



ISSN 0975 - 2986



ENVIS ON HAZARDOUS WASTES

Newsletter

Vol.11 No. 10-12

Sponsored by Ministry of Environment, Forest and Climate Change

October-December 2016

Current News

Reef degradation on Maui linked to quality of coastal groundwater

Land-based pollutants, such as fertilizers and chemicals in wastewater, infiltrate into the groundwaters beneath land and eventually exit into nearshore ecosystems as submarine groundwater discharge (SGD)--seeping into the coastal zone beneath the ocean's surface. A new study used a combination of field experiments and chemical analysis of water and algae to show that the quality of coastal groundwater plays a major role in determining the health of nearshore ecosystems in Hawai'i.

Land-use practices on tropical oceanic islands can have large impacts on reef ecosystems, even in the absence of rivers and streams. Various sources of pollution, such as agriculture or sewage treatment facilities, have identifiable chemical signatures, particularly the isotopes of nitrogen in the nutrients they contain. This study assessed groundwater quality, coastal water quality and reef health across six different bays on Maui with various potential sources of pollution. By comparing the nitrogen isotope signature of algae tissues and potential pollution, the research group traced nutrients in the algae back to their land-based sources. This study is the first to show the extent of the impact of wastewater injection wells at Kahului Wastewater Reclamation Facility, Maui's highest-volume sewage treatment plant, on Kahului Bay. In addition to relatively high nutrient levels in marine surface waters in Kahului Bay, shallow areas were almost entirely dominated by a thick fleshy mat of

colonial zoanths, a phenomenon not reported anywhere else in the state. A concurrent companion study to this work, led by James Bishop at the UHM Department of Geology and Geophysics, found that water collected from beach sands, which represents coastal groundwater, next to the Kahului Wastewater Reclamation Facility contained up to 75% treated wastewater -- highlighting the impact of wastewater in this area.

"Our timely study builds on previous research from UH scientists and recent federal court rulings that show that treated wastewater is



Two samples of *Ulva* spp., that were deployed near shore on Maui, show large differences due to growth in coastal waters that have either high (left) or low (right) levels of SGD-derived nitrogen

illegally discharged to the ocean from injection wells at the Lahaina Wastewater Reclamation facility via SGD to Kahekili Beach Park on West Maui," said Daniel Amato, lead author and recent graduate of the UHM College of Natural Sciences. "This is not an isolated or unique occurrence." Reefs adjacent to large areas of sugarcane agriculture were the most impacted of all the sites in this study. At Ku'au and M 'alaea Bays, coastal waters contained nearly 100 times more nitrogen than less impacted locations due to fertilizer-enriched SGD. These high levels of nutrients were reflected in the tissues of common macroalgae and measures of reef community structure. A few species of macroalgae dominated intertidal and subtidal surfaces at Ku'au and M 'alaea Bays. In contrast, areas where coastal groundwater nutrient levels were relatively low, researchers observed much greater diversity and corals were generally present, indicating a healthier, potentially more robust, ecosystem.

This study suggests that contaminated groundwater may present a chronic risk to nearshore marine ecosystems throughout the main Hawaiian Islands. These results are especially significant for coastal managers and lawmakers who will influence the future of land-use policy in Hawai'i. Of particular future interest is the possible benefit gained in health of our reefs by the reduction in Maui's sugarcane production. Reducing groundwater pollution could result in future increases in reef health and decreases in the occurrence of nuisance algal blooms for impacted areas. "The long-term goal of this research group is to bridge the disciplines of hydrology, geochemistry and marine biology to help answer pressing questions regarding the source and impact of nutrient pollution in Hawaiian coastal waters," said Craig Glenn, Henrietta Dulaiova and Celia Smith, the collaborating principal investigators and co-authors of the Hawai'i Sea Grant project.

(Source: Daniel W. Amato, James M. Bishop, Craig R. Glenn, Henrietta Dulai, Celia M. Smith. Impact of Submarine Groundwater Discharge on Marine Water Quality and Reef Biota of Maui. PLOS ONE, 2016; 11 (11): e0165825 DOI: 10.1371/journal.pone.0165825; <https://www.sciencedaily.com/releases/2016/11/161116101435.htm>)

New LEDs may offer better way to clean water in remote areas

Nanotech enables powerful and portable sterilization equipment. For the first time, researchers have created light-emitting diodes (LEDs) on lightweight flexible metal foil. Engineers are developing the foil based LEDs for portable ultraviolet (UV) lights that soldiers and others can use to purify drinking water and sterilize medical equipment.

In the journal *Applied Physics Letters*, the researchers describe how they designed the LEDs to shine in the high-energy "deep" end of the UV spectrum. The university will license the technology to industry for further development.

Deep UV light is already used by the military, humanitarian organizations and industry for applications ranging from detection of biological agents to curing plastics, explained Roberto Myers,



Ohio State University researchers have developed a technique to create light emitting diodes on metal foil

associate professor of materials science and engineering at Ohio State. The problem is that conventional deep-UV lamps are too heavy to easily carry around.

