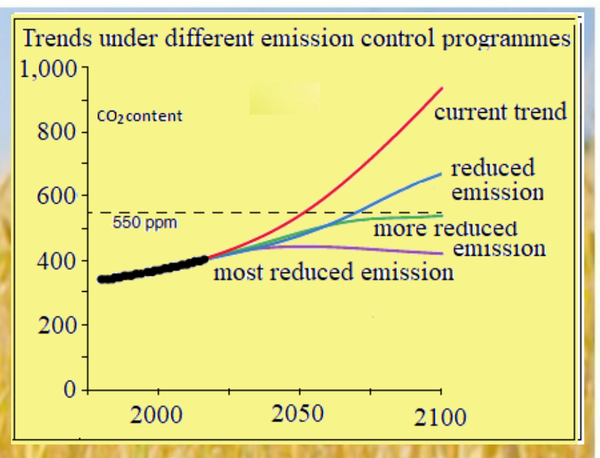
Global warming Spreads its wings

Rising CO_2 levels in the atmosphere would depress nutrients in food crops



GROUPS	Population (million) 2050	Increase in Zn deficit %	Newly zinc deficient (million)	Increase in protein deficiency	Newly protein deficient	In countries at high risk of iron deficiency children million in 2050	women
High income	1,073	0.6	6.1	0.4	4.6	0	0
South/tropical South America	328	0.8	2.7	0.6	1.8	0	0
Central/Andean/Latin/Carib.	456	2.2	9.8	0.8	3.4	2.3	7.2
Central/Eastern Europe	278	1.0	2.8	0.8	2.3	1.1	4.1
Central Asia, N Africa, Mid East	839	2.7	22.5	1.2	10.3	56.2	179.2
Sub-Saharan Africa	2.203	1.7	33.6	0.8	16.0	26.8	69.6
South Asia (excluding India)	605	2.2	13.1	1.8	10.8	38.9	133.3
India	**1,705**	**2.9**	**49.6**	**2.2**	**38.2**	**106.1**	**396.0**
East and SE Asia,Pacific (excl China)	872	1.9	16.2	1.5	12.3	23.0	84.3
China	1,357	1.4	18.3	1.6	22.1	59.4	231.9
Global	9,716	1.9	175.0	1.3	121.8	311.3	1095.6

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The 21st century is set to see rising levels of carbon in the atmosphere. The atmospheric carbon dioxide content is now 410 parts per million, a rise from 280 ppm in the mid-18th century and 300 ppm in 1950. While the governments of the world have got together to limit the release of CO_2 by cities and industry, the rise is expected to continue till the end of the century. Human population, which would keep increasing for most of this period, would compound the problem by greater demand for food and increasing pressure on land use.

Matthew R Smith and Samuel S Myers from the Harvard TH Chan School of Public Health, at Boston, and the Harvard University Center for the Environment, write in the journal, *Nature Climate Change*, that apart from shortages of food and land to grow food, the rising CO_2 levels would affect vital nutritional components of food crops.

The most vulnerable populations of the world, which depend on vegetal sources, would face a double challenge of shortage of food and depleted quality. The data that the study reports puts the spotlight on India as the leader in conditions that need urgent attention.

The current trends of emission from fossil fuels and the changes in land use, worldwide, are expected to take CO_2 levels to a disastrous 940 ppm by the century end. Mitigation measures that are proposed and which may be implemented, would lead to slower rise of CO_2, as shown in the graph. But, as we can see, all programmes, except the most ambitious one, would reach a CO_2 level of 550 ppm. For the purpose of the present study, of the effect of CO_2 on nutrients in food crops, the paper takes it that the rise in CO_2 would follow the current trajectory, and reach the level of 550 ppm by the year 2050.

Experimental trials have been carried out, the paper says, with food crops that are grown in open field, both under ambient conditions and under conditions where CO_2 levels are at about 550 ppm. The trials reveal that in many important crops, the concentration of protein, iron and zinc falls by some three to 17 per cent.

