Could conservation prevent pandemics?

Disease-carrying animal life is concentrated in the spaces where humans have cleared forests, for planting crops or building cities

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Does human activity select from the environment? Does it act like a filter – throwing out species that may do us, not harm, but no harm, and promoting those that are likely to carry disease?

Rory Gibb, David W Redding, Kai Qing Chin, Christl A Donnelly, Tim M Blackburn, Tim Newbold and Kate E Jones, from the departments of genetics, evolution and environment and public health, University College, London, department of statistics, University of Oxford and the Zoological Society of London, report in the journal, *Nature*, that this is just what the conversion, by humans, of natural habitats to agriculture or urban settlement has done. The finding is uncannily relevant at a time when the world is battling a pathogen that has crossed over from animals to humans, even as the Earth faces a bleak future arising from the injuries that humans have inflicted on the environment.

Many diseases come to humans from animal reservoirs and are then transmitted and spread by the high mobility and sociability of humans. Examples of bacterial diseases brought to us by animals or insects, zoonoses, as they are called, are anthrax, plague, leptospirosis, salmonellosis, Lyme disease. And examples of viral zoonoses are Zika, Dengue, Eastern Equine encephalitis, West Nile, Yellow Fever Chikungunya and Rift Valley Fever. And then there are fungi and parasitical diseases, which come to humans from animal hosts.

Transfer of pathogens from animals to humans is a rare event. In the context of Covid-19, of the hundreds of viruses known as coronaviruses that are found in animals, there are just seven which have been able to cross over and infect humans. Pathogens, including viruses, evolve to co-exist with specific hosts. Infecting other species happens only when a virus, by mischance, develops a surface feature that enables its survival in cells of the other species.

There is a general impression that new pathogens, against which humans often do not have effective defences, have been appearing more often. And the paper in *Nature* cites evidence that human encroachment, which destroys natural habitats is associated with an increase in zoonotic diseases in humans. How this comes about, however, has been unclear, the paper says. One suggestion has been that the composition and diversity of animals, which are the reservoir of pathogens, may undergo a change when the animal habitat is disturbed. This could be because some species are more capable than others to resist the human invasion. There has not been, however, the paper says, a study of just how human land use affects the diversity and composition of animal populations.

This is the analysis the team undertook, with the help of a massive database of information about how species on Earth respond to human pressures, collected from scientists, worldwide. The database is built up through a collaborative effort called PREDICTS – Projecting Responses of Ecological Diversity In Changing Terrestrial Systems, and has over 2.5 million biodiversity records from over 21,000 sites, covering more than 38,000 species.

This database was used in combination with the Enhanced Infectious Diseases Database, a tabulation, created by the University of Liverpool, of the relationships between human and animal diseases and their hosts, pathogens that cause disease and how they are transmitted. And then, the Global Mammal Parasite Database, a compilation of records of parasites and their hosts, and other databases of different animals that were zoonotic reservoirs.

The databases were surveyed to identify instances of animal hosts that shared at least one pathogen that affected humans – to classify species as zoonotic hosts. "The PREDICTS data compiles more than 3.2 million species records from 666 published studies that sampled biodiversity across land use gradients using consistent protocols," the paper says. A land use gradient is the path of increasing land use by humans, rising from natural environments, to mildly exploited forest, cultivated and urbanised land. "Records of 376 host species in a dataset of 6,801 survey sites from 184 studies across six continents," the paper says, enabled a global comparison of how species diversity responded to the intensity of land use.

The survey resulted in a first estimation of the effect of human land use on two measures – the richness or diversity of the host species, and hence the diversity of the pathogens that affected humans, and then the numbers of these species. The remarkable discovery was that both the measures increased when land use increased – in contrast to declining diversity and numbers of species that were not hosts of pathogens that affected humans. What this amounts to is that the proportion of species that harbour pathogens that affect humans increases, and the risk of humans catching zoonotic infections increases with more intense land use. Coming to specifics, it was found that host species in perching songbirds (about half of all birds), bats and rodents increased, respectively by 14 to 96 per cent, by 45 per cent and 52 per cent, while non-host species declined by 28 per cent to 43 per cent, 13 per cent and 53 per cent.

And what could be the reason for this? One suggestion is that smaller and short lived animals, like rats and smaller birds, can afford less investment in the immune system and thus harbour more pathogens. In contrast, longer lived and larger animals, the rhino, for instance, need to keep pathogens away and are a lesser threat to humans. The smaller animals were also more resilient and able to cope with habitat change and thrived in habitat change.

That Sars-CoV-2, the virus behind the current pandemic was of animal origin has created the apprehension that there is a reservoir of unknown diseases lurking in the wild. The results of the study are different - - that disease-carrying animal life is concentrated in the spaces where humans have cleared forests, for planting crops or building cities.