"Right now, if you want to make deep ultraviolet light, you've got to use mercury lamps," said Myers, who is also an associate professor of electrical and computer engineering. "Mercury is toxic and the lamps are bulky and electrically inefficient. LEDs, on the other hand, are really efficient, so if we could make UV LEDs that are safe and portable and cheap, we could make safe drinking water wherever we need it." He noted that other research groups have fabricated deep-UV LEDs at the laboratory scale, but only by using extremely pure, rigid single-crystal semiconductors as substrates—a strategy that imposes an enormous cost barrier for industry. Foil-based nanotechnology could enable large-scale production of a lighter, cheaper and more environmentally friendly deep-UV LED. But Myers and materials science doctoral student Brelon J. May hope that their technology will do something more: turn a niche research field known as nanophotonics into a viable industry.

"People always said that nanophotonics will never be commercially important, because you can't scale them up. Well, now we can. We can make a sheet of them if we want," Myers said. "That means we can consider nanophotonics for large-scale manufacturing." In part, this new development relies on a well-established semiconductor growth technique known as molecular beam epitaxy, in which vaporized elemental materials settle on a surface and self-organize into layers or nanostructures. The Ohio State researchers used this technique to grow a carpet of tightly packed aluminum gallium nitride wires on pieces of metal foil such as titanium and tantalum. The individual wires measure about 200 nanometers tall and about 20-50 nanometers in diameter—thousands of times narrower than a human hair and invisible to the naked eye. In laboratory tests, the nanowires grown on metal foils lit up nearly as brightly as those manufactured on the more expensive and less flexible single-crystal silicon. The researchers are working to make the nanowire LEDs even brighter, and will next try to grow the wires on foils made from more common metals, including steel and aluminum.

(Source: <https://www.sciencedaily.com/releases/2016/11/161115155318.htm>)

Wastewater treatment plants: An overlooked source of carbon emissions

Nations that pledged to carry out the Paris climate agreement have moved forward to find practical ways to reduce greenhouse gas emissions, including efforts to ban hydrofluorocarbons and set stricter fuel-efficiency standards. Now scientists report that one source of carbon dioxide, a primary greenhouse gas, has been overlooked: wastewater treatment plants. Based on their findings, they recommend actions that could curb emissions from this source.

Linda Y. Tseng, currently at Colgate University, Diego Rosso, and colleagues from the University of California, Irvine, note that when the Intergovernmental Panel on Climate Change (IPCC) estimated global carbon dioxide (CO₂) emissions, the data available to the organization did not include CO₂ emission estimates from



wastewater, which may contain fossil sources of carbon such as petrochemicals. Although it does take into account greenhouse gases methane and nitrous oxide, the IPCC model assumes that wastewater largely contains and releases carbon from non-petroleum sources -- for example, human waste. However, studies have shown that relevant amounts of petroleum products, such as synthetic chemicals from detergents, wash into wastewater and can eventually add to total greenhouse gas emissions. The team investigated the fossil-related carbon content of municipal and industrial wastewaters at various points in the treatment process. Including this carbon from treatment plants could increase estimates of their total greenhouse gas emissions by 12 to 23 percent over previous estimates that only included methane and nitrous oxide. However, the researchers found that treating wastewater sludge could offer an opportunity to reduce the fossil carbon emissions from treatment plants. They note that on-site carbon sequestration run on renewable energy could also lower these plants' impact.

(Source: Linda Y. Tseng, Alice K. Robinson, Xiaying Zhang, Xiaomei Xu, John Southon, Andrew J. Hamilton, Reza Sobhani, Michael K. Stenstrom, Diego Rosso. Identification of Preferential Paths of Fossil Carbon within Water Resource Recovery Facilities via Radiocarbon Analysis. *Environmental Science & Technology*, 2016; DOI: 10.1021/acs.est.6b02731; <https://www.sciencedaily.com/releases/2016/11/161102085229.htm>)

Hexavalent chromium is widespread in North Carolina wells but not linked to coal ash

Hexavalent chromium, a carcinogen made famous by the movie Erin Brockovich, is far more abundant in drinking water wells in North Carolina than previously thought, a new study finds.

The contamination doesn't, however, stem from leaking coal ash ponds as many people feared after state officials tested wells near coal plants last year and detected potentially harmful levels of hexavalent chromium in the water. Instead, it's caused by the natural leaching of mostly volcanic rocks in aquifers across the Piedmont region. "About 90 percent of the wells we sampled had detectable levels of hexavalent chromium, and in many cases the contamination is well above recommended levels for safe drinking water. But our analysis clearly shows it is derived from natural sources, not coal ash," said Avner Vengosh, professor of geochemistry and water quality at Duke's Nicholas School of the Environment. "This doesn't mean it poses less of a threat," Vengosh stressed. "If anything, because the contamination stems from water-rock interactions that are common across the Piedmont region, people in a much larger geographic area may be at risk. This is not limited only to wells near coal ash ponds. "The bottom line is that we need to protect the health of North Carolinians from the naturally occurring threat of hexavalent chromium, while also protecting them from harmful contaminants such as arsenic and selenium, which our previous research has shown do derive from leaking coal ash ponds," Vengosh said. "The impact of leaking coal ash ponds on water resources is still a major environmental issue."

