Environment News Futures

‘Hot Spots’ Increase Efficiency of Solar Desalination

June 18, 2019— Rice University

Researchers in Rice’s Laboratory for Nanophotonics (LANP) this week showed they could boost the efficiency of their solar-powered desalination system by more than 50% simply by adding inexpensive plastic lenses to concentrate sunlight into “hot spots.” The results are available online in the *Proceedings of the National Academy of Sciences*.

“The typical way to boost performance in solar-driven systems is to add solar concentrators and bring in more light,” said Pratiksha Dongare, a graduate student in applied physics at Rice’s Brown School of Engineering and co-lead author of the paper. “The big difference here is that we’re using the same amount of light. We’ve shown it’s possible to inexpensively redistribute that power and dramatically increase the rate of purified water production.”

In conventional membrane distillation, hot, salty water is flowed across one side of a sheetlike membrane while cool, filtered water flows across the other. The temperature difference creates a difference in vapour pressure that drives water vapour from the heated side through the membrane toward the cooler, lower-pressure side. Scaling up the technology is difficult because the temperature difference across the membrane—and the resulting output of clean water—decreases as the size of the membrane increases. Rice’s “nanophotonics-enabled solar membrane distillation” (NESMD) technology addresses this by using light-absorbing nanoparticles to turn the membrane itself into a solar-driven heating element.

Dongare and colleagues, including study co-lead author Alessandro Alabastri, coat the top layer of their membranes with low-cost, commercially available nanoparticles that are designed to convert more than 80% of sunlight energy into heat. The solar-driven nanoparticle heating reduces production costs, and Rice engineers are working to scale up the technology for applications in remote areas that have no access to electricity.

The concept and particles used in NESMD were first demonstrated in 2012 by LANP director Naomi Halas and research scientist Oara Neumann, who are both co-authors on the new study. In this week’s study, Halas, Dongare, Alabastri, Neumann and LANP physicist Peter Nordlander found they could exploit an inherent and previously unrecognized nonlinear relationship between incident light intensity and vapour pressure.

Past Climate Change: A Warning for the Future?

Disruptions rippled out from climate change in South America

June 17, 2019—University of Utah

A new study of climate changes and their effects on past societies offers a sobering glimpse of social upheavals that might happen in the future. The prehistoric groups studied lived in the Amazon

Basin of South America hundreds of years ago, before European contact, but the disruptions that occurred may carry lessons for our time, says study coauthor Mitchell J. Power, curator of the Garrett Herbarium at the Natural History Museum of Utah, University of Utah.

The paper, "Climate change and cultural resilience in late pre-Columbian Amazonia," published on the *Nature Ecology & Evolution* website June 17, traces impacts in the Amazon before 1492. Climatic conditions in the Amazon Basin underwent natural shifts during periods when much of the rest of the Earth also was impacted. These times are known as the Medieval Climate Anomaly, from about AD 900 to 1250, and the Little Ice Age, 1450-1850. In Amazonia, rainfall amounts and patterns changed, affecting agriculture and subsistence patterns.

Presently, climate change is affecting most parts of the world; but the difference now is that it's human-caused.

One of the biggest problems in the future may be that climate extremes will harm many countries, and that their "climate refugees" will be pushed from ancestral homes into more temperate and developed places not as badly affected by climate change. The migrations could cause great stresses in the host countries, Power said.

The surprising results of the study show that these types of crises occurred during and after the first millennium in the Amazon Basin.

"Were we getting a window into that in prehistoric Amazonia? I think so," said Power, who is also an associate professor of geography at the University of Utah. "So it's kind of a one-two punch: if the climate doesn't get you, it might be the thousands of bodies that show up that you have to feed because extreme drought forced them out of their homelands."

Climate was a dominant factor in the social and cultural changes in ancient Amazonia, he emphasized, but the study also shows "more nuanced" effects because of subsistence and cultural practices as well as population movements. In particular, those cultural groups that subsisted with diverse food resources or polycultures and agroforestry, avoided political hierarchies with an elite ruling class, and adopted a strategy of creating organic and charcoal-rich soil, called "Amazonian Dark Earth," were most resilient to extreme climate variations.

