## PHOTOCHEMICAL SMOG

# The brownish shroud

QUAMRUL HAIDER, *Ph.D*

WE can survive without food for several days, without water for a few days, but we cannot survive more than a few minutes without air. Yet we are altering the chemical make-up of air via rampant emissions of gaseous and particulate matters. The pollutants vented into the atmosphere come from a number of different sources natural and man-made. Among the man-made sources, most harmful are the effluents from vehicles and emissions from industries. They are precursors to the formation of smog, a term coined to describe a mixture of smoke and fog.

Smog is produced through a complex set of photochemical reactions involving particulate matter (dust, soot, etc) and various gases nitrogen oxides, water vapor, carbon monoxide, and carbon dioxide which come out through the exhaust system of a vehicle. They react in the presence of sunlight to produce a witch's brew of virulent pollutants. Among some of the worse are formaldehyde, peroxyacyl nitrate (PAN), and acrolein. Furthermore, ozone is formed at the ground-level through chemical reactions involving unburned hydrocarbons in gasoline, volatile organic compounds, various oxides of nitrogen, and sunlight. The net result is a brownish orange shroud of air pollution called photochemical smog. In addition, smog in industrial towns forms when smoke and sulfur emissions from burning fossil fuels combine with fog. Smog occurs more frequently in communities situated in valleys with surrounding hills and mountains where there is less air circulation and more accumulation of pollutants in the air.

Ozone is one of the most prevalent chemicals in smog. Problematic ozone levels occur mostly on hot summer afternoons when there is little wind and temperatures soar above 30 degrees Centigrade. Effects

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of ozone are primarily health related. Lungs are ozone's primary target. It aggravates respiratory diseases, particularly asthma, emphysema, and chronic bronchitis. When inhaled, ozone can inflame pulmonary membranes causing significant temporary reduction in lung capacity, from 15 to 20 percent. Adults with respiratory diseases are most susceptible to the adverse effects of ozone. Even healthy adults engaged in strenuous outdoor activities like jogging, gardening, manual labor, etc., will suffer from ozone-related health effects. Ozone can also impair our immune system.

In tandem with ozone, the inherent toxicity in smog can cause chest pains, coughing, throat irritation, and shortness of breath. In the worst case scenario, it may contribute to lung cancer. Formaldehyde, a component of smog, is a colorless gas with pungent smell. It is toxic and will cause burning sensations in the eyes, nose, and throat. The PANs are extremely potent oxidant. They are irritating and harmful. They act like tear gas and irritate the skin, eyes, and nasal passages. The other component of smog, acrolein, is a colorless liquid with an acrid smell. It is a strong irritant for the eyes. Unfortunately, human body has very little defense against these pernicious effects of smog.

Children with asthma are especially vulnerable to the harmful effects of ozone and smog alike. Because of their physiology, they are much more likely than adults to develop smog-related lung damage. Even healthy children are at risk because their respiratory systems are still in the developmental stage.

To make a bad situation worse, smog remains under siege for days if it is accompanied by temperature inversion (TDS, 8 January 2013). We witnessed it earlier this month when major parts of China were trapped in a toxic blanket of smog leaving the citizens literally breathless. Scenes of Chinese cities smothered by smog are a disturbing reminder of the Great London Smog of 1952 which killed over 4,000 people. Ironically, smog-related problems are non-local. The pollutants in smog drift in the wind and can travel to faraway places making the smog in those places more severe.

