for biodiversity.

At a societal level, is there a take-home message from your research?

It is easy to forget just how much we depend on tropical forests. It is hard to imagine ourselves without coffee, chocolate, tea, bananas, palm oil, etc. And think how different our relationships, health and families would be if we lacked plant-derived rubber, diosgenin and progesterone – to name a few! While climate change mitigation is better appreciated today, it is just one of many vital ecosystem services provided by forests for free. We ignore them at our peril.

From the ground up

As rainforests shrink and greenhouse gas emissions continue to rise, the **Pan-Tropical Observatory** project promotes global teamwork in a multidisciplinary approach to monitor forest activity more closely

THE RISE OF anthropogenic greenhouse gas emissions over the last 150 years is a well-publicised phenomenon. But one factor limiting the damaging impact of atmospheric carbon dioxide is its large-scale absorption by plant life for photosynthesis, with much of this taking place in tropical rainforests. However, there have been concerns for many years regarding extensive deforestation of these regions, which is leading to the destruction of thousands of species' habitats and interference in the essential role plants play in removing carbon dioxide from the atmosphere.

Atmospheric changes and the unprecedented material demands of 7 billion people mean there is no longer any historical precedent to help us predict what will happen next. Professor Oliver Phillips, Project Coordinator of the Pan-Tropical Observatory and Chair of Tropical Ecology at the University of Leeds, outlines its significance: "We live at a unique point in the history of Earth – one species has now changed everything. All that we see, all that we eat, drink, and breathe, has a human signature". As such, effective monitoring of climate-related tropical rainforest dynamics and the resulting impacts on the environment is more crucial now than ever before.

ACUTE OBSERVATIONS

Climate change and tropical forest ecology are inextricably linked, and both are capable of having profound effects on each other. The Pan-Tropical Observatory aims to build a standardised global database of plant activity through monitoring of tropical rainforest areas, in order to improve understanding of the changing climate's impact on forests and vice versa. Phillips outlines the team's objectives: "Our long-term research goals are to explore the dynamics of carbon and biodiversity across the world's tropical forests, how these respond to the changing climate, and how they feed back on the whole planet".

The Observatory itself is not a physical facility, but rather a network of hundreds of plots of rainforest that are regularly monitored by connected centres across the world. Regular and effective ground-based monitoring of rainforest processes, in addition to remote monitoring from satellites, is essential to create a more detailed and accurate picture of rainforest activity. These observations also allow significant local changes in specific areas to be monitored, and for that data to be extrapolated over a much wider area to estimate the likely effect if these changes should occur on a larger scale. This was achieved to great effect using data from the Amazon drought of 2005, when the plots revealed that trees died in large numbers, becoming a source of CO_2 rather than a sink, releasing vast quantities of the gas into the atmosphere as a result of decomposition and reduced tree growth. Significant negative effects are inferred from this if severe droughts become more frequent and CO_2 release transpires on a larger scale.

WHAT NEXT?

Research undertaken by the Pan-Tropical Observatory has the potential to yield results of great global importance. Not only can the standardised data provide information and advice on deforestation and the impact of disturbance to forests, but it may have implications for international policy regarding climate, as Phillips elaborates: "Research by colleagues, including partners in the Amazon Forest Inventory Network (RAINFOR), shows that the forests most at risk from climate change are those that are already fragmented and degraded by direct human disturbance". As countries are increasingly concerned with limiting their carbon emissions and environmental impact, this information could influence more nations to take action to preserve rainforest areas.

The project hopes to heighten global awareness of just how profound human impacts can be – for the rainforests themselves, the wealth of biodiversity within them, and, by extension, for our planet as a whole. "Ultimately, our work is about helping make sure humans keep a close eye on changes in our planet's most treasured places," Phillips explains. "If we don't look, we won't see, and only by seeing can we hope to understand and preserve these benefits for generations to come." By bringing researchers from across the world to focus on a common goal, and committing to their aims of improving understanding and awareness of forest sensitivity to climate, the Pan-Tropical Observatory may play a key part in this preservation.


TREE SURVEY, GUYANA

INTELLIGENCE

CREATING A TROPICAL FOREST OBSERVATORY FOR THE GLOBAL CHANGE CENTURY

OBJECTIVES

To build standardised monitoring on-the-ground of the world's tropical forests to improve understanding of the changing climate's impact on forests and vice versa.

PARTNERS

Partnership is key to this work. The Observatory is 'a network of networks'. The pioneering Amazon network of forest monitoring RAINFOR has been joined by newer initiatives in Africa, (the African Tropical Rainforest Observation Network – AfriTRON), in Asia, and by making much more detailed carbon cycle measurements at a smaller number of sites (the GEM network). These are being led by partners in the Pan-Tropical Observatory, Dr Simon Lewis (University of Leeds), Dr Lan Qie (Leeds and CIFOR) and Professor Yadvinder Malhi (University of Oxford), with collaborators worldwide.

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PROFESSOR OLIVER PHILLIPS was educated at the University of Cambridge, UK, and Missouri Botanical Garden, USA. His research centres on the floristics, ecology, and human use of tropical forests, which are undergoing unprecedented change. In particular he has, along with colleagues worldwide, pioneered the application of geographically-distributed networks to revealing their biodiversity and long-term dynamics.