To conduct the new study, the researchers collected groundwater samples from 376 wells located both close to and far from coal ash ponds across the Piedmont region of central North Carolina. Using forensic geochemical tracers, they analyzed each sample for a wide range of inorganic chemicals, including hexavalent chromium. The tracers, which were developed by Vengosh and his team, allowed the scientists to identify the geochemical fingerprints of contaminants in the groundwater and trace each contaminant back to its source. "Our analysis showed that groundwater samples with high levels of hexavalent chromium have very different geochemical fingerprints than what we see in groundwater contaminated from leaking coal ash ponds," Vengosh said. "This, combined with the wide geographic distribution of samples containing elevated hexavalent chromium -- regardless of proximity to a coal ash pond -- points to the natural leaching of chromium from aquifer rocks in certain Piedmont geological formations," he said. Piedmont formations with volcanic rocks are common across the southeastern United States and other areas worldwide, Vengosh noted, so

millions of people in regions outside North Carolina with similar aquifers may be exposed to hexavalent chromium without knowing it. The Duke team published its findings in the peer-reviewed journal *Environmental Science and Technology Letters*.



In 2015, water-quality officials in North Carolina issued temporary "do not drink" recommendations to residents living near coal-burning plants after tests detected potentially harmful levels of hexavalent chromium in their well water samples. Because elevated levels of chromium typically occur in coal ash, many people assumed the contamination was linked to the coal ash ponds. Vengosh's team's study is the first to show otherwise. The current drinking water standard for chromium in the United States is 100 parts per billion. This is based on an assumption that most chromium contained in drinking water is composed of a less toxic form known as trivalent chromium. Only California has set a statewide standard of 10 parts per billion for the much more toxic hexavalent form. Vengosh hopes his study's findings will lead more states to establish hexavalent chromium standards of their own. "One of the most striking outcomes of this study is that it shows the concentration of hexavalent chromium in groundwater is almost identical to the concentration of total dissolved chromium, measured by a totally different technique" he said. "That means when you will find chromium in groundwater, it is actually composed of its toxic form of hexavalent chromium, not the less toxic trivalent form." Groundwater testing revealed that nine out of ten drinking water wells in North Carolina's Piedmont region contain detectable levels of the carcinogen hexavalent chromium, and that the contamination stems from natural sources.

(Source: Avner Vengosh, Rachel Coyte, Jonathan Karr, Jennifer S. Harkness, Andrew J. Kondash, Laura S. Ruhl, Rose B. Merola, Gary S. Dywer. Origin of Hexavalent Chromium in Drinking Water Wells from the Piedmont Aquifers of North Carolina. *Environmental Science & Technology Letters*, 2016; DOI: 10.1021/acs.estlett.6b00342; <https://www.sciencedaily.com/releases/2016/10/161026111400.htm>)

Microbe hunters discover long-sought-after iron-munching microbe

A microbe that 'eats' both methane and iron: microbiologists have long suspected its existence, but were not able to find it - until now. Researchers have discovered a microorganism that couples the reduction of iron to methane oxidation, and could thus be relevant in controlling greenhouse gas emissions worldwide.

The balance between methane-producing and -consuming processes has a major effect on the worldwide emission of this strong greenhouse gas into our atmosphere. The team of microbiologists and biogeochemists now discovered an archaeon -- the other branch of ancient prokaryotes besides bacteria -- of the order Methanosarcinales that uses iron to convert methane into carbon dioxide. During that process, reduced iron become available to other bacteria. Consequently, the microorganism initiates an energy cascade influencing the iron and methane cycle and thus methane emissions, describe first authors Katharina Ettwig and Baoli Zhu in the paper.

Application in wastewater treatment

Besides, these archaea have another trick up their sleeve. They can turn nitrate into ammonium: the favourite food of the famous anammox bacteria that turn ammonium into nitrogen gas without using oxygen. "This is relevant for wastewater treatment," says Boran Kartal, a microbiologist who recently moved from Radboud University to the Max Planck Institute in Bremen. "A bioreactor containing anaerobic methane and ammonium oxidizing microorganisms can be used to simultaneously convert ammonium, methane and oxidized nitrogen in wastewater into harmless nitrogen gas and carbon dioxide, which has much lower global warming potential." The same process could also be important in paddy fields, for example, which account for around 20 percent of human-related emissions of methane.