The scientists searched for indications of prehistoric climate and culture in six regions throughout the enormous Amazon Basin during the last few thousand years: the Guianas Coast, Lianos de Moxos, and the Eastern, Central, Southwestern and Southern Amazon. Up to 8-10 million people were estimated to have lived in the Greater Amazon region before European contact. Researchers synthesized paleoecological, archaeological and paleoclimate studies by combining evidence of changes in natural vegetation and cultigens, changes in precipitation and disturbance regimes as well as changes in cultural practices and population movements.

Rainfall estimates were derived by measuring the percent of titanium in sediments deposited by runoff, as well as oxygen isotopes in cave speleothem records from across Amazonia. Botanical remains, including phytoliths (microscopic silica formations in plant tissue that are long-lasting in the soil), pollen- and other plant fossil-based evidence of cultigens, including maize, manioc, squash, peanuts and cotton was used to reconstruct subsistence strategies through time.

Earth's Heavy Metals Result of Supernova Explosion, Research Reveals

June 13, 2019—University of Guelph

In a finding that may overthrow our understanding of where Earth's heavy elements such as gold

and platinum come from, new research by a University of Guelph physicist suggests that most of them were spewed from a largely overlooked kind of star explosion far away in space and time from our planet.

Some 80 per cent of the heavy elements in the universe likely formed in collapsars, a rare but heavy element-rich form of supernova explosion from the gravitational collapse of old, massive stars typically 30 times as weighty as our sun, said physics professor Daniel Siegel.

Boy or Girl? It's in the Father's Genes

December 12, 2008—Newcastle University

A Newcastle University study involving thousands of families is helping prospective parents work out whether they are likely to have sons or daughters. The work by Corry Gellatly, a research scientist at the university, has shown that men inherit a tendency to have more sons or more daughters from their parents. This means that a man with many brothers is more likely to have sons, while a man with many sisters is more likely to have daughters.

The research involved a study of 927 family trees containing information on 556,387 people from North America and Europe going back to 1600.

"The family tree study showed that whether you're likely to have a boy or a girl is inherited. We now know that men are more likely to have sons if they have more brothers but are more likely to have daughters if they have more sisters. However, in women, you just can't predict it," Mr Gellatly explains.

Men determine the sex of a baby depending on whether their sperm is carrying an X or Y chromosome. An X chromosome combines with the mother's X chromosome to make a baby girl (XX) and a Y chromosome will combine with the mother's to make a boy (XY).

The Newcastle University study suggests that an as-yet undiscovered gene controls whether a man's sperm contains more X or more Y chromosomes, which affects the sex of his children. On a larger scale, the number of men with more X sperm compared to the number of men with more Y sperm affects the sex ratio of children born each year.

Sons or daughters?

A gene consists of two parts, known as alleles, one inherited from each parent. In his paper, Mr Gellatly demonstrates that it is likely men carry two different types of allele, which results in three possible combinations in a gene that controls the ratio of X and Y sperm.
Men with the first combination, known as mm, produce more Y sperm and have more sons.

- The second, known as mf, produce a roughly equal number of X and Y sperm and have an approximately equal number of sons and daughters.
- The third, known as ff produce more X sperm and have more daughters.

"The gene that is passed on from both parents, which causes some men to have more sons and some to have more daughters, may explain why we see the number of men and women roughly balanced in a population. If there are too many males in the population, for example, females will more easily find a mate, so men who have more daughters will pass on more of their genes, causing more females to be born in later generations," says Newcastle University researcher Mr Gellatly.

Origin of Life: A Prebiotic Route to DNA

June 18, 2019—Ludwig-Maximilians-Universität München

DNA, the hereditary material, may have appeared on Earth earlier than has been assumed hitherto. Chemists now show that a simple reaction pathway could have given rise to DNA subunits on the early Earth.

Spiders Risk Everything for Love

Extravagant courtship displays make wolf spiders an easy target for birds

June 20, 2019—University of Cincinnati

A biology study finds that blue jays can easily spot wolf spiders engaged in their courtship rituals. The results demonstrate the powerful influence of sexual selection. University of Cincinnati biologist George Uetz long suspected the extravagant courtship dance of wolf spiders made them an easy mark for birds and other predators. But it was only when he and colleague Dave Clark from Alma College teamed up with former University of Minnesota researcher Tricia Rubi and her captive colony of blue jays that he could prove it.