

Changing climate imperils global food and water supplies, new U.N. study finds

Agriculture and other land use accounts for 23 percent of human-caused greenhouse gas emissions.



Areas of forest that have been cleared for oil palm plantations in Aceh, Indonesia. (Hotli Simanjuntak/EPA-EFE/REX/Shutterstock)

By [Brady Dennis](#)

August 8

The world cannot avoid the worst impacts of climate change without making serious changes to the ways humans grow food, raise livestock and manage forests, according to a landmark study Thursday from an international group of scientists.

The sprawling [report](#) from the U.N. Intergovernmental Panel on Climate Change (IPCC) examines how land use around the world contributes to the warming of Earth's atmosphere. But the report also details how climate change is already threatening food and water supplies for humans: turning arable land to desert; degrading soil; and increasing the threat of droughts, floods and other extreme weather that can wreak havoc on crops.

It makes clear that although fossil fuel-burning power plants and automobile tailpipes are the largest drivers of climate change, activities such as agriculture and forestry account for an estimated 23 percent of total human-caused greenhouse gas emissions.

"We already knew that humanity's over-exploitation of the Earth's lands is a key driver of climate

change, and that we need to take urgent, ambitious action to address these issues,” Jennifer Tabola, director for global climate strategy at the Nature Conservancy, said in a statement. “We have a choice: do we balance the needs of human development and nature, or do we sleepwalk into a future of failing farmlands, eroding soil, collapsing ecosystems and dwindling food resources?”

Four years ago in Paris, world leaders [agreed to take aggressive action](#) to keep global warming to “well below” 2 degree Celsius, compared with preindustrial levels. Their aspiration was to limit warming to no more than 1.5 degrees Celsius (the world has already warmed 1 degree).

But Thursday’s report, which includes the work of 107 experts from 52 countries, underscores that meeting those goals will require fundamental changes not only to the transportation and energy sectors, but also by cutting emissions from agriculture and deforestation — all while feeding growing populations.

Last fall, IPCC scientists found that nations will need to take “unprecedented” actions to cut their carbon emissions over the next decade to avoid devastating effects from rising seas, more intense storms and other impacts of climate change.

[The world has just over a decade to get climate change under control, U.N. scientists say]

They also detailed how such a radical transformation would require large swaths of land currently used to produce food to instead be converted to growing trees that store carbon and crops designated for energy use.

“Such large transitions pose profound challenges for sustainable management of the various demands on land for human settlements, food, livestock feed, fibre, bioenergy, carbon storage, biodiversity and other ecosystem services,” the authors wrote at the time.

A significant amount of agricultural emissions [comes from livestock](#) — primarily from the belches of cattle. Additionally, while all soils emit some nitrous oxide, soil on farms often emits higher levels because of nitrogen that is added in the form of manure, fertilizers or other material. Meanwhile, deforestation in places such as [the Amazon and Indonesia](#) has harmed the ability of forests to retain carbon dioxide from the atmosphere.

But solving those problems is complicated.

While sharply reducing the number of livestock could have significant impacts by cutting emissions by billions of tons, that would require large-scale changes to what people eat.

“After decades of overconsumption, our society needs to shift toward healthy, ecological, plant-based farming,” Reyes Tirado, a senior research scientist at the Greenpeace Research Laboratories, based at the University of Exeter, said in a statement about the report. “This won’t be easy, but it is critical if we’re to reverse the devastation our current food system is having on ecosystems and communities around the world.”

Meanwhile, planting massive new forests, an approach known as afforestation, could help remove meaningful amounts of carbon dioxide from the atmosphere each year. But doing that on a massive scale could sharply increase food prices and put millions of people at risk of undernourishment, said Pamela

McElwee, an associate professor of human ecology at Rutgers and a lead author of the report.

“So that’s a very serious trade-off,” McElwee told reporters Wednesday. “One of our arguments is: Let’s understand those trade-offs now and think about them, but also think about things that maybe would help us avoid those trade offs.”

If there is a silver lining in such a daunting challenge, it is the fact that forests and farms play a key role as “carbon sinks” that remove greenhouse gases from the atmosphere, but that benefit will continue only if humans use land in sustainable ways.

Cattle in a dry paddock in the drought-hit area of Quirindi in New South Wales on Aug. 7, 2018. (Glenn Nicholls/AFP/Getty Images)

“As we’ve continued to pour more and more carbon dioxide in the atmosphere, the earth’s system has responded, and it’s continued to absorb more and more,” Louis Verchot, of the International Center for Tropical Agriculture and a lead author on the report, told reporters in a call Wednesday. “But the important finding of this report, I think, is that this additional gift from nature is limited. It’s not going to continue forever.”

Left unchecked, climate change could imperil food security in parts of the world, putting further strain on a food system that’s already stressed, Thursday’s report found. Crop yields could shrink. Foods such as wheat could become less nutritious. Damage from thawing permafrost could endanger infrastructure. Water scarcity could become an urgent problem in dry areas.

“Today’s report is a clarion call for the need for us to manage land better for people, nature and the climate,” Katherine Kramer, global climate lead for the London-based charity Christian Aid, said in a statement.