Closer than expected

While there have been numerous indications that such iron-dependent methane oxidizers existed, researchers have never been able to isolate them. Surprisingly, they were right in front of our doorstep: "After years of searching, we found them in our own sample collection," says microbiologist Mike Jetten of Radboud University with a smile. "We eventually discovered them in enrichment cultures from the Twentekanaal in The Netherlands that we've had in our lab for years. We obtained a large amount of biomass by feeding them with methane and nitrate." Kartal adds, "Based on the genetic blueprint of these microorganisms, we hypothesized that they could also convert particulate iron coupled to methane oxidation. When we tested our hypothesis in the lab, these organisms did the trick." In the next step, Kartal wants to look closer into the details of the process. "These findings fill one of the remaining gaps in our understanding of anaerobic methane oxidation. Now we want to further investigate which protein complexes are involved in the process."

Magical square of microbiology

Years ago, Jetten and his team drew up a table chart with available electron donors and acceptors, that should allow for the growth of -- still unknown -- microorganisms. He expected that each box would fit a bacteria or archaeon, since evolution rarely leaves a niche unoccupied. His team has already discovered eight of the nine ghost microorganisms in the table chart: Methanosarcinales fills up the next-to-last box. "This is a really special finding," Jetten explains. "We hope to discover the last microorganism soon, but Australian and American researchers are snapping at our heels, so these are exciting times."

Billions of years ago

The newly discovered process could also lead to new insights into the early history of our planet. Already billions of years ago, *Methanosarcinales archaea* might have abundantly thrived under the methane-rich atmosphere in the ferruginous (iron holding) Archaean oceans, 4 to 2.5 billion years ago. More information on the metabolism of this organism can therefore shed new light on the long-standing discussion of the role of iron metabolism on early earth.

(Source: Katharina F. Ettwig, Baoli Zhu, Daan Speth, Jan T. Keltjens, Mike S. M. Jetten, and Boran Kartal. *Archaea catalyze iron-dependent anaerobic oxidation of methane*. PNAS, October 2016 DOI: 10.1073/pnas.1609534113; <https://www.sciencedaily.com/releases/2016/10/161024161655.htm>)

Non-toxic solvent removes barrier to commercialization of perovskite solar cells

Scientists have developed a solvent system with reduced toxicity that can be used in the manufacture of perovskite solar cells, clearing one of the barriers to the commercialization of a technology that promises to revolutionize the solar industry.

Perovskites -- a family of materials with the crystal structure of calcium titanate -- have been described as a 'wonder material' and

shown to be almost as efficient as silicon in harnessing solar energy, as well as being significantly cheaper to produce. By combining methylamine and acetonitrile, researchers have developed a clean solvent with a low boiling point and low viscosity that quickly crystallises perovskite films at room temperature and could be used to help coat large solar panels with the material. The results are published in the Royal Society of Chemistry journal *Energy & Environmental Science*. Dr Nakita Noel of Oxford's Department of Physics, lead author of the study, said: 'At the moment, there are three main solvents used in the manufacture of perovskite solar cells, and they are all toxic, which means you wouldn't want to come into contact with them. 'Additionally, the most efficient perovskite solar cells are currently made through a process called solvent quenching -- a technique that is not easily transferred from lab-scale deposition techniques to large-scale deposition techniques. While vapour deposition of these materials can overcome this problem, it will come at additional costs. One of the main selling points of this material is that it is cheap and can be easily solution-processed. 'We have now developed the first clean, low-boiling-point, low-viscosity solvent for this purpose.' Dr Noel added: 'What is really exciting about this breakthrough is that largely reducing the toxicity of the solvent hasn't led to a reduction in the efficiency of the material in harnessing solar energy.'



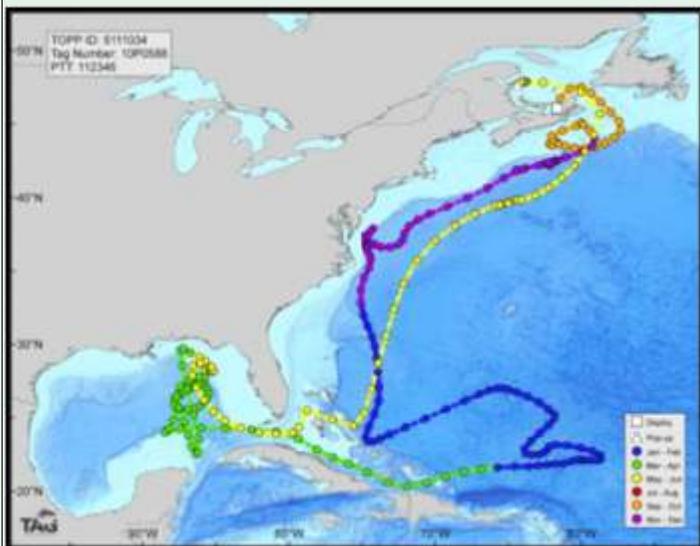
In recent years, perovskite-based solar cells have raced to the front of emerging photovoltaics, already competing on efficiency against well-established solar technologies such as the inorganic thin-film and multi-crystalline silicon used in solar panels around the world. Perovskites also have the shortest 'energy payback time' -- the time taken for a material to save the same amount of energy that was expended in its production. It has been said that the sun supplies enough power in 90 minutes to meet the world's total energy needs for a year. Study co-author Dr Bernard Wenger, also of Oxford's Department of Physics, said: 'While we are probably still a few years from seeing perovskite-based solar panels on people's roofs, this is a big step along the way.' Professor Henry Snaith, senior author on the paper and leader of the photovoltaics group at Oxford, has been a pioneer in the development of perovskite solar cells and was one of the first researchers to recognise their potential as a low-cost, highly efficient material for this purpose.