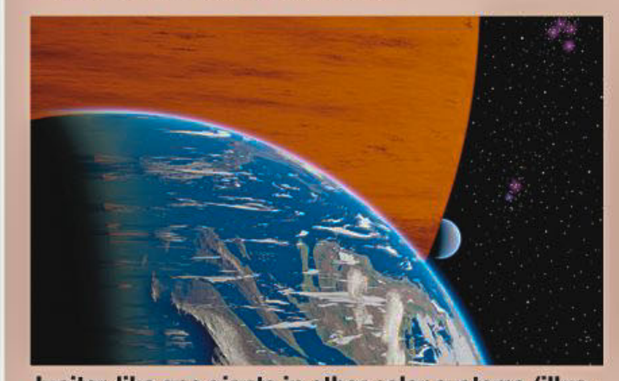
For many years we viewed pollution as a sign of progress. Today, pollution is seen as signs of failed technologies. The "airpocalypse" in China is clear evidence our atmosphere is too finite to absorb the pollutants dumped into it. Also, it is disquieting to note that except for our lungs, we have run out of place to put them away. If we want to pursue a reasonably healthful existence, we have to live by the maxim "solution to pollution is dilution." The air we breathe should not make us cough.

Next time you see the setting Sun painting the sky pink and orange, remember it is smog which made the colors so brilliant. There is an ugly story "behind every pretty picture."

The writer is a Professor in the Department of Physics & Engineering Physics, Fordham University, New York.

MOON TREK

## Life on exomoons



Jupiter-like gas giants in other solar systems (illustrated in orange) may host moons that could support life (foreground).

EARTH-sized moons in planetary systems trillions of miles away could be hotbeds for alien life, astronomers report in the January Astrobiology.

"It's the most thorough look at exomoon habitability I've seen," says Darren Williams, an astronomer at Penn State Erie who was not involved in the research. "I'm encouraged by the paper that we'll find exomoons in abundance and that a fraction of them could be habitable."

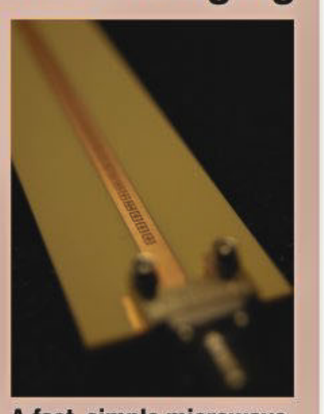
Astronomers have found about 3,600 confirmed or probable planets orbiting other stars, none of which have the ideal combination of size and temperature to support life. However, more than 150 of them are gas giants in orbits where liquid water could exist, if only it had a solid surface to puddle on. Life might be able to survive on the rocky moons of those Neptune- and Jupiter-like planets.

This bounty of temperate giants led astronomers René Heller of Germany's Leibniz Institute for Astrophysics Potsdam and Rory Barnes of the University of Washington to examine all the factors that determine the habitability of exomoons. Moons are substantially more complicated than planets because they are at the mercy of both their host planet and star: The star pelts them with radiation, and so does the reflection off the top of their planet's gaseous clouds. (Jupiter, for example, reflects about a third of solar radiation that strikes it.) Moons also get squeezed and deformed by the gravitational pull of their massive planetary companions, a phenomenon called tidal heating that supplies yet another source of energy.

Source: **Science News**

LIGHT TRICK

## Simpler microwave imaging



A fast, simple microwave imaging system that involves no lens.

THE days of standing still, arms raised, in an airport security scanner may soon be a thing of the past. A new microwave imaging system offers a fast, inexpensive way to see through clothing and other objects that gathers data without involving complicated moving parts.

The new system, reported in the Jan. 18 Science, employs a thin copper strip as an aperture that collects a range of microwave-frequency light. Elegant math then converts those data into an image in less than a second.

"This definitely represents a less expensive and potentially faster alternative to current imaging methods," says technologist Kevin Kelly of Rice University in Houston, who was not involved in the research. "You can imagine an MRI or PET scanner where instead of sitting in a machine for 50 minutes you sit in it for five minutes."

In a digital camera, the lens focuses light onto an array of pixels on a detector. If you want a million-pixel image, you essentially need a million detectors, says John Hunt, a Duke University physicist who led the new work. That many-pixel, many-detector approach doesn't work with microwaves, which are longer than waves in the visible part of the electromagnetic spectrum. So microwave imagers used in car collision avoidance systems for their ability to see through fog and rain have a single detector that must be slowly moved across a plane with the help of complicated, expensive gears.