The paper says that the source of most of these important nutrients, for humans worldwide, is plant-based food. As much as 63 per cent of dietary protein, 81 per cent of iron and 68 per cent of zinc, the paper says, come from vegetal sources.

There is already severe nutritional deficiency, worldwide — over two billion people are estimated to be deficient in at least one essential nutrient. This is a condition that has cascading implications — of poor health, rising medical costs and low productivity. A fall in the nutritional content of plant-based food would hence exacerbate the problems, of which the third world would bear the greatest brunt.

In order to assess the impact of climate change and elevated CO_2, the current study has integrated the best available estimates of population growth, physiological nutritional requirements and future diets. The effect on the nutrient content of a large number of kinds of food — 225, against 98 used in earlier studies — has then been modelled.

Age and sex-specific data sets have been used and data from sources selected to enable comparison and analysis. "With the enhancement and harmonisation of datasets and assumptions, we have attempted to provide the most accurate synthesis of the global health burden from elevated CO_2-related nutrient shifts in crops," the paper says.

After going through the findings, one can see that India leads in the increase in nutrient deficiency, followed by China. Latin America, Central Asia, North and sub-Saharan Africa and the rest of Asia are not far behind. The effect is to add to the pressures on the areas that are already under the highest stress.

Apart from impaired productivity and higher health care costs, are the human costs of infant and premature, diet-related, adult mortality. The economic impact, according to "Global Impact", an independent group of experts, comes to US$ 3.5 trillion per year, or US$ 500 per individual, worldwide.

The findings underline another area where many parts of the world need to adapt while coping with climate change. The study notes that the diets and health of global populations are changing rapidly. Nutrition experts and planners need to take the effects of enhanced CO_2 on the nutritional value of plant foods into account and influence choices to reduce impact.

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An extract from the paper

"..India has shown inconsistent gains in addressing undernutrition and nutritional deficiencies. Despite significant progress in reducing the rate of underweight children since 1990, Indian children still have the fourth worst global weight-for-age scores (the standard measure for underweight), and nearly 35 per cent of Indian children continue to meet the criteria for being underweight, far above the developing country average of 20 per cent.

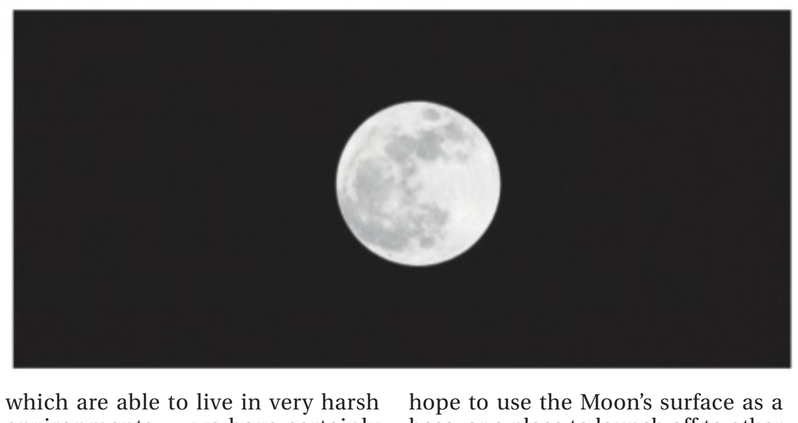
Meanwhile, India has seen significant progress in reducing the burden of anaemia, decreasing the number of years lost to disability from anaemia by 28 per cent between 1990 and 2015. However, the prevalence of inadequate zinc intake has increased over much of that same timeframe from 28 to 31 per cent between 1990 and 2015.

In contrast, China actively targeted improvements in child nutrition over the same period, reducing its undernourished rate from 24 to nine per cent between 1991 and 2015. It also decreased its years lost to disability caused by anaemia by 30 per cent between 1990 and 2015, and reduced its rate of inadequate zinc intake from 17 to eight per cent between 1990 and 2005."

