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The *Polarstern* research vessel will carry about 300 scientists on its 12-month mission.

is to improve strikingly uncertain climate projections for the rapidly warming Arctic, and study the effects of climate change on the region's ocean chemistry and ecosystems.

The Arctic is heating up faster than any other region on Earth. Positive feedback loops, in particular the loss of snow and ice that help to reflect sunlight, have amplified climate change in the region, which has already warmed by 2 °C over the past century.

UNCERTAIN CHANGE

Climate models disagree wildly on how much more the Arctic will heat up as the concentration of greenhouse gases in the atmosphere rises and sea ice dwindles. Some models project that the Arctic could warm by about 5 °C by 2100, relative to the 1986–2005 average, under a high greenhouse-gas-emissions scenario. Others suggest that high northern latitudes might warm by more than 10 °C. The region has already changed dramatically: the extent of sea ice in summer has halved since the 1970s, and the ocean around Norway's Svalbard archipelago has been largely ice-free even in winter in some recent years. Winter air temperatures there have been more than 7 °C higher than normal in the past few decades.

"The Arctic has changed very much since the days when Nansen was here," says Rex. "If climate change proceeds unabated, it will turn into a completely different environment."

Scientists worldwide are eagerly awaiting the wealth of data that the MOSAiC team hopes to collect. "This is a truly wonderful opportunity for the entire climate and polar-research community," says Jens Hesselbjerg Christensen, a climate scientist at the University of Copenhagen.

Among the data will be continuous measurements of the heat exchanged between the atmosphere and the Arctic surface over the four seasons. This information will help scientists to understand why the region is warming at least twice as fast as the rest of the globe, says Mark Serreze, director of the National Snow and Ice Data Center at the University of Colorado Boulder. Current climate models don't seem to correctly capture energy fluxes and sea-ice change in the Arctic, he says. The models are also poor at representing changes in cloud cover and cloud properties, which have a substantial effect on the Arctic climate, he notes. "We don't know nearly enough about clouds; we just haven't got the data. MOSAiC will hopefully provide just that."

A number of Serreze's colleagues from the University of Colorado will be on *Polarstern*, along with scientists from countries including China, Russia and Japan. Participants will each spend about ten weeks on the ship. Scientists, food and supplies will be ferried to and from the vessel by one of four icebreakers. Life and work under extreme Arctic conditions is a special experience, physically and emotionally, says Rex, who plans to spend ten months on board.

"This will be a tremendous experience — slightly nerve-racking but monstrously beautiful," says Elise Droste, a PhD student at the University of East Anglia in Norwich, UK, who studies how sea ice affects carbon uptake by the ocean. ■

DESERTS

China's tree-planting could falter in a warming world

Researchers warn that the push to hold back deserts could strain water resources.

BY MARK ZASTROW

China has planted billions of trees over the past four decades as part of its fight against expanding deserts, mostly in its north. Each year, the country sows seedlings over an area nearly the size of Ireland. It is even sharing its desert-control methods with others as part of its Belt and Road trade initiative.

The trees have held back China's deserts. But some scientists worry that the planting could exacerbate water scarcity. Many of the trees are not native to the regions where they have been planted, and they use a lot of water — and are being placed in areas that are experiencing reduced rainfall owing to global warming.

"The idea is nice, but it's kind of foolish to plant trees in a desert," says Troy Sternberg, a geographer at the University of Oxford, UK.

Chinese scientists say there are good reasons to plant vegetation in barren areas, but that the programme needs to take into account local conditions. They say local and national governments are already planting more shrubs, herbs and other native vegetation that needs less water.

The Gobi Desert and similarly arid regions are expanding as processes such as overgrazing deplete vegetation on their borders, letting wind and gravity erode soil. China's largest tree-planting drive, the Three-North Shelter Forest Program, also called the Great Green Wall, is designed to halt that encroachment. The government says it has planted more than 66 billion

MAAYAN HAREL

trees across 13 provinces in the country's north since the programme began in 1978.

Around 2000, deserts across the country were expanding by 10,400 square kilometres a year, says the government. But in 2017, it reported that China's deserts were shrinking by more than 2,400 square kilometres a year.

A 2018 study[1] of satellite data from the US National Oceanic and Atmospheric Administration found that forest cover has increased in line with government statistics, but suggested that changes in logging policy were more important than afforestation — planting forests where none were before.

In 1999, the Chinese government began planting millions of trees in its Grain for Green Program, intended to repair damaged farmland in the northern Loess Plateau, which is roughly the size of France.

And the afforestation drive is continuing apace: in 2018, the government announced a target of 30% forest coverage by 2050. At the moment, the coverage is around 22%.

It's still too early to determine whether it has solved the problem, says Congbin Fu, director of the Institute for Climate and Global Change Research at Nanjing University. Land restoration can take several decades or even 100 years, he says.

There are pitfalls to mass tree-planting. Large parts of China — including some areas where trees are being planted — are getting drier. A paper[2] co-authored by Sternberg found that arid areas in China had increased by roughly 1.6 million square kilometres, about the size of Iran, since 1980 — probably due largely to anthropogenic climate change.

Many of the plants introduced to the Loess Plateau use more water than native vegetation. A 2016 study[3] found that the revitalized ecosystem is already sucking up rainfall and reducing the amount of water that runs off to rivers; a drier climate could exacerbate the situation and trigger water shortages for humans. A modelling study[4] co-authored by Fu and published last month reached similar conclusions, and cautioned against continuing the Grain for Green Program.

Considering water shortages is important, says Shixiong Cao, an ecologist at Beijing Forestry University. He thinks the national forestry department has recognized the error of planting trees in arid areas, and that in recent years, it has moved towards planting shrubs with lower water requirements.

The head of the forestry department, Zhang Jianlong, told state media in March that efforts should go to keep vegetation healthy, rather than simply planting trees. ■

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An artist's impression of a young female Denisovan, based on skeletal traits derived from ancient DNA.

ANCIENT HUMANS

Denisovan portrait drawn from DNA

Reconstruction based on epigenetics reveals broad, Neanderthal-like facial features.

BY EWEN CALLAWAY

For the first time, scientists analysing the DNA of Denisovans — an extinct group of ancient humans that was discovered around a decade ago — have offered a glimpse of what they might have looked like.

Ever since archaeologists uncovered the first fragmented Denisovan remains in a Siberian cave, researchers have scoured the globe for clues to how the mysterious hominins looked. Denisova Cave has yielded a few more small fossils, and a jawbone from the Tibetan Plateau added detail this year. But none of these fossils is large or complete enough to reconstruct many anatomical details.

Now, computational biologists have produced a rough sketch of Denisovan anatomy based on epigenetic changes — chemical modifications to DNA that can alter gene activity. Their approach reveals that Denisovans were similar in appearance to Neanderthals but had some subtle differences, such as a wider jaw and skull (D. Gokhman *et al. Cell* http://doi.org/dbqk; 2019).

"It does help to paint a clearer picture of how they might have looked. Just the idea that it's possible to use the DNA to predict morphology so well is very impressive," says Bence Viola, a palaeoanthropologist at the University of Toronto in Canada who has analysed Denisovan remains, but was not involved in this research.

MAPPING METHYLATION

Epigenetic modifications to DNA have a profound influence on most biological traits throughout life. They can help to determine differences between cells with otherwise identical genomes. One of the best-studied epigenetic changes is the addition to a DNA base of a methyl chemical group — made up of one carbon atom and three hydrogens — which often quells the activity of a gene.

A team co-led by Liran Carmel, a computational biologist at the Hebrew University of Jerusalem, discovered a way to identify parts of ancient DNA that had once been ▶