

# Mapping a greener future

By combining rocket science with muddy boots science, Gabon is to produce its most detailed carbon map yet. The work, the result of a collaboration with a NASA scientist and a team of international experts, will help the country manage its carbon emissions

Members of Gabon's carbon mapping team: NASA's Dr Sassan Saatchi (far right); Yadvinder Malhi (centre), Professor of Ecosystem Science, University of Oxford, Environmental Change Institute, and Professor Lee White (far left), the head of Gabon's National Parks Agency, in the Mondah Forest

**D**EEP IN the Mondah Forest, a group of people are admiring different species of trees. They stop to smell the intoxicating resin from an Okoumé tree and reach to measure its thick buttresses. But this is no idle observation; there is benchmark research going on here in northwest Gabon.

Heading up the team of researchers is Dr Sassan Saatchi, an eminent NASA (National Aeronautics and Space Administration) scientist. He is in Gabon to help develop a map showing how much carbon is stocked in its forests so that the knowledge can be used in how to develop land in the future.

His work is part of an ambitious programme involving national and international research institutions. He is working in close collaboration with Professor Lee White, head of Gabon's National Parks Agency (ANPN) who is the co-ordinator of forest carbon and climate change science for Gabon's inter-ministerial government panel on climate change, and a team of international scientists from the Oxford and Leeds universities in the United Kingdom and Duke University in the United States, among others.

Many people are aware of global campaigns

to stop deforestation and preserve our beautiful tropical forests but there is a hard scientific objective behind them. Deforestation releases carbon held or 'stocked' in trees to the atmosphere, adding to the potentially catastrophic problem of global warming.

## Forest protection

Around 75 per cent of Gabon (some 22 million hectares) is lush forest, part of which lies in the Congo Basin, the largest contiguous block of tropical rainforest after the Amazon. These forests are called 'carbon sinks' due to their immense natural capacity to use photosynthesis to produce and store more carbon than they release. The Congo Basin is estimated to hold an almost unimaginable 50 billion tonnes of carbon in its forest alone, according to a recent published study by Dr Saatchi and his colleagues.

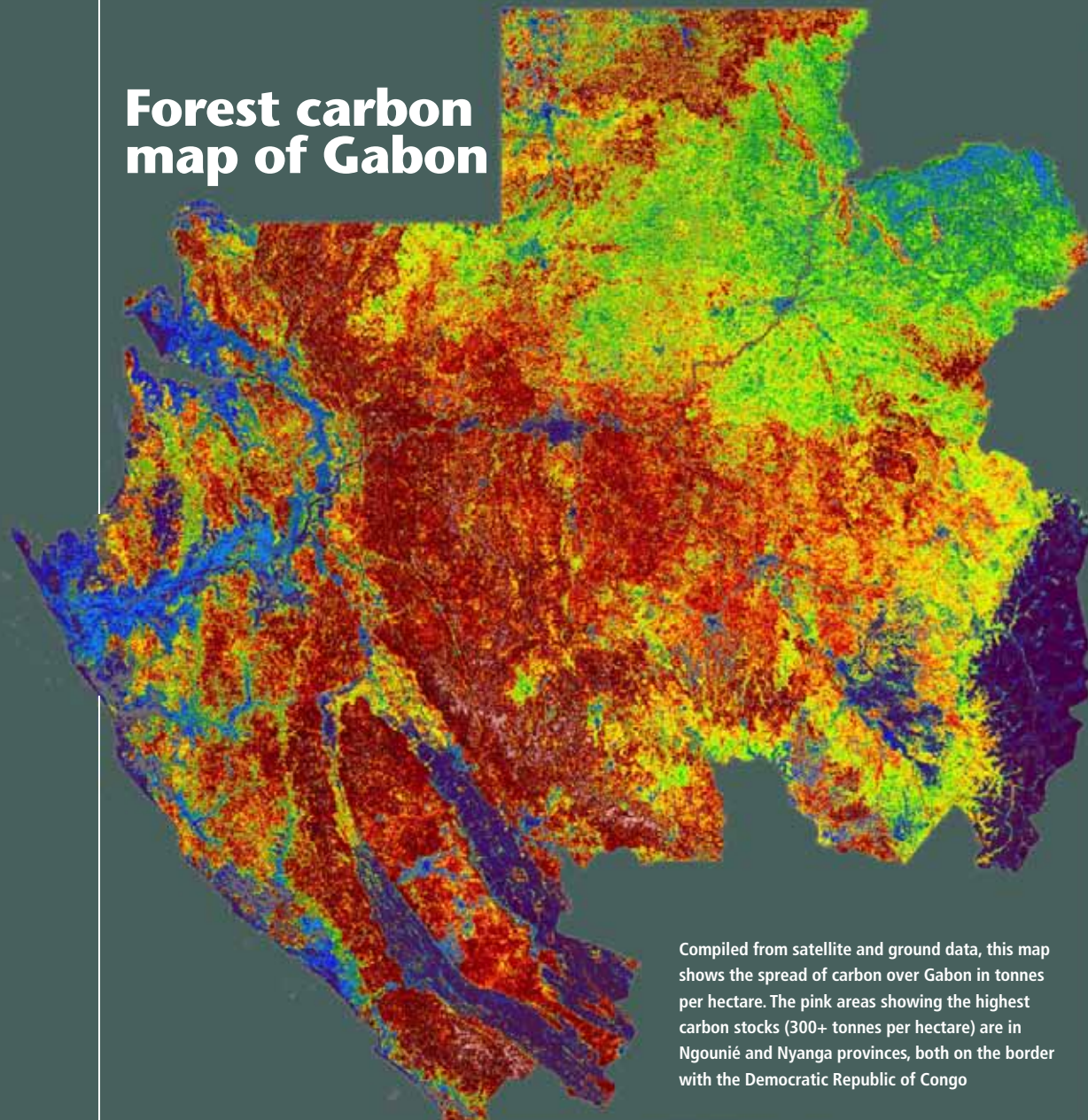
Unlike developed countries, which have felled most of their forests, Central African countries still have the opportunity to reduce CO<sub>2</sub> emissions by using their forests wisely. Gabon's creation of its national parks system in 2002 locked up some 375 million tonnes of standing carbon.