Of hope lurking in icy craters

Nasa's grand vision for the future notwithstanding, the best prospect for life on the Moon is if we put it there ourselves

ANDREW GRIFFIN



Scientists have found ice scattered across the Moon's surface. And it's a discovery that could have major consequences for other things up there, too.

Across the surface of our nearest neighbour is frozen ice, hiding out in places in the polar regions that aren't touched by the sun. The discovery was made using data from Nasa's Moon Mineralogy Mapper instrument, which was on board Chandrayaan-1 spacecraft in 2008.

The breakthrough has prompted discussion of a village that could allow people to live on the Moon. From there, we could launch into the rest of our neighbourhood, providing vast new opportunities for space exploration.

And, as ever, it has prompted discussion of whether the water spread throughout our Solar System might mean alien life is living far nearer to us than we think.

Probably not! Nasa's ruling principle in its search for aliens has been to follow the water, since that is thought to be required for any kind of life, but that doesn't necessarily mean that life exists everywhere water does.

The environment on the Moon is still unremittingly harsh. It is freezing cold in the shade where the ice is, and devastatingly hot out of it; almost certainly too difficult for life. And that's not to get started on the radiation that pounds the Moon's surface.

Of course, we can't say for sure there aren't aliens; nobody can, until we've scoured the entire Moon. There might be forms of life that look entirely different to what we expect, and which are able to live in very harsh environments — we have certainly found such organisms here on Earth.

There are much better moons to go hunting for aliens on in our own solar system, anyway. Scientists are very excited about discoveries from Jupiter's moons Enceladus and Europa, for instance — both of which seem to have many more of the ingredients required for life than our relatively barren satellite.

And it's also worth noting that some scientists have suggested that there might once have been life on the Moon, even if it's not there anymore. That's probably not especially comforting if you're keen on meeting aliens — but whatever life we found on any Moon nearby would probably be very simple organisms, so are unlikely to have much of a chat with us anyway.

The much more enticing prospect for life on the Moon is if, instead of searching for it, we put it there ourselves. The life we've been looking for might be our own.

The researchers behind the new paper noted that their discovery is of intriguing importance to those who hope to use the Moon's surface as a base, or a place to launch off to other more distant parts of the Solar System.

"We found direct and definitive evidence for surface-exposed water ice in the lunar polar regions," the researchers in the new paper, which is published in the journal Proceedings of the National Academy of Sciences.

"The abundance and distribution of ice on the Moon are distinct from those on other airless bodies in the inner Solar System such as Mercury and Ceres, which may be associated with the unique formation and evolution process of our Moon. These ice deposits might be utilised as an *in situ* resource in future exploration of the Moon."

While we might be able to take the important parts of the infrastructure for life on the Moon up with us — the technology that would allow us to breathe and protect ourselves from the harsh environment, for instance — it will be far too resource-intensive to take supplies like water at the same time. So things like water are key to being able to establish ourselves on the Moon.

Spectacular indeed

Nasa boss Jim Bridenstine has laid out his grand vision to use the water on the Moon to power the space exploration of the future.

The agency should launch a new and "sustainable" mission of human exploration of our nearest neighbour, he said. And the new discovery that there is water ice on the lunar surface is a key part of that mission.

Eventually, it could become something far more spectacular. He laid out a vision of tugs going back and forth between Earth and the Moon, which would have a space station built around it and serve as a launching point for missions to Mars and deeper into the Solar System.

The discovery holds tantalising implications for efforts to return humans to the moon for the first time in half a century. The presence of water offers a potentially valuable resource not only for drinking but for producing more rocket fuel and oxygen to breathe.