The message is two-fold. First, encroaching on virgin land to grow more food carries the price-tag of rising health care costs. Second, it is in our immediate surroundings, not the deep woods, that we should expect new pathogens to arise.

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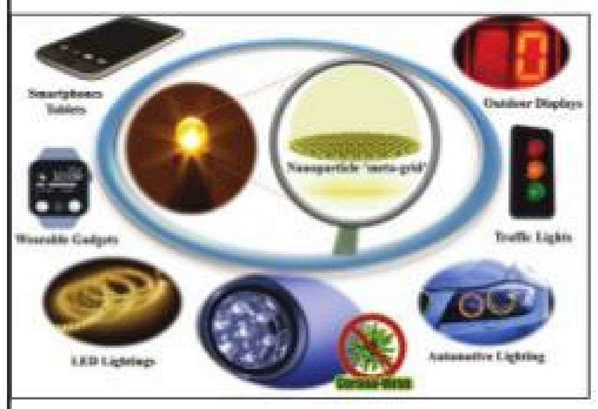
PLUS POINTS

Brighter & more durable



Researchers from the Indian Institute of Technology-Guwahati and Imperial College London have developed a tailored "meta-grid" of nanoparticles that could make light-emitting diodes brighter, energy-efficient and durable.

In today's world, Leds are deployed almost everywhere – from traffic lights to backlighting for electronic displays, smartphones, large billboards, decorative lightings, water purification, and decontamination of infected surfaces. An increase in Led light output would significantly reduce energy needs on a large scale, and therefore, contribute towards curbing global warming and climate change.

Over the years, a significant research drive towards this objective is in exploring new materials for Led-chip encapsulation, mostly by deploying either higher refractive index glasses or epoxy materials incorporated with filler powders or nanoparticle-loaded-epoxy or engineered epoxy resins, etc. However, these techniques either make the Led chips bulkier or their fabrication becomes more challenging and less economically viable for mass production. Debabrata Sikdar, assistant professor from IIT-Guwahati, along with Sir John B Pendry and Alexei A Kornyshev from Imperial College London, have developed a nanoparticle "meta-grid", which needs to be placed at an appropriate location within the epoxy casing of the Leds, for improving light output. A "meta-grid" is a specially designed, optimised, two-dimensional array of specific nanoparticles, of a size much smaller than the wavelength of light. The findings have been recently published in Light: *Science & Applications* journal of the Nature Publishing Group. The technique has revealed optimal design parameters for such meta-grids to produce greater light output over any narrow/broadband emission spectrum, besides boosting Leds' lifetime by eliminating heating of the chip from unwanted reflections within it.

The technique is deployable by itself or in combination with other existing techniques applied for increasing efficiency. The entire original theoretical framework needed for the invention has been developed in-house and is rigorously tested against standard commercial simulation tools. The research team plans to fabricate a prototype device within one year and corroborate their theoretical predictions with experiments.

Sikdar said, "With the continuous advancement in nanofabrication technology, it is now possible to fabricate metallic nanoparticles which are mostly monodisperse or having a very narrow spread. Still, there could always be some randomness in particle size and/or position, flatness of grid, and variation in refractive index due to fabrication error or material defects, which are unavoidable. Effects from most of these inaccuracies can be estimated from our tolerance study and it has shown the robustness of our scheme."

Worrying trend

Last month was the world's third-hottest July on record, new data shows, the latest milestone in a global warming trend that has seen the three hottest Julys within the last five years.

With the heat has come a high level of ice melt in the Arctic, where the extent of sea ice last month hit the lowest level for July since the polar satellite record-keeping began four decades ago, according to the European Union's Copernicus Climate Change Service.

The new findings come as France and Belgium brace for a possible weekend heatwave, while Italian roads near an Alpine glacier were closed amid warnings that high temperatures could cause ice to collapse. In the Arctic, which has been warming at more than twice the global rate in recent decades, the expanse of sea ice shrank to its lowest level recorded for any July since 1979.

The data service said satellite images reveal ice-free conditions "almost everywhere" along the Siberian coastline – a shipping route that, until a few years ago, could be crossed only with an ice-breaking vessel. The heat has also been linked with wildfires that have been scorching patches of Siberian forest and permafrost since mid-June. An image from a Copernicus satellite showed a massive smoke cloud over the remote Russian region last week. Carbon monoxide levels over Siberia suggest the wildfires "really took off" in the past two years, said Mark Parrington, a senior scientist at Copernicus tracking wildfire emissions.

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CONTROLLING TRANSMISSION

Here's how to use ventilation and air filtration to prevent the spread of coronavirus indoors

SHELLY MILLER

The vast majority of Sars-CoV-2 transmission occurs indoors, most of it from the inhalation of airborne particles that contain the coronavirus. The best way to prevent the virus from spreading in a home or business would be to simply keep infected people away. But this is hard to do when an estimated 40 per cent of cases are asymptomatic and asymptomatic people can still spread the coronavirus to others.