The country's Forestry Code also obliges permit holders to undertake sustainable forestry and maintain the 1.25 million →



Okoumé trees are prevalent in Gabon. Trees with more than one trunk are difficult to measure for carbon but satellite technology can help give a more accurate carbon reading

## Forest carbon map of Gabon



Compiled from satellite and ground data, this map shows the spread of carbon over Gabon in tonnes per hectare. The pink areas showing the highest carbon stocks (300+ tonnes per hectare) are in Ngounié and Nyanga provinces, both on the border with the Democratic Republic of Congo

## “GABON WILL BE ONE OF THE FIRST COUNTRIES IN THE WORLD TO USE SUCH A COMPLETE PICTURE OF INFORMATION”

tonnes of standing carbon (4.5 billion tonnes of CO<sub>2</sub>). President Ali Bongo Ondimba is continuing this effort with his vision for ‘Green Gabon’ to protect biodiversity and the development of a national climate change plan which will be unveiled at the UN Climate Change Conference in Durban in December.

### Mapping carbon

One of the newest tools in the fight against climate change is carbon mapping, a sophisticated technique that identifies and monitors hotspots with the aim of stopping these areas from being felled. Dr Saatchi, who is based at the NASA/Jet Propulsion Laboratory in California, is a pioneer

of carbon maps. In June he published the world’s first global map, which shows estimated carbon stocks of 247 gigatonnes for 75 tropical countries in Africa, Asia and Latin America. “This map will assist developing country governments, land managers, policymakers and civil society to become more informed about the likely result of their policies and programmes in reducing national greenhouse gas emissions from the land-use sector,” wrote Dr Saatchi and his team in the *Proceedings of the National Academy of Sciences* journal which published the map.

So how exactly do you calculate carbon stocks? “The most accurate way ... is to uproot a tree and then weigh it,” says Dr

Saatchi, “but we can’t do that.” Instead, scientists estimate the carbon in the trees above ground and calculate the carbon in roots below ground and add them up to get the tree’s ‘carbon number’. Soil carbon and leaves can be measured by taking samples. For the tree itself, scientists multiply its measured height by its diameter. Generally, the chunkier and taller a tree is, the more carbon there is. What has been difficult in the past is getting the height measurement of a tree.