“There are many opportunities to create win-wins in the ways we use the land, but it’s vital we implement these quickly to avoid having to make bleak choices between feeding people and reducing emissions.”

Chris Mooney contributed to this report.

Climate crisis reducing land's ability to sustain humanity, says IPCC

UN report finds ecosystems never before under such threat and restoration is urgent

How climate's impact on land threatens civilisation – and how to fix it

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Deforestation in Brazil's Para state. Stripping land wholesale, for uses such as cattle farms and coffee plantations, can affect the climate which then affects the health of the land. Photograph: Andre Penner/AP

The climate crisis is damaging the ability of the land to sustain humanity, with cascading risks becoming increasingly severe as global temperatures rise, according to a landmark UN report compiled by some of the world's top scientists.

Global heating is increasing droughts, soil erosion and wildfires while diminishing crop yields in the tropics and thawing permafrost near the poles, says the report by the Intergovernmental Panel on Climate Change.

Further heating will lead to unprecedented climate conditions at lower latitudes, with potential growth in hunger, migration and conflict and increased damage to the great northern forests.

The **report**, approved by the world's governments, makes clear that humanity faces a stark choice between a vicious or virtuous circle. Continued destruction of forests and huge emissions from cattle and other intensive farming practices will intensify the climate crisis, making the impacts on land still worse.



Cattle ranch in drought-hit California, US. Intensive farming is a heavy user of water and big cause of greenhouse gas emissions.
Photograph: Lucy Nicholson/Reuters

However, action now to allow soils and forests to regenerate and store carbon, and to cut meat consumption by people and food waste, could play a big role in tackling the climate crisis, the report says.

Such moves would also improve human health, reduce poverty and tackle the huge losses of wildlife across the globe, the IPCC says.

Burning of fossil fuels should end as well to avoid “irreversible loss in land ecosystem services required for food, health and habitable settlements”, the report says.

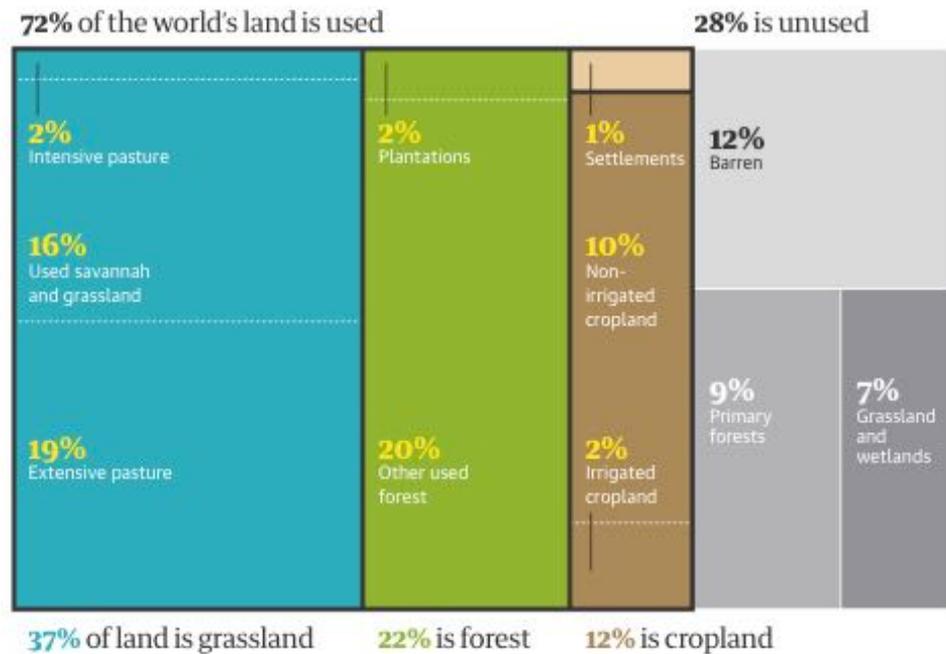
“This is a perfect storm,” said Dave Reay, a professor at the University of Edinburgh who was an expert reviewer for the IPCC report. “Limited land, an expanding human population, and all wrapped in a suffocating blanket of climate emergency. Earth has never felt smaller, its natural ecosystems never under such direct threat.”

Piers Forster, a professor at the University of Leeds, said: “This important report shows we need to substantially change the way we use our land to limit temperature change below 1.5C. In a nutshell we need less pasture [for livestock] and more trees.” The land-use advice was contained in [an IPCC report in October](#).

Prof Jim Skea, from the IPCC, said the land was already struggling and climate change was adding to its burdens. Almost three-quarters of ice-free land was now directly affected by human activity, the report says.

Poor land use is also behind almost a quarter of the planet’s greenhouse gas emissions – the destruction of forests, huge cattle herds and overuse of chemical fertilisers being key factors.

Most of the planet's land is used by humans



Guardian graphic. Source: IPCC. Note: percentage of ice-free land shown

Emissions relating to fertilisers have risen ninefold since the early 1960s. Rising temperatures are causing deserts to spread, particularly in Asia and Africa, and the Americas and Mediterranean are at risk, the report says.