(Source: Nakita K. Noel, Severin N. Habisreutinger, Bernard Wenger, Matthew T. Klug, Maximilian T. Hörantner, Michael B. Johnston, Robin J. Nicholas, David T. Moore, Henry J. Snaith. A low viscosity, low boiling point, clean solvent system for the rapid crystallisation of highly specular perovskite films. *Energy Environ. Sci.*, 2016; DOI: 10.1039/c6ee02373h; <https://www.sciencedaily.com/releases/2016/10/161005103628.htm>)

Deepwater Horizon oil spill impacted bluefin tuna spawning habitat in Gulf of Mexico

The release of 4 million barrels of crude oil into the Gulf of Mexico during the Deepwater Horizon disaster during peak spawning season for Atlantic bluefin tuna could have both near- and long-term impacts on the population, new research shows.

In a study published in *Nature: Scientific Reports*, scientists from Stanford and NOAA provide the best yet analysis of how the 2010 breeding season might have been impacted by the oil spill. Although the spill encompassed a relatively small proportion of the bluefin tuna spawning grounds, which extend throughout the northern Gulf of Mexico, the authors showed the cumulative oiled tuna habitat was roughly 3.1 million square miles, representing the potential for a significant impact on eggs and larval bluefin tuna in the Gulf of Mexico. The authors concluded that the spill impacts combined with the multiple stressors of ocean warming and fishing pressure could make it more difficult for this unique population to rebuild. "We know that bluefin tuna face numerous threats in the Gulf of Mexico and the oil spill represents another potential impact during a critical portion of their life history," said Elliott Hazen of NOAA Fisheries' Southwest Fisheries Science Center in La Jolla, California, and first author of the study. The scientists directly mapped the preferred spawning habitat of the Atlantic bluefin tuna by drawing from a 16-year data set of electronic tagging data from 66 fish, which provided information such as the animals' locations, temperatures and unique diving patterns after up to a year of being tracked on sojourns of thousands of miles. They then overlaid this data with satellite observations of the oil spill's reach, to map the potential impact. "It took us many years to establish and perfect the techniques of putting a satellite tag, essentially a small computer, on giant bluefin tuna, many over 1,000 pounds in this study, and figure out exactly where and when they potentially spawn in the Gulf of Mexico," said study co-author Barbara A. Block, a professor of marine sciences at Stanford. Block led the effort to discern exactly where and when the bluefin spawn. They found that the timing of the oil spill directly overlapped with the maximum extent of adult bluefin tuna foraging and spawning habitat in the Gulf of Mexico. At its peak in May 2010, the spill covered more than 5 percent of the spawning habitat of Atlantic bluefin tuna in the U.S. Exclusive Economic Zone.



Electronic tagging data from bluefin tuna show that the fish were actively spawning in the Gulf of Mexico during the height of the Deepwater Horizon spill (green and yellow data points)

Exposure to oil has previously been shown to have physiological consequences to the heart, and can cause deformations and death in eggs and larval fish, making it crucial to understand the effects in order to assess the impacts of oil spills. The effect of oil on spawning adult fish is not as well understood but the crude oil may add stressors to all life history stages occurring in the Gulf of Mexico. "The bluefin tuna population in the Gulf of Mexico has been struggling to rebuild to healthy levels for over 30 years," Block said. "These fish are a genetically unique population, and thus stressors such as the Deepwater Horizon oil spill, even if minor, may have population-level effects. It is difficult to measure recruitment from the Gulf of Mexico post-2010, as the fish take a long time to enter into the commercial fishery where monitoring occurs, so we remain

concerned." The researchers said that their results are only inferring that the Deepwater Horizon spill likely harmed a sliver of the spawning habitats, and thus at least some of the 2010 class of bluefin tuna, but further monitoring is needed to understand how that affects the population at large. "Because of their economic and ecological importance, we need to ensure the conservation and protection of Atlantic bluefin tuna on their spawning grounds," Hazen said. "We need to ensure maintained -- if not increased -- monitoring of Atlantic bluefin tuna in the years to come."

(Source: Elliott L. Hazen, Aaron B. Carlisle, Steven G. Wilson, James E. Ganong, Michael R. Castleton, Robert J. Schallert, Michael J. W. Stokesbury, Steven J. Bograd, Barbara A. Block. Quantifying overlap between the Deepwater Horizon oil spill and predicted bluefin tuna spawning habitat in the Gulf of Mexico. *Scientific Reports*, 2016; 6: 33824 DOI: 10.1038/srep33824 ; <https://www.sciencedaily.com/releases/2016/10/161003131241.htm>)

How Have China's Crabs Revealed a Pollution Crisis?

