

# Scientists reveal huge new areas of threatened fog-generated ecosystems in Peru and Chile

- New scientific paper uses 20 years of satellite imagery and cloud computing technology to see through fog and cloud layers, mapping this desert ecosystems in Latin America in detail for first time
- Data will help government authorities to manage and protect the fog oasis as biodiversity and ecosystems resources vulnerable to threats from climate change and development

In a new paper, published today in the International Journal of Applied Earth Observations and Geoinformation, scientists used over twenty years of satellite imagery, supported by two decades of fieldwork verification on the ground, to reveal the true extent of the desert fog oasis ecosystem running along the coast of Peru and Chile.

Their results show that fog oases are much more extensive than previously believed, rich in endemic plants found nowhere else. These findings highlight how ecosystem loss is greatly exacerbated by a lack of distribution knowledge and the interrelated lack of protection.

Peru and Chile's fog oasis ecosystems, known as the 'Lomas' or 'fog oasis' locally, appear like 'islands' of vegetation along the 3000km hyper-arid desert coast of the two countries. Entirely dependent on sea-generated fog for their moisture, this ecosystem is packed with unique and useful native plants which provide a wealth of vital ecosystem services.

Until recently however, they had been poorly recorded and recognised by satellite data, due to their ephemeral nature and almost blanket fog cover when they are most productive. Outside the larger urban areas such as Peru's capital Lima, this has prevented their discovery and conservation, whilst a lack of long-term funding for research has inhibited protection.

To address this, a team of scientists from the UK, Peru and Chile, used hundreds of MODIS satellite images to penetrate two decades of fog seasons, and like an X-Ray, reveal hidden layers pulsing with life across the desert landscape.

This plant productivity mapping, combined with on-the-ground surveys, meant scientists could build up a picture of where the fog oases occur and how they are affected by climate and landscape. The technology and repeated fieldwork allowed the researchers to discover and map over four times more fog oases than previously recorded, with a productive area of over 17,000 km<sup>2</sup> (10 times the size of London), revealing extensive little-known plant and animal habitats, many with few or no scientific records.

Justin Moat, scientist at the Royal Botanic Gardens, Kew and lead author of

the paper says:

Clearly fog-driven ecosystems are truly amazing, globally very rare, and must be conserved at all costs. What many don't realise is that over 58% of Peru's population live alongside (or within) this unique ecosystem, so they are vital for water, clean air, culture and human wellbeing.

The ecosystem also houses many endemic species including wild tomatoes, medicinal plants, and animals such as populations of Andean Condor, foxes, lizards and wild llama (guanaco).

However, these endemic-rich fog oases, means the ecosystem is intrinsically linked to coastal climatic factors and ocean currents which makes them extremely sensitive to natural and human induced climate change.

Oliver Whaley, a scientist at RBG Kew who has worked in Peru for 25 years, says:

As many fog oases are not mapped and at times only flourish for a single season every few years, they are subject to a host of threats including urbanisation, mining, invasive plants, overgrazing and off road vehicles. We see this both on the ground and from satellites, even after many years Dakar rally tracks are still visible in this fragile ecosystem.

The global community must support Peru and Chile governments and local researchers to protect fog-oases now, before it is too late, and millions of years of evolutionary history and natural capital is lost – incredibly only 4% of fog oases are protected.

Peter Clements, Deputy Head of Mission and General Consulate, Lima Peru, says:

These are indeed remarkable findings. This study brings out the importance of Lomas for water, biodiversity and environmental balance. This is a great example of scientific collaboration between the Royal Botanic Gardens, Kew, one of the UK's leading organisations on biodiversity and conservation, and Peruvian researchers.

The study represents a first step towards protecting this vital ecosystem. The British Embassy in Lima will continue supporting Peru's efforts towards mitigation and adaptation to climate change, including the initiative to create its first national botanic garden.

## **What now? The fight to protect the fog islands teeming with biodiversity**

In the paper, the scientists aimed to summarise all knowledge of biodiversity, threats and protection of this unique ecosystem, so that when combined with a detailed map it can provide new data to help protect the fog oases and increase understanding of how they function.