One of the most stark conclusions in the IPCC report is that soil, upon which humanity is entirely dependent, is being lost more than 100 times faster than it is being formed in ploughed areas; and lost 10 to 20 times faster even on fields that are not tilled.

The report recommends strong action from governments and business, including ending deforestation and enabling new forests to grow, reforming farming subsidies, supporting small farmers and breeding more resilient crops. Many of those solutions, however, would take decades to have an impact, the IPCC says.



Saplings being planted in Inner Mongolia this year to control desertification as temperatures rise. Photograph: Xinhua/Barcroft Images

Consumers in rich nations could act immediately by reducing their consumption of intensively produced meat and dairy foods – products that have a **huge environmental impact**.

“There is much more we could do in that space that we are not doing, partly because it is difficult,” said Pete Smith, a professor at the University of Aberdeen and a senior IPCC author. “You wouldn’t want to tell people what to eat, that would go down badly. But you could incentivise.”

The IPCC report suggests “factoring environmental costs into food”. Previous studies have suggested **meat taxes**, or subsidised fruit and vegetables. Meat production ties up most farmland and cutting consumption could release millions of square kilometres for forestry or bioenergy crops, the report says, as could cutting food waste.

Caterina Brandmayr, of the Green Alliance thinktank, said: “The key message from the IPCC is urgency: we need to act now to plant new forests, restore our ecosystems, and, yes, to eat less meat.”

David Viner, a professor at the University of East Anglia and a senior IPCC author, said: “Land is a vital resource and we have to look after it if we are going to have a sustainable future.”



How climate’s impact on land threatens civilisation – and how to fix it

“What the IPCC highlights is that we urgently need a revolution in the way we currently utilise land,” said Anna Krzywoszynska, of the University of Sheffield. “Food systems today are built not on soil but on the oil needed for chemicals and machinery.”

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Clare Oxborrow, of Friends of the Earth, said: “The way land is being used and abused is rebounding on us. The scientific evidence is clear: political leaders must transform the way land and resources are used, otherwise life on Earth just won’t be possible.”

Land is heating up faster than the oceans: the average surface temperature is now 1.5C higher than in the late 19th century. This is already affecting food security, the IPCC report says, as heat, drought and changes in rainfall damage crops.

Prof Pete Smith, of the University of Aberdeen, who was one of the report's authors, said the food system would not be able to feed the world if global heating surged beyond 2C.

“Going into a world where we are way above 2C has massive implications for the food system and production in particular,” he said. “We get more droughts, more people going without food and who need more disaster relief. It's a place we don't want to go.”



A solitary maize plant grows in a parched landscape in Hoopstad, South Africa, in 2016 during the worst drought in over a century.
Photograph: Siphwe Sibeko/Reuters

The burning of fossil fuels is the biggest source of carbon emissions and **is still rising**, despite the need for urgent cuts. But land use causes a quarter of greenhouse gas emissions, half from forest destruction and half from farming, including methane from cattle and rice paddies and nitrous oxide from chemical fertiliser use and manure.

The exploitation of land and fresh water today is unprecedented in human history, the IPCC report says. Three-quarters of all ice-free land is used by humans. Rising global population and consumption is driving the **loss of 10bn trees a year** and meat consumption has doubled since 1961. Intensive farming means soil is being lost 100 times as fast as it is being formed in ploughed fields.

However, the IPCC report says solutions exist. Among the most important is halting the destruction of forest, peatlands and wetlands, which store huge

amounts of carbon and can absorb more if left undisturbed.

“Conserving what we have got is the first thing to do,” Smith said. “It is also a quick win that delivers across a whole range of things we want to do to preserve a liveable planet,” including halting the annihilation of wildlife, which some scientists think is the start of a new mass extinction.

Enabling the restoration of forests is also important, as is using farming techniques that preserve rather than erode soils. Cutting the amount of meat and dairy products eaten in rich nations is a “major opportunity”, the IPCC report says, due to the heavy environmental impact of intensively reared cattle. Drastically reducing food waste – 25-30% of all food is never eaten – is a priority as well.

Another opportunity is to help smallholder farmers around the world sustainably increase their yields, including by breeding new crop varieties that better withstand heat and drought.

Bioenergy crops have been suggested as a way to pull carbon dioxide from the atmosphere but the IPCC report warns that large-scale use could conflict with growing food, with serious consequences for food security.



A man helps his children as they take part in a tree-planting campaign in New Delhi in 2018. Photograph: Chandan Khanna/AFP/Getty Images

The report says global heating could boost some crops in higher and cooler latitudes as growing seasons get longer and higher levels of CO₂ in the air fertilises plants. “But in terms of global food production and food access it is definitely a net negative,” said Smith, as the most vulnerable populations live at lower latitudes such as in sub-Saharan Africa and India, where fierce temperatures will harm crops.