Chinese authorities banned the exportation of hairy crabs from two mainland farms after testing uncovered contaminated crabs in Hong Kong. The affected crabs contained harmful levels of dioxins, a carcinogenic chemical compound which can also damage the immune system and reproductive organs.

More concerning, it has surfaced that dioxin-testing is not normal practice among hairy crab farmers, meaning that the carcinogens could have been present in crab samples for years.

Anasty contaminant

During testing, the Chinese Centre for Food Safety found that two out of five hairy crab samples contained alarming amounts of dioxins and polychlorinated biphenyls. These are complex chemical compound which have been known to wreak havoc on the body's reproductive and immune systems, as well as causing cancer if consumed in excessive levels. The "safe" level of dioxins is 6.5 picograms per gram. The concentrations of the substance in the two offending samples were 11.7 and 40.3 picograms per gram, respectively. As a result, the two mainland farms located in Jiangsu Province implicated in the scandal were prohibited from selling any more crabs until further notice. However, the pair supply as much as 80% of Hong Kong's import market and it's feared that countless contaminated crabs have already been sold and consumed.

No immediate cause for concern

The Centre for Food Safety were quick to downplay fears, claiming that there was no immediate threat to anyone's health unless they had consumed the offending crustaceans in excessive quantities. Dr Philip Ho Yuk-yin claimed that a person would not have exceeded their recommended limit of the toxins unless they ate more than 14 large crabs over a three-month period. For those whose diet consisted mostly of fatty foods, the safe number of crabs would drop to just three. The dioxins and polychlorinated biphenyls are formed as by-products of a variety of industrial processes, such as pesticide, steel and paint production, as well as toxic waste incineration. Unfortunately, the compounds involved are fat-soluble, meaning they're difficult to break down. It's this longevity that is of particular concern, especially since the area around Lake Tei (the breeding ground for many of the crabs) is a heavily industrialised one.

The extent of the problem unknown

Most concerning of all, the director of one of the mainland farms implicated in the story Sun Xingliang says that his products have never been tested for dioxins in the past. "It's the first time that my company's product has been accused of dioxin contamination in 16 years of exporting. I have no idea what a dioxin is," he said. Meanwhile, a director of an environmental thinktank Mao Da confirmed fears that the toxins could be present across China and beyond, since the crabs are also exported to Macau, Taiwan and

Singapore. "The mainland's food safety standards do not refer to dioxin levels," he said. "So it is possible that hairy crabs sold on the mainland are also tainted with dioxin." Clearly, stricter dioxin remediation is called for, similar to that which is currently taking place in Danang in neighbouring Vietnam, where US incentives are hopeful of clearing up the toxic fallout caused by the Vietnam War.

(Source: <https://www.pollutionsolutions-online.com/news/hazardous-waste/20/breaking-news/how-have-china39s-crabs-revealed-a-pollution-crisis/41156>)

Scientists discover hazardous waste-eating bacteria

Tiny single-cell organisms discovered living underground could help with the problem of nuclear waste disposal, say researchers involved in a study at The University of Manchester.

Although bacteria with waste-eating properties have been discovered in relatively pristine soils before, this is the first time that microbes that can survive in the very harsh conditions expected in radioactive waste disposal sites have been found. The findings are published in the ISME (Multidisciplinary Journal of Microbial Ecology) journal. The disposal of our nuclear waste is very challenging, with very large volumes destined for burial deep underground. The largest volume of radioactive waste, termed 'intermediate level' and comprising of 364,000m³ (enough to fill four Albert Halls), will be encased in concrete prior to disposal into underground vaults. When ground waters eventually reach these waste materials, they will react with the cement and become highly alkaline. This change drives a series of chemical reactions, triggering the breakdown of the various 'cellulose' based materials that are present in these complex wastes.

One such product linked to these activities, isosaccharinic acid (ISA), causes much concern as it can react with a wide range of radionuclides - unstable and toxic elements that are formed during the production of nuclear power and make up the radioactive component of nuclear waste. If the ISA binds to radionuclides, such as uranium, then the radionuclides will become far more soluble and more likely to flow out of the underground vaults to surface environments, where they could enter drinking water or the food chain. However, the researchers' new findings indicate that microorganisms may prevent this becoming a problem. Working on soil samples from a highly alkaline industrial site in the Peak District, which is not radioactive but does suffer from severe contamination with highly alkaline lime kiln wastes, they discovered specialist "extremophile" bacteria that thrive under the alkaline conditions expected in cement-based radioactive waste. The organisms are not only superbly adapted to live in the highly alkaline lime wastes, but they can use the ISA as a source of food and energy under conditions that mimic those expected in and around intermediate level radwaste disposal sites. For example, when there is no oxygen (a likely scenario in underground disposal vaults) to help these bacteria "breathe" and break down the ISA, these simple single-cell microorganisms are able to switch their metabolism to breathe using other chemicals in the water, such as nitrate or iron.