The researchers are working to establish a protected continental coastal network to allow fog oases to be permanently protected, monitored and restored. It is hoped this ecological biome network can be used to gauge ENSO and climate change, using ecosystem and species fluctuation indicators it may be possible to predict precipitation and maritime climate intensity, for example.

This new data-driven mapping of fog oases will help researchers work with Peruvian and Chilean government agencies, to better locate permanent and ephemeral habitats using online maps. Presently with the leverage of a grant from The National Geographic Society, the team is working with the Peruvian government to establish protected areas and a concession for conservation. Already using the combination of drone mapping, historical satellite analysis, and detailed groundwork of the team, has helped provide delimitation for Reserva Nacional San Fernando critical plant habitats. The area is already seeing a slight recovery of a highly endangered Guanaco population, providing reasons for hope.

Alfonso Orellana-Garcia, scientist and ecosystem management specialist at Peru's National University of San Marcos and co-author of the paper says:

We hope this new data will help Peruvian and Chilean government officials give the Lomas a special and effective protected status, something myself and our partners in Chile and the UK have been fighting for in wide inclusive community collaboration for over two decades.

Likewise, this research is very important to help provide data to support technical and scientific efforts with environmental authorities (GORE ICA) and institutions in environmental, forestry and wildlife including MINAM, SERFOR, SERNANP, INIA; among other entities, who make critical decisions to protect our biodiversity and ecosystems locally and nationally.

Carolina Tovar, a Peruvian ecologist working at RBG Kew and author of the paper says:

Working with our Peruvian colleagues we are very close to having a very fragile and most unique fog oases protected after years of work, providing the evidence of its value to nature and people. As we lead up to the critical COP26 discussions this year,

highlighting the importance of preserving and understanding the biodiversity around us couldn't be more crucial.

Nature is a valuable and often underappreciated resource; we know that plants and fungi offer many solutions to the challenges we face. Saving areas such as the fog oasis of Peru and Chile, full of untapped and unknown species and ecosystem resources, would be one step in the right direction.

## **Full list of institutions involved in this research**

Royal Botanic Gardens, Kew, UK; Universidad Nacional Mayor de San Marcos, Museo de Historia, Natural and Facultad de Ciencias Biológicas, Lima, Peru; Huarango Nature, Lima, Peru; Biota Gestión y Consultorías Ambientales Ltda, Chile; Royal Botanic Garden Edinburgh, Edinburgh, UK; Centro del Desierto de Atacama, Pontificia Universidad Católica de Chile, Santiago, Chile; Universidad Continental, Cusco, Peru; Proyecto para la conservación, gestión y rehabilitación de los ecosistemas frágiles de lomas en Lima (EbA Lomas) SERNANP – PNUD, Lima Peru; Rainforest Concern, Bath, UK; Fundación Chilco, Santiago, Chile.

## **About the Royal Botanic Gardens, Kew**

The Royal Botanic Gardens, Kew is a world-famous scientific organisation, internationally respected for its outstanding collections as well as its scientific expertise in plant and fungal diversity, conservation and sustainable development in the UK and around the world. Kew Gardens is a major international and a top London visitor attraction. Kew Gardens' 132 hectares of landscaped gardens, and Wakehurst, Kew's wild botanic garden in Sussex, attract over 2.5 million visits every year. Kew Gardens was made a UNESCO World Heritage Site in July 2003 and celebrated its 260th anniversary in 2019. Wakehurst is home to Kew's Millennium Seed Bank, the largest wild plant seed bank in the world, as well as over 500 acres of designed landscapes, wild woodlands, ornamental gardens and a nature reserve. The Kew Madagascar Conservation Centre is Kew's third research centre and only overseas office. RBG Kew receives approximately one third of its funding from Government through the Department for the Environment, Food and Rural Affairs (Defra) and research councils. Further funding needed to support RBG Kew's vital work comes from donors, membership and commercial activity including ticket sales.