The special role of indigenous people is highlighted in the report. “Finally, the world’s top scientists recognise what we have always known,” said a statement by indigenous and community leaders from 42 countries that account for 76%

of the world's tropical forests. "We play a critical role in safeguarding the world's lands and forests. The report recognises that strengthening our rights is a critical solution to the climate crisis." Women must also have stronger rights, the report says, as they often do much of the farming but little of the decision-making.

Reyes Tirado, of the Greenpeace Laboratory at the University of Exeter, said: "This is a crisis of our own making but it's a crisis we can solve if we act now. Changing the way we produce food and what we eat will protect our climate and promote food security." She said freeing up land used for animal grazing and feed could allow forests to regrow.

Katherine Kramer, of Christian Aid, said: "The land sector alone cannot be a silver bullet. The need to end the fossil era as soon as possible remains as clear as ever. [But] we need land to be part of the solution as well."

14 AUGUST 2019

Teenage activists and an IPCC triumph

The latest report from the Intergovernmental Panel on Climate Change is a well-timed blueprint for action. Decision makers must now pay attention — a nascent youth movement is showing them how.



Climate negotiators meeting in Japan in 1997 were helped by the IPCC's reports confirming a human fingerprint in climate change — paving the way for the Kyoto Protocol. Credit: The Asahi Shimbun/Getty

It isn't often that a climate report is this well timed. The Intergovernmental Panel on Climate Change (IPCC) review on climate and land use, [released last week](#), has arrived in time for several international meetings on the future of the environment. This August and September, government representatives will gather under the United Nations umbrella in Nairobi, New Delhi and New York City to review progress in protecting biodiversity and mitigating desertification and climate change. The IPCC's latest warnings should turbocharge those deliberations.

Between 2007 and 2016, food production, agriculture, forestry and other human activities related to land use accounted for 21–37% of anthropogenic, or human-caused, greenhouse-gas emissions, the IPCC review says. These emissions could be reduced, it adds, if more land was available to absorb carbon. This could be achievable if more consumers reduced their meat consumption in favour of plant-based diets; more forests were protected and managed sustainably; and soils were replenished with organic content.

But this is as far as the IPCC's authority goes. The panel's job is to describe what humans are doing to the climate. It can suggest how to slow down or reverse these effects, and how humans might adapt to a warming

world. The IPCC can make suggestions, but turning these into action is beyond its remit.

When it comes to the role of international political leadership in tackling climate change, the record of achievement leaves much to be desired. But now, because of the IPCC's findings, and with the help of a vigorous youth climate movement — which, unlike adult policymakers, seems to actually pay attention to the IPCC — an opportunity has arisen for real action.

Take the UN Convention on Biological Diversity, representatives of which will gather in Nairobi later this month. A decade ago, the convention's member countries set themselves a 2020 deadline to address the underlying causes of biodiversity loss. Despite the impending deadline, progress has been limited. Delegates will consider extending the deadline and, potentially, setting new targets. But biodiversity is dwindling, in large part, because industrial-scale farming and broader industry is destroying and polluting habitats. As long as these issues remain, an extension is unlikely to make a difference.

At the beginning of next month, it will be the turn of countries belonging to the UN Convention to Combat Desertification (UNCCD) to meet in New Delhi. Desertification happens when land in already-dry parts of the world is degraded through the loss of productive soils. Its human causes include over-cultivation, overgrazing, deforestation and poor irrigation.

The UNCCD's member countries will consider a proposal to integrate their work in combating desertification with the UN's Sustainable Development Goals — a move that should be encouraged. This would avoid duplication of effort, and could speed up progress. But, as the latest IPCC report indicates, droughts in dryland regions have been increasing, on average, by slightly more than 1% per year since 1961. And climate change is making land degradation worse.

Last, but not least, as September draws to a close, world leaders will assemble in New York City for a climate summit convened by UN secretary-general António Guterres, where the IPCC's latest findings will also be considered. As the IPCC report points out, the global mean surface temperature increased by about 0.87 °C (with a likely range of 0.75–0.99 °C) between 1850 and 2015. Guterres wants leaders to come to New York with concrete plans to reduce greenhouse-gas emissions by 45% over the next decade, and to reach net zero by 2050. But whether they are capable of this — or willing to do so — is an open question.

Combating climate change and desertification and slowing the rate of biodiversity loss are even more difficult to achieve, because each respective UN convention is structured to be independent of the others — unlike the reality of threats to biodiversity, climate change and desertification, which are interlinked.

This is where the IPCC's report also stands out. Its authors come from diverse disciplines — and, for the first time, a majority are from developing countries. They have engaged in detailed conversations and produced a document that integrates perspectives on biodiversity and desertification, as well as food and agriculture, into its analysis and findings. The UN conventions could do much more to adopt such an approach.

Young people care about climate

As each of the UN conventions faces continuing challenges, the IPCC can at least be assured of support from the next generation. It has garnered a following among the growing international youth climate movement. Members keenly absorb every new report, including participants in the school strike for climate, led by Swedish teenage activist Greta Thunberg.

Thunberg makes a point of namechecking the IPCC and quoting paragraph and page numbers in speeches, as she did in an address to the French parliament at the end of last month.