But satellites are now so advanced that they can pinpoint trees from space and measure the height as well as the crown size (or leafiness). To put together the 2011 global carbon map, Dr Saatchi and his team of scientists used data from the Geoscience Laser Altimeter System (GLAS) on board NASA’s ICESat (Ice, Cloud and land Elevation Satellite). These findings were then calibrated with ground findings and mapped to give not only an overall estimate of carbon stocks per hectare of land examined, but, importantly, the



Above: Perhaps Gabon’s most exciting and ambitious climate change project to date is the launch of Central Africa’s first satellite-image reception station near Nkok, Libreville. This Earth-observation project – SEAS-Gabon (Surveillance Environnementale Assistée par Satellite) – is expected to play a crucial role in tropical forest protection across the region. This image: A view of Lopé National Park, a World Heritage Site which is ‘of international importance for monitoring of carbon stock’ due to the 25-year scientific study conducted by Professors White and Saatchi and their colleagues



## NASA scientist Dr Sassan Saatchi

DR SASSAN SAATCHI is a senior scientist with the NASA/Jet Propulsion Laboratory at Caltech in California, a post held since 1991. He also works with the Centre for Tropical Research of the University of California. Originally from Iran, Dr Saatchi studied in the US, gaining a PhD in Electrophysics in Washington.

His projects take him to the four corners of the globe to work on developing remote sensing techniques and understanding impacts of climate change on forests. He is an active science team member on NASA’s programme to build the next generation of satellites for mapping forest carbon from space. He is a member of the North American Carbon Programme and, thanks to his specialist knowledge in forest structure and ecosystems, led a team during the Large-Scale Biosphere Atmosphere experiment in Amazonia, to produce the first carbon map of the Amazon using satellite technology in 2007.

He went on to publish an acclaimed global carbon map in 2011, covering 75 tropical countries. Now he is lending his expertise to lead research in the tropics of Central Africa and assisting Gabon in its use and protection of carbon stocks. Dr Saatchi has produced more than 100 publications (including two in collaboration with Professor Lee White, head of Gabon’s National Parks Agency) and more than 500 conference and lecture papers.

accuracy of that estimate too. The Mondah Forest has an average of 200-250 tonnes of carbon per hectare, attributable to the fact that it is several hundred years old and has a prevalence of Okoumé trees that grow quickly and accumulate carbon rapidly.

### Theory into practice

Now Gabon is taking figures from the global map to create its own detailed map which can then be factored into a proposal by a developer wanting to build on the outskirts of Libreville. The developer, the government and even environmentalists can consult the map to consider what will be the best way to preserve land densely stocked with carbon.

“What we are trying to do here,” says Dr Saatchi, “is to better quantify what resources the Gabonese have in terms of carbon, what are the areas that are important to preserve and what is the impact of climate change in these areas.” Scientists recognise that development must happen, says Dr Saatchi:

“But the question is always how to make it balance, to make it sustainable and have less impact on the forest.”

The idea is to provide a range of information about Gabon’s ecosystems, such as habitat structure and biodiversity, maps of wetlands and geomorphology. Gabon will be one of the first countries to use such a complete picture of information. “Environmental knowledge is getting mixed with economic development: this is the new frontier – a pioneering approach,” he adds.

### Future plans

To refine the global map data, scientists in Gabon are to collaborate with logging companies to obtain more precise measurements from felled trees. They will also be using aircraft provided by Olam International – the Singaporean group developing the Special Economic Zone at Nkok near Libreville – to observe the forests with much higher resolution remote sensors than before.

At Nkok there are plans to next year build a satellite imaging station with a 2,600-km observation range as part of the newly formed Gabonese Space Agency (AGEOS, Agence gabonaise d’études et d’observation spatiale). The station would be able to interpret data from space directly and add it to Gabon’s carbon map.

“Our science is helping to demonstrate how economic development and forest preservation can be optimally balanced, ensuring that the most carbon-rich forests are assigned their appropriate importance in Gabon’s national development and land use strategies,” says Professor White.

“Through this collaboration with Dr Saatchi and NASA and the creation of the SEAS (Surveillance Environnementale Assistée par Satellite) base station, Gabon is demonstrating leadership and forging a new model for north-south collaboration.” ■

Vaila Finch