But much remains to be learned. Nasa lunar scientist Sarah Noble told Reuters separately by phone that it is still unknown how much ice is actually present on the moon and how easy it would be to extract in sufficient quantities to be of practical use. Most of the newly-confirmed frozen water is concentrated in the shadows of craters at both poles, where the temperature never rises higher than minus 250 degrees Fahrenheit.

Bridenstine spoke to *Reuters* about making the next generation of lunar exploration a "sustainable enterprise", using rockets and other space vehicles that could be used again and again. "So we want tugs that go from Earth orbit to lunar orbit to be reusable. We want a space station around the Moon to be there for a very long period of time, and we want landers that go back and forth between the space station around the Moon and the surface of the Moon," Bridenstine said.

Nasa's previous program of human moon exploration ended with the Apollo 17 mission in 1972. The Trump administration's $19.9 billion budget proposal for Nasa for the fiscal year beginning 1 October includes $10.5 billion for human space exploration. As part of the budget proposal, Nasa also is planning to build the Lunar Orbital Platform-Gateway — a space station in Moon orbit — in the 2020s.

The independent


Artist's impression of a lunar base

PLUS POINTS

Older than thought

The first living thing to emerge on our planet appeared at least 100 million years earlier than previously thought, according to a new study. Around 3.9 billion years ago — shortly after the Earth had been struck by the planet Theia and while it still faced a barrage of meteors — the ancestor of all living things sprang into being.

Scientists have traditionally used the fossil record to trace the origins of life on Earth but the further back in the planet's history they travel the more difficult this becomes. "The problem with the early fossil record of life is that it is so limited and difficult to interpret — careful reanalysis of the some of the very oldest fossils has shown them to be crystals, not fossils at all," explained PhD student Holly Betts from the University of Bristol, UK, the lead author of the study.

In their research, published in the journal, *Nature Ecology and Evolution*, Betts and her colleagues used a combination of fossil and genetic data to trace back the so-called "Luca" — the last universal common ancestor.

By combining data from all available sources scientists are able to construct "molecular clocks", based on the idea that the number of differences in genetic code between different species is proportional to the time since they shared a common ancestor. Using information on 29 genes from a total of 102 living organisms, the team assembled a timeline with dates for the appearance of all the major groups of life forms, such as bacteria. The scientists concluded that the hypothetical Luca existed before the "late heavy bombardment" when multiple meteors smashed into Earth.

This is far earlier than the oldest fossil evidence of life, which is no more than 3.8 billion years old. While there are still uncertainties, the scientists knew that life on Earth could not stretch back further than 4.5 billion years, when Theia crashed into the fledgling planet.

This devastating event not only broke off pieces of the Earth that would ultimately form the Moon, it would have effectively sterilised the planet and killed any life already existing there.

The independent

VR learning

Virtual reality is moving beyond purely entertainment to become a potential tool in improving literacy. New Zealand's University of Otago's information science department has been working with Methodist Mission Southern to look at a totally new way of helping prisoners in the Otago Corrections Facility to improve reading and writing skills.

VR uses computer technology to create a simulated environment. Instead of viewing a screen in front of them, users are immersed inside an experience and able to interact with three-dimensional worlds.

Methodist Mission Southern business development leader Jimmy McLauchlan approached the information science group because the social agency wanted to rethink the way literacy is taught to people who often fall through the cracks — particularly those in prison. PhD student Jonny Collins then brought the need and the technology together into a prototype VR application using a setting that is both familiar and motivating to the learner — a simulated car workshop.

The prototype is a 360-degree virtual world programme that involves car assembly in an automotive workshop, consulting with an actual automotive repair business to make sure the virtual world represents a realistic environment. The model has already been showcased at an education conference in Los Angeles, US.

Head of the University's information science department professor Holger Regenbrecht says, "It's already understood that people can learn another language through immersion, both in a real-world context and through using VR technology.

"It is expected that there will be significant international interest in VR-contextualised learning. I believe this immersion technology has the potential to revolutionise learning."