As government delegates get ready for Delhi, Nairobi and New York, they must prepare to answer why, if children can understand the meaning of the IPCC assessments, adults cannot do the same?

The youth climate movement's members are brave, and they are right. It has been almost three decades since the three UN conventions — on biodiversity, climate and desertification — were agreed at the Earth Summit in Rio

de Janeiro. And it has been 31 years since the IPCC was created to advise decision makers. Yet environmental promises have not been matched by meaningful action.

Younger generations know, perhaps better than the adults, that the world might not have another three decades to prevent climate impacts that will be even more serious than those we face now. Politicians must act now.

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Stop abusing land, scientists warn

By Roger Harrabin
BBC environment analyst
5 August 2019



Indonesian forest being cleared for palm oil plantations

Scientists are to deliver a stark condemnation of the damage being done to the land surface of the planet.

Human activities have led to the degrading of soils, expanded deserts, felled forests, driven out wildlife, and drained peatlands, they will say.

In the process, land has been turned from an asset that combats climate change into a major source of carbon.

The scientists will say this land abuse must be stopped to avoid catastrophic climate heating.

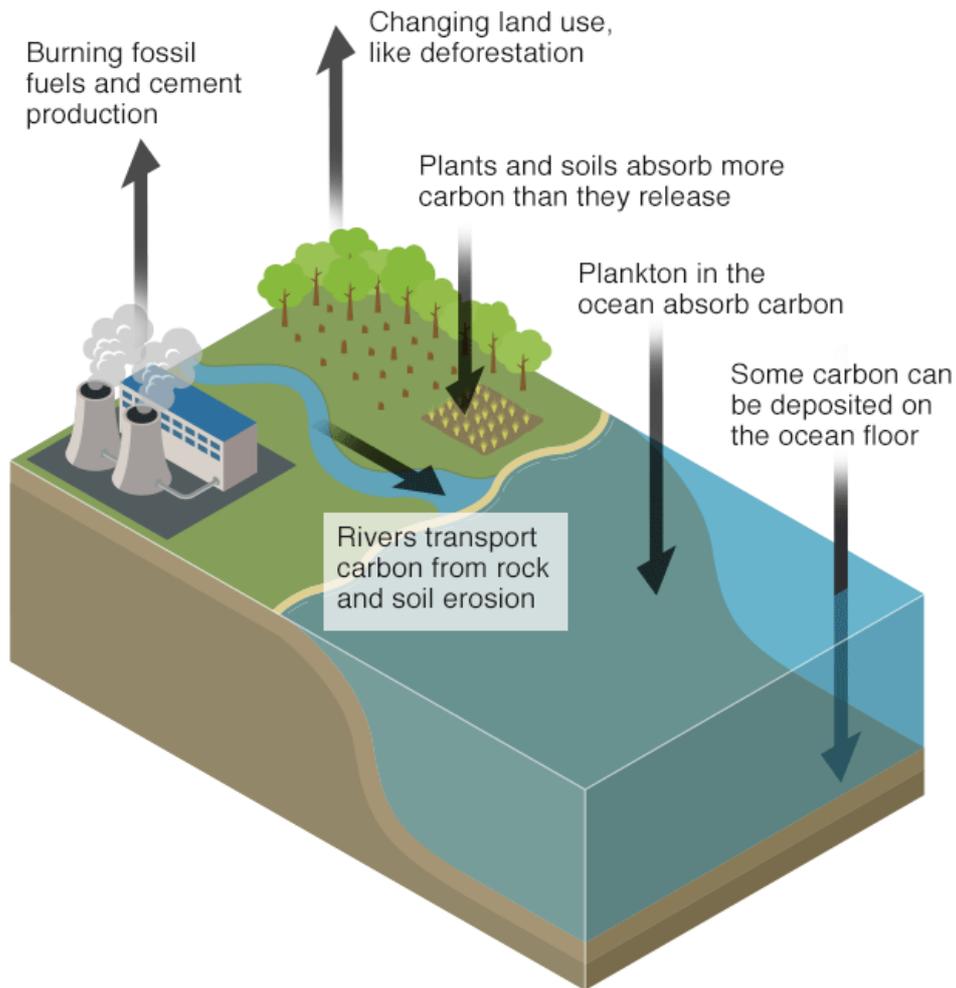
How can the land protect us from climate change?

Uncultivated land covered with vegetation protects us from overheating because the plants absorb the warming gas CO₂ from the air and fix it in the soil.

But the scientists meeting in Geneva, Switzerland, will say the way we farm and grow timber often actually increases emissions of carbon dioxide.

Between a quarter and a third of all greenhouse gas emissions are now estimated to come from land use.

How the carbon cycle works



Source: IPCC

BBC

The scientists will warn of a battle for land between multiple competing demands: biofuels, plant material for plastics and fibres, timber, wildlife, paper and pulp - and food for a growing population. Their report will say we need to make hard choices about how we use the world's soil. And it will offer another warning that our hunger for red meat is putting huge stress on the land to produce animal feed, as well as contributing to half of the world's emissions of methane - another greenhouse gas.

What is the report?