Masks do a decent job at keeping the virus from spreading into the environment, but if an infected person is inside a building, inevitably some virus will escape into the air.

Much of my work has focused on how to control the transmission of airborne infectious diseases indoors, and I've been asked by my own university, my kids' schools and even the Alaska State Legislature for advice on how to make indoor spaces safe during this pandemic. Once the virus escapes into the air inside a building, you have two options – bring in fresh air from outside or remove the virus from the air inside the building.

It's all about fresh, outside air

The safest indoor space is one that constantly has lots of outside air replacing the stale air inside. In commercial buildings, outside air is usually pumped in through heating, ventilating and air-conditioning systems. In homes, outside air gets in through open windows and doors, in addition to seeping in through various nooks and crannies.

Simply put, the fresher outside air inside a building, the better. Bringing in this air dilutes any contaminant in a building, whether a virus or something else, and reduces the exposure of anyone inside. Environmental engineers like me quantify how much outside air is getting into a building using a measure called the air exchange rate. This number quantifies the number of times the air inside a building gets replaced with air from outside in an hour. While the exact rate depends on the number of people and size of the room, most experts consider roughly six air changes an hour to be good for a 10-foot-by-10-foot room with three to four people in it. In a pandemic this should be higher, with one study from 2016 suggesting that an exchange rate of nine times per hour reduced the spread of Sars, Mers and H1N1 in a Hong Kong hospital.

Many buildings in the US, especially schools, do not meet recommended ventilation rates. Thankfully, it can be pretty easy to get more outside air into a building. Keeping windows and doors open is a good start. Putting a box fan in a window blowing out can greatly increase air exchange too. In buildings that don't have operable windows, you can change the mechanical ventilation system to increase how much air it is pumping. But in any room, the more people inside, the faster the air should be replaced.

Using CO_2 to measure air circulation

So how do you know if the room you're in has enough air exchange? It's actually a pretty hard number to calculate. But there's an easy-to-measure proxy that can help. Every time you exhale, you release CO_2 into the air. Since the coronavirus is most often spread by breathing, coughing or talking, you can use CO_2 levels to see if the room is filling up with potentially infectious exhalations. The CO_2 level lets you estimate if enough fresh outside air is getting in. Outdoors, CO_2 levels are just above 400 parts per million. A well ventilated room will have around 800 ppm of CO_2. Any higher than that and it is a sign the room might need more ventilation.

Last year, researchers in Taiwan reported on the effect of ventilation on a tuberculosis outbreak at Taipei University. Many of the rooms in the school were underventilated and had CO_2 levels above 3,000 ppm. When engineers improved air circulation and got CO_2 levels under 600 ppm, the outbreak completely stopped. According to the research, the increase in ventilation was responsible for 97 per cent of the decrease in transmission. Since the coronavirus is spread through the air, higher CO_2 levels in a room likely mean there is a higher chance of transmission if an infected person is inside. Based on the study above, I recommend trying to keep the CO_2 levels below 600 ppm.

Air cleaners

If you are in a room that can't get enough outside air for dilution, consider an air cleaner, also commonly called air purifiers. These machines remove particles from the air, usually using a filter made of tightly woven fibres. They can capture particles containing bacteria and viruses and can help reduce disease transmission.

The US Environmental Protection Agency says that air cleaners can do this for the coronavirus, but not all air cleaners are equal. Before you go out and buy one, there are few things to keep in mind. The first thing to consider is how effective an air cleaner's filter is. Your best option is a cleaner that uses a high-efficiency particulate air filter, as these remove more than 99.97 per cent of all particle sizes. The second thing to consider is how powerful the cleaner is. The bigger the room – or the more people in it – the more air needs to be cleaned. I worked with some colleagues at Harvard to put together a tool to help teachers and schools determine how powerful of an air cleaner you need for different classroom sizes. The last thing to consider is the validity of the claims made by the company producing the air cleaner.

Keep air fresh or get outside

Both the World Health Organization and US Centers for Disease Control and Prevention say that poor ventilation increases the risk of transmitting the coronavirus. If you are in control of your indoor environment, make sure you are getting enough fresh air from outside circulating into the building. A CO_2 monitor can help give you a clue if there is enough ventilation, and if CO_2 levels start going up, open some windows and take a break outside. If you can't get enough fresh air into a room, an air cleaner might be a good idea. If you do get an air cleaner, be aware that they don't remove CO_2, so even though the air might be safer, CO_2 levels could still be high in the room.

If you walk into a building and it feels hot, stuffy and crowded, chances are that there is not enough ventilation. Turn around and leave.

By paying attention to air circulation and filtration, improving them where you can and staying away from places where you can't, you can add another powerful tool to your anti-coronavirus toolkit.

The writer is professor of mechanical engineering, University of Colorado Boulder, US. This article first appeared on www.theconversation.com