The fascinating biological processes that they use to support life under such extreme conditions are being studied by the Manchester group, as well as the stabilizing effects of these humble bacteria on radioactive waste. The ultimate aim of this work is to improve our understanding of the safe disposal of radioactive waste underground by studying the unusual diet of these hazardous waste eating microbes. One of the researchers, Professor Jonathan Lloyd, from the University's School of Earth, Atmospheric and Environmental Sciences, said: "We are very interested in these Peak District microorganisms. Given that they must have evolved to thrive at the highly alkaline lime-kiln site in only a few decades, it is highly likely that similar bacteria will behave in the same way and adapt to living off ISA in and around buried cement-based nuclear waste quite quickly. "Nuclear waste will remain buried deep underground for many thousands of years so there is plenty of time for the bacteria to become adapted. Our next step will be to see what impact they have on radioactive materials. We expect them to help

keep radioactive materials fixed underground through their unusual dietary habits, and their ability to naturally degrade ISA."

(Source: http://www.brightsurf.com/news/headlines/100327/Scientists_discover_hazardous_waste-eating_bacteria.html)

Percolating a solution to hexavalent chromium

Coffee husks clean up toxic chromium. The metal chromium is an essential nutrient for plant and animal metabolism, but it can accumulate to toxic and hazardous levels in the environment when discharged in industrial waste water; a point made infamous by the movie Erin Brockovich.

Chromium-contaminated wastewaters usually originate from dye and pigment manufacturing, wood preserving, electroplating and leather tanning. The element can exist in water as charged particles in one of two states, oxidation state 3+ (trivalent form) and 6+ (the hexavalent form usually exists as chromate or dichromate). Other oxidation states are possible but are unstable in water and revert to either 3+ or 6+. The hexavalent form of chromium is the most toxic. There are various costly and not altogether effective methods of removing hexavalent chromium from wastewater; these include reduction and precipitation, adsorption on activated carbon, solvent extraction, freeze separation, reverse osmosis, ion exchange and electrolytic methods. Adsorption on to an inexpensive and readily available material that can be disposed of safely, or recycled, would be a more commercially viable alternative.

Thermal power station fly ash, algal and fungal biomass, and waste slurry from fertilizer plants have been investigated previously. Now, writing in the International Journal of Environment and Pollution, researchers at the Energy & Wetlands Research Group, in Bangalore, and Karnataka University, India, explain how coffee husks might offer an effective solution. They looked at the effects of pH, contact time, initial concentration and adsorbent dosage on the adsorption of hexavalent chromium. Adsorption capacity is almost 50 milligrams per gram of coffee husk material. Reversing the process for analytical purposes revealed that they can retrieve about two-thirds of the adsorbed hexavalent chromium which can then be recycled. The team points out that coffee husks are not only readily available but their use represents an economical and viable part of a wider waste-management strategy. The lack of protein in coffee husks means that they do not putrefy under moist conditions meaning the material would be safe in storage and during transportation.

(Source: http://www.brightsurf.com/news/headlines/59660/Percolating_a_solution_to_hexavalent_chromium.html)

Recycling industrial waste water

Scientists at the University of Cologne discover a new method of producing hydrogen. A research group composed of Dr. Martin Prechtel, Leo Heim and their colleagues at the University of Cologne's Department of Chemistry has discovered a new method of generating hydrogen using water and formaldehyde. The generation of hydrogen from liquids is of particular interest when it comes to fuel cell technologies. The results of the project, entitled "Selective and mild hydrogen production using water and formaldehyde", have recently been published in the journal Nature Communications.

Among other applications, the new approach can be used to recycle industrial wastewater contaminated by formaldehyde to break down the contaminants whilst simultaneously generating hydrogen. With the aid of this method, it is possible to reclaim an important raw material from industrial wastewater. Prechtel and his colleagues have also identified an air-stable and robust catalyst that can be employed with the technique. The researchers have already filed a corresponding patent application. Formaldehyde is one of the most important raw materials used in chemical engineering; around 30 million tonnes of the substance are produced annually around the world. It is therefore available as a source of hydrogen in large quantities and at low cost. The study was financed through the

'returnee programme' of North-Rhine Westphalia's Ministry for Innovation, Science and Research.

(Source: http://www.brightsurf.com/news/headlines/95581/Recycling_industrial_waste_water.html)

Waste water treatment plant mud used as 'green' fuel

Catalan scientists have shown that using mud from wastewater treatment plants as a partial alternative fuel can enable cement factories to reduce their CO₂ emissions and comply with the Kyoto Protocol, as well as posing no risk to human health and being profitable. These are the results of an environmental impact assessment.