Source: **Science News**

DAMNED

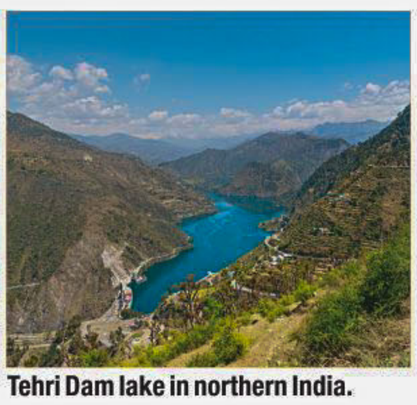
## Life-threatening Himalayan dams

A team of researchers led by Professor Maharaj K. Pandit from the University Scholars Programme at the National University of Singapore (NUS) found that unprecedented dam building in the Indian Himalaya holds serious consequences for biodiversity and could pose a threat to human lives and livelihoods.

Prof Pandit, who also holds a courtesy appointment with the Department of Geography at the NUS Faculty of Arts and Social Sciences, and his team at the University of Delhi and the Kunming Institute of Botany of the Chinese Academy of Sciences investigated close to 300 dams and related hydropower infrastructure on the Himalayan rivers across some of the biggest river basins in the world, namely the Indus, Ganga and Brahmaputra. The study, co-funded by NUS, was published in the journal Science in January 2013 as well as other scientific journals such as Conservation Biology, PLOS ONE and cited in a Nature article in 2012.

**Impact of dam-building activities on biodiversity**

Using field data and modelling, the researchers discovered that almost 90% of the Himalayan valleys would be affected by dam building and that 27% of these dams would affect dense forests with unique biodiversity. The team projected that dam-related activities will submerge and destroy about 170,000 hectares of forests. The researchers also predicted that the dam density in the Himalaya is likely to be about 62 times greater than the current global average, which would



Tehri Dam lake in northern India.

result in deforestation and the extinction of 22 flowering plants and 7 vertebrate species.

Impact of dam-building activities on human lives

Furthermore, the study found that water volume is the main driver of the richness of fish species in the rivers. Water withdrawals due to massive dam building activity would seriously undermine fish survival and diversity, fragment habitats and limit fish migration in these rivers, with long-term consequences for the livelihoods of fishermen.

Besides threatening biodiversity, the study also revealed the impact of dam-building activities on human lives and livelihoods. Due to high population density, dams have displaced Indian citizens for decades.

Prof Pandit opined, "We are deeply aware of the country's need to develop economically. However, there is a need to balance development and not venture into haphazard dam building without caring for biodiversity and people."

Recommendations to improve dam-building projects

The findings from the study highlight the need for sustainable power development. In their paper published in Science, Prof Pandit and his co-author Dr Edward Grumbine from the Kunming Institute of Botany of the Chinese Academy of Sciences provided suggestions to improve the planning and implementation of India's proposed Himalaya hydropower projects such as the reduction of power losses during transmission and distribution.

Prof Pandit sees an important role for Singapore in this area. He explained, "The power infrastructure in India is worn out and needs to be updated. Singapore has the technological know-how in the maintenance of transmission and distribution networks and this is a golden opportunity for Singapore to provide expertise to aid India's efforts on environmental conservation."

Further research into biodiversity and conservation

Prof Pandit will continue his research on the impact of water withdrawals on the biodiversity of Himalayan rivers at NUS. His research will focus on the large number of endemic species inhabiting the marshy habitats and the floodplains in the Himalayan foothills, such as the one-horned rhino, which are likely to go extinct due to upstream water withdrawals.

Source: **Science Daily**

FLEETING DINOS

## Swimming Dinosaurs

FOSSILIZED track marks from a stampede of dinosaurs in Australia actually may have come from swimming animals, new research suggests.

The finding, published in the January issue of the Journal of Vertebrate Paleontology, upends the traditional interpretation of the world's only dinosaur stampede.