The document's being finalised this week among scientists and government officials on the UN's Intergovernmental Panel on Climate Change (IPCC). It will become the most authoritative report yet on the way we use and abuse the land. Scientists hope it will give the issue of land use greater prominence in negotiations on climate change. At its heart will be the paradox that the land can be a source of CO₂ emissions, or a sink for CO₂ emissions. The question is how we use it.

Why is that an issue?

Take the fenlands in the east of England – a huge expanse of lowland peat. In its natural state, it's saturated with water. But over centuries, 99% of it has been drained for farming. Food crops don't grow in peat bogs. The remaining un-drained 1% is Wicken Fen, a plot owned by the charity the National Trust, where the soft black soil is still 4m deep.

The surrounding drained farmland is noticeably lower, because as it's been drained the peat has shrunk to just 50cm thick.

Between 1-2% of the soil on the drained farmland is still being lost every year.



The fens in eastern England constitute a huge expanse of lowland peat

That's because when peat is exposed to the air, it oxidises and produces CO₂.

But here's the problem: the peaty fields are also some of the most productive cropland in the UK – they're known as Black Gold.

Farmers want to grow food on them – not soak them to save carbon.

One young farmer, Charles Shropshire, told me he was concerned about carbon loss from his fields.

He's already finding that existing climate change is disrupting growing patterns.



Farmer Charles Shropshire is adopting regenerative farming techniques on his farm near Soham

So now he's adopting so-called "regenerative farming" techniques - such as shallow ploughing, keeping the land covered in vegetation in the winter, and using drip-feed watering.

He's willing to experiment with National Trust ideas such as re-wetting the soil over the winter, or growing sphagnum moss for use in beauty treatments or hanging baskets.

But many other farmers don't want to change the way they run their business.

And all round the world you'll find similar stories as farmers strive to increase production of the food people

want, which can negatively affect land in the long term.

Part of the problem is that consumption of meat and vegetable oils has doubled since the 1960s.

Can we solve the problem?

Scientists say the problem is huge. They admit it will be hard to solve, especially as conservation-style farming would involve teaching half a billion farmers to work differently.

They believe we need to:

- Protect as much natural forest as we can, particularly in the tropics

- Change diets to eat less red meat and more vegetables

- Safeguard peatlands and restore them where possible

- Grow plants and trees to produce energy... but only on a small local scale

- Do more agro-forestry, where food crops are mixed in with trees

- Improve crop varieties

Are the solutions agreed?



Farmers in some parts of the world will be hit harder by climate change

There's still some debate. One option is to concentrate intensive farming into the smallest possible area of land, in order to leave as much natural land as possible to soak up CO₂.

Another option is to farm in a less intensive, more climate-friendly way – but that means taking up more natural land to compensate.

Either way, the report will warn that the poorest farmers will be hardest hit by global warming, and they'll be least able to afford new technologies to change the way they farm.

Kelly Levin, from the US green think tank WRI, told BBC News the report should heap pressure on politicians to cut fossil fuel emissions.

She said: "If we consider the climate problem hard now, just think about how much harder it will be without the land serving as a large sink for carbon dioxide emissions."

Will the report change policies?

Prof John Boardman, from the Oxford Environmental Change Institute, told us climate change was already causing soil erosion in southern England through more intense rain.

But he warned: "We should recognise that in most parts of the world, a little more or less rain or heat is an irrelevance compared to human pressures.

"(In some areas) if we change the land use from winter wheat to maize, we triple the risk of erosion."

Prof Jane Rickson from Cranfield University, UK, told us: "Increased temperatures and heavier rainfall will aggravate soil erosion, compaction, loss of organic matter, loss of biodiversity, and landslides... many of which are irreversible.

"I hope the final IPCC report will be robust enough to motivate politicians and land managers to implement policies and practices that will reverse, mitigate and adapt to the climate crisis".

Plant-based diet can fight climate change - UN

By Roger Harrabin
BBC environment analyst, Geneva
3 hours ago
661 comments



Vegan burgers are now a fixture on many restaurant menus

Switching to a plant-based diet can help fight climate change, UN experts have said.