Dependency on oil and coal could be coming to an end. Researchers from the Rovira i Virgili University (URV) have analysed the environmental and human health impacts of an alternative fuel that solves various problems simultaneously. This is the solid waste from the water treatment plants of large cities. The scientists have carried out the first study into this method at a cement plant in Vallcarca (Catalonia), which has been producing cement for more than 100 years, and they confirm in the latest issue of the journal *Environmental Science and Pollution Research* that it is "the best option for getting rid of mud that would have had to be dumped elsewhere, while also powering the plant". "As this mud is already waste, burning it does not enter into the atmospheric CO₂ emissions assigned to each country under the Kyoto Protocol", José Luis Domingo, lead author of the study and director of the Toxicology and Environmental Health Laboratory at the URV, tells SINC. This would enable plants producing cement, one of the most contaminating industries in terms of CO₂ as well as emissions of dioxins, furans and heavy metals, to consume energy in a more environmentally-friendly way. Up to 20% of the fossil fuel energy used at the Catalan plant has now been substituted for the fuel from waste water treatment plant mud. From an economic point of view, the scientists will not say that cement plants could increase their profits by using this method, but "they will not have to pay anything to exceed their agreed emissions", the researcher points out. The economic benefits of this system also depend on the price of fuel. One of the most important issues for the URV scientists is the reduction in environmental impact, and consequently the health risks for people living near the plants. The experiment with the mud has led to a 140,000 tonne reduction in CO₂ emissions between 2003 and 2006, and will have limited the potential deaths from exposure to chemical pollutants. In addition, the study shows that using this green fuel would reduce the cancer rate by 4.56 per million inhabitants. The researchers say it is essential to carry out separate studies for each plant because "we still don't know whether this will be positive for the whole cement industry", according to Domingo. However, if the conditions are right, using mud from waste water treatment plants in cement factories is "a very good solution", he concludes.

(Source: http://www.brightsurf.com/news/headlines/46502/Waste_water_treatment_plant_mud_used_as_green_fuel.html)

What happens to oil after a spill?

Very little is known about what happens to oil in the ocean after an oil spill and what happens to it once a chemical dispersant has been applied. New research summarizes what is known and what important knowledge gaps remain. Investigators note that there is a great need to study extracellular polymeric substances (EPS), which are polymers released into the environment by microbes such as bacteria and phytoplankton in response to environmental stresses. EPS help determine the fate and transport of oil after a spill.

"The production of marine oil snow and its sedimentation and accumulation to the seafloor were observed on an expansive scale after the Deepwater Horizon oil spill in the Northern Gulf of Mexico in 2010," said Dr. Antonietta Quigg, lead author of the *Limnology & Oceanography Letters* study. Marine oil snow is a shower of organic

matter that interacts with oil and falls from upper waters to the deep ocean. "To improve our response to future oil spills, we need a better understanding of the biological and physiochemical controls of EPS production by microbes under a range of environmental conditions, and in this paper, we provide the key knowledge gaps that need to be filled to do so," said Dr. Quigg. "This work is only possible because of the dedication of numerous students, postdocs, and colleagues working collaboratively across traditional boundaries of biology, chemistry, and oceanography."

(Source: Antonietta Quigg, Uta Passow, Wei-Chun Chin, Chen Xu, Shawn Doyle, Laura Bretherton, Manoj Kamalanathan, Alicia K. Williams, Jason B. Sylvan, Zoe V. Finkel, Anthony H. Knap, Kathleen A. Schwehr, Saijin Zhang, Luni Sun, Terry L. Wade, Wassim Obeid, Patrick G. Hatcher, Peter H. Santschi. The role of microbial exopolymers in determining the fate of oil and chemical dispersants in the ocean. *Limnology and Oceanography Letters*, 2016; DOI: 10.1002/lol2.10030; <https://www.sciencedaily.com/releases/2016/11/161122080548.htm>)

Policies

Ban cigarette filters to save the environment, suggest researchers

*Ban cigarette filters. Start a deposit-return scheme for used butts. Hold manufacturers responsible for clean-ups. Place warnings on packets about the impact of simply flicking one's used cigarettes away. These are among the policy measures that Thomas Novotny of the San Diego State University in the US and Elli Slaughter advocate to curb the environmental harm done through the large-scale littering of cigarette butts, packaging and matches. The suggestions are part of a review article in Springer's journal *Current Environmental Health Reports*.*

Cigarette butts and other tobacco product waste are the items that are most commonly picked up during urban and beach clean-ups worldwide. An estimated 4.5 trillion of the annual 6 trillion cigarettes sold worldwide do not end up in a dustbin or ashtray, but are simply flicked away along a roadside or on a pavement. The ban on indoor smoking may have exacerbated this. Tobacco waste products contain the same toxins, nicotine, pesticides and carcinogens found in cigarettes and cigars, and can contaminate the environment and water sources. Studies show that the chemicals within cigarettes, such as arsenic, nicotine, lead and ethyl phenol, could leach into salt and fresh water and be acutely toxic to aquatic micro-organisms and fish. It is not only the cigarette ingredients that harm the environment, but also the materials they are made of. Plastic cigarette filters are practically non-biodegradable and can leach chemicals for up to ten years. In the US alone an estimated 49.8 million kilograms of filters are discarded annually. This excludes the weight of remnant butt tobacco, discarded packages, lighters and matches, and other tobacco products such as cigars and smokeless tobacco. The researchers call filtered cigarettes a "farce" in terms of consumer safety