Instead of a group of small dinosaurs trying to escape a massive carnivore, the fossils may reveal an ancient dinosaur "superhighway" or river crossing, said study co-author Anthony Romilio, a paleontologist at the University of Queensland in Australia.

**Dinosaur tracks**

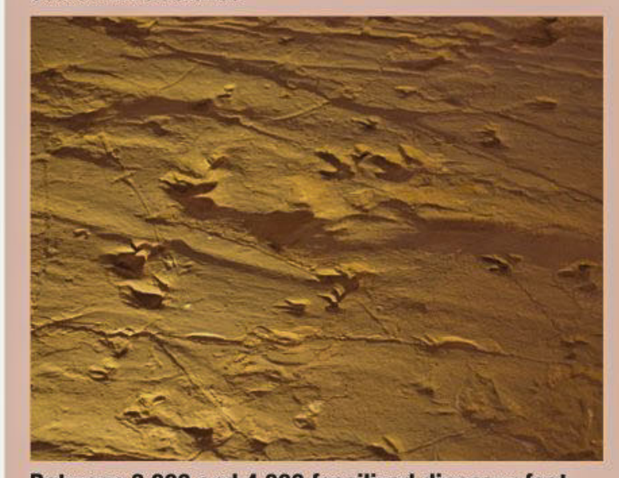
Some 3,000 to 4,000 fossilized dinosaur footprints were formed about 95 million years ago in a sandy riverbank in what was once a lush, coniferous forest. The site, known as Lark Quarry, is only about the size of a basketball court, and has become an enclosed and air-conditioned museum a major tourist attraction in Australia.

The tracks came from several types of dinosaurs, ranging in size from a chicken to an emu with one oddball: a giant dinosaur that left its 23.6-inch-long (60 centimeters) footprints there.

In 1984, scientists Tony Thulborn and Mary Wade interpreted the tracks as evidence of a stampede of smaller dinosaurs escaping the clutches of a 4-ton theropod, a bipedal carnivore. [Paleo Art: Stunning Illustrations of Dinosaurs]

But in recent work, Romilio and his colleagues studied the large track marks and concluded the primeval creature was actually a large plant-eating dinosaur called Muttaburrasaurus. That suggested the "fleeing a predator" theory needed a rethink.

Source: **Live Science**



Between 3,000 and 4,000 fossilized dinosaur footprints were found in Central Australia.

STAR NURSERY

SOURCE: SCIENCE DAILY

## Space clouds

A jaw-dropping new photo from a telescope in South America has revealed a smoke-black cloud in deep space hiding a bustling nursery of baby stars.

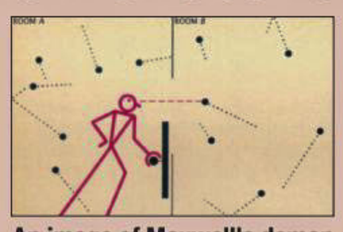
The new image, captured by a telescope at the European Southern Observatory in Chile, is the best view ever of the dark space cloud Lupus 3. The cosmic cloud is about 600 light-years from Earth in the constellation Scorpious (The Scorpion).

This evocative image shows a dark cloud where new stars are forming along with a cluster of brilliant stars that have already emerged from their dusty stellar nursery. This cloud is known as Lupus 3 and it lies about 600 light-years from Earth in the constellation of Scorpius.

DID YOU KNOW?

## What is Maxwell's demon?

In the philosophy of thermal and statistical physics, Maxwell's demon is a thought experiment created by the physicist James Clerk Maxwell to "show that the Second Law of Thermodynamics has only a statistical certainty".



An image of Maxwell's demon extracting energy from the thermal motion of particles in Escher's Waterfall.

It demonstrates Maxwell's point by hypothetically describing how to violate the Second Law: a container of gas molecules at equilibrium, is divided into two parts by an insulated wall, with a door that can be opened and closed by what came to be called "Maxwell's demon".