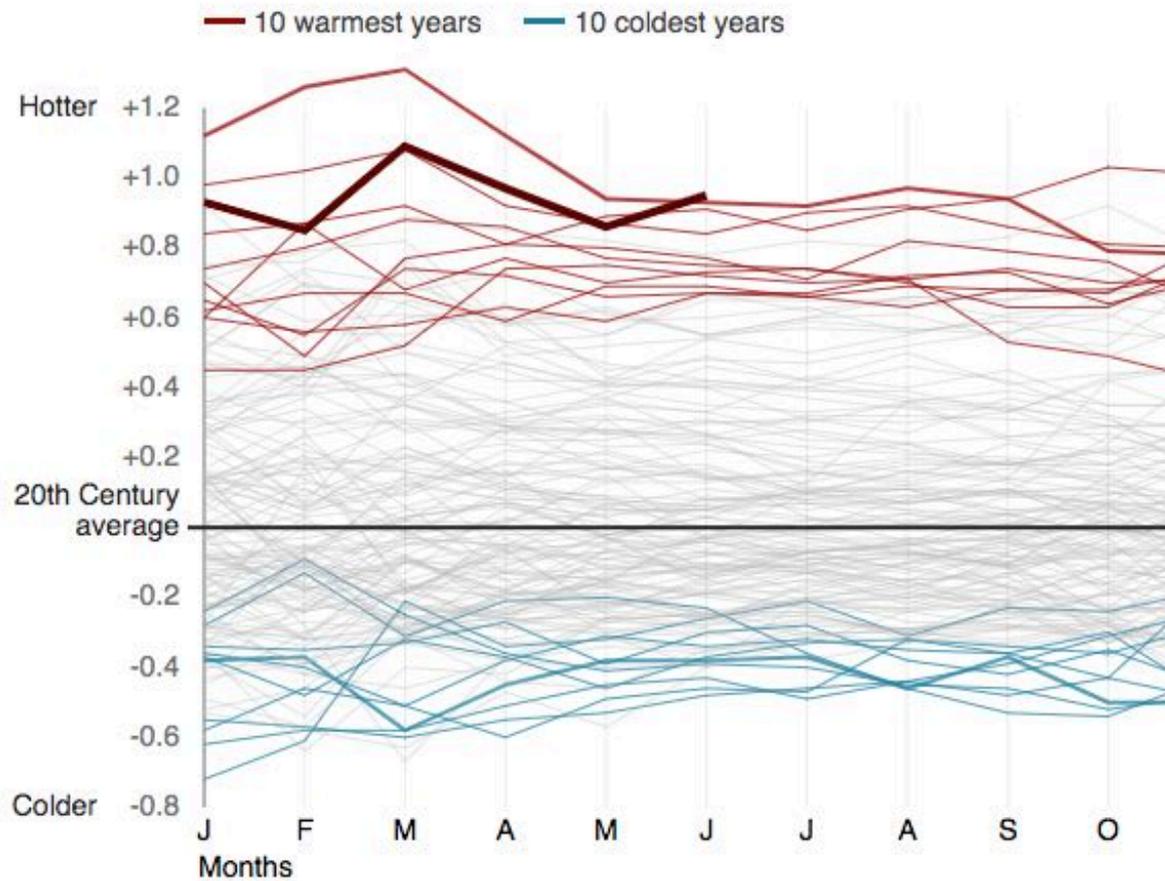
A major report on land use and climate change says the West's high consumption of meat and dairy produce is fuelling global warming.

But scientists and officials stopped short of explicitly calling on everyone to become vegan or vegetarian. They said that more people could be fed using less land if individuals cut down on eating meat.

The document, prepared by 107 scientists for the UN's **Intergovernmental Panel on Climate Change (IPCC)**, says that if land is used more effectively, it can store more of the carbon emitted by humans.

It was finalised following discussions held here in Geneva, Switzerland.

2019 is on course to be in the top three warmest years



"We're not telling people to stop eating meat. In some places people have no other choice. But it's obvious that in the West we're eating far too much," said Prof Pete Smith, an environmental scientist from Aberdeen University, UK.

The report calls for vigorous action to halt soil damage and desertification - both of which contribute to climate change.

It also warns that plans by some governments to grow trees and burn them to generate electricity will compete with food production unless carried out on a limited scale.

The Earth's land surface, and the way it is used, forms the basis for human society and the global economy.

But we are re-shaping it in dramatic ways, including through the release of greenhouse gases into the atmosphere. How the land responds to human-induced climate change is a vital concern for the future.



Gases produced by livestock are a major factor in global warming, so should we change our eating habits?

How are climate change and food linked?

Climate change poses a threat to the security of our food supply. Rising temperatures, increased rain and more extreme weather events will all have an impact on crops and livestock.

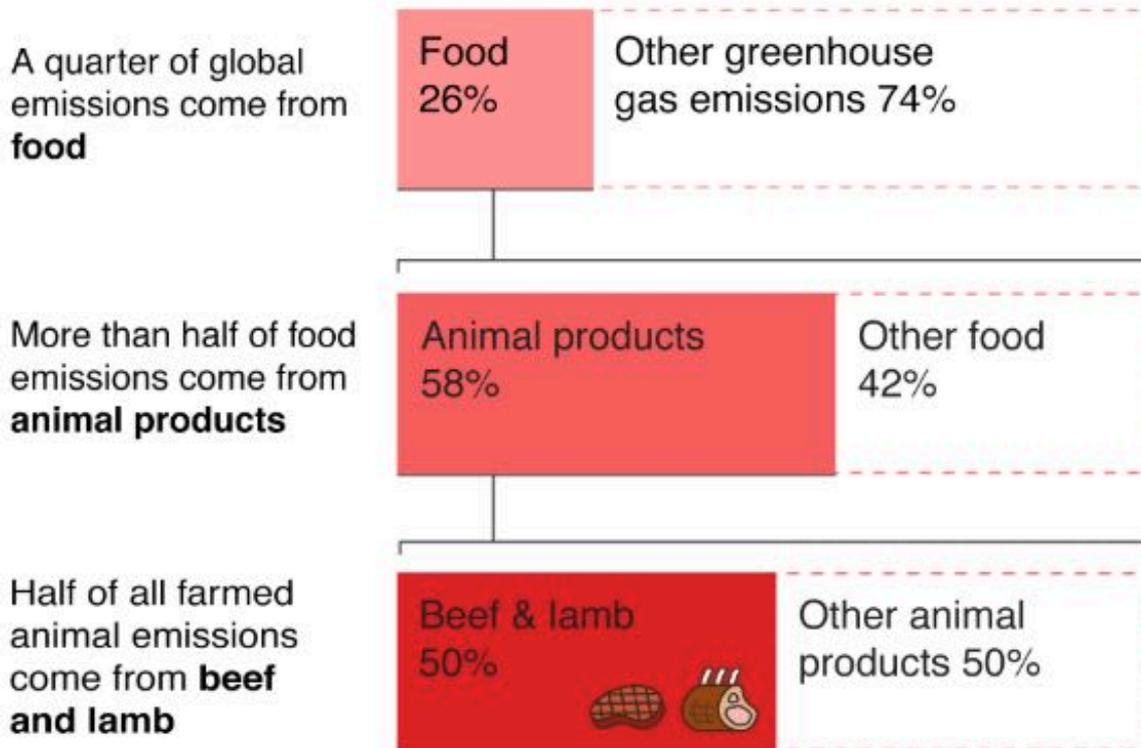
But food production also contributes to global warming. Agriculture - together with forestry - accounts for about a quarter of greenhouse gas emissions. Livestock rearing contributes to global warming through the methane gas the animals produce, but also via deforestation to expand pastures, for example.

The environmental impact of meat production is important to many vegetarians and vegans. A UK-based group called #NoBeef lobbies caterers to take beef and lamb off student menus.

In the US, vegan burger patties are made from plant-based meat substitutes said to taste like the real thing thanks to an iron-rich compound called heme.

How much impact does food have?

Proportion of total greenhouse gas emissions from food



Source: Poore & Nemecek (2018), Science

B

Peter Stevenson, from Compassion in World Farming, said: "A reduction in meat consumption is essential if we are to meet climate targets."

But in some parts of the world, such as China, beef consumption is growing. This is despite attempts by the Chinese central government to promote traditional diets.

Can food waste be reduced?



Geneva-based company Partage is helping tackle waste by taking in unsold food

The authors of the report encourage action to stop wasting food - either before or after its sale to consumers.

Waste food can sometimes be used as animal feed or, if suitable, redirected to charities to feed people in need.

One organisation here in Switzerland called Partage takes in unsold food discarded by shops and distributes it to local families.

It also collects stale bread and turns it into biscuits, dries fruit, and cans vegetables. All of this helps reduce the CO₂ emissions involved in producing food.

Don't trees absorb the CO₂ we release?



Extra atmospheric carbon can nourish forests, but there comes a point where they are overwhelmed

The extra carbon that humans have put into the atmosphere is nourishing the growth of forests - especially in the Northern Hemisphere.

This can help to mitigate climate change, but it all comes down to a balance of factors. Experts say this

effect on forests will be negated if the Earth heats up too much.

In fact, the report says areas near the equator may already be losing vegetation through heat stress.

Dr Katrin Fleischer, from the Technical University of Munich, Germany, warned that in some places a shortage of phosphorus in soil - a key ingredient for plant growth - would also hinder tree growth.

She said: "This would mean that the rainforest has already reached its limit and would be unable to absorb any more carbon dioxide emissions.

"If this scenario turns out to be true, the Earth's climate would heat up significantly faster."

How does soil fit in?

Soil is sometimes neglected as part of the climate system. But it's the second largest store of carbon after the oceans.

Plants absorb CO₂ from the atmosphere and lock the carbon away in the soil. But deforestation and poor farming practices can damage its ability to do this. When soil is degraded, carbon is released back into the atmosphere as CO₂, while further plant growth is compromised.

Climate change is expected to speed this process up. Higher temperatures can help break down the organic matter in soil, boosting greenhouse emissions.

The report says reducing and reversing soil damage provides immediate benefits to local communities.

Better land management, including controlled grazing by animals and tree planting, can boost soil fertility, helping to reduce poverty and boost food security.

"It's really clear that the land's being degraded through over-exploitation - and that's making climate change worse," said Prof Smith.

"The land is part of the problem but if we wise up about the way we use it, it can part of the climate solution."

Can the problems be solved?

Changing the way humans use the land surface is a daunting challenge, especially as it will entail a major shift in farming methods.

Nevertheless, scientists say people need to:

- Protect natural forest, particularly in the tropics

- Eat less red meat and more vegetables

- Safeguard and restore peatlands

- Encourage "agroforestry", where food crops are mixed in with trees

- Improve crop varieties

But one practice touted as a climate change solution - bioenergy - has been treated with caution by IPCC experts.

Bioenergy involves burning vegetation as a substitute for fossil fuels.

To some countries, it appears to be an attractive option because CO₂ emissions from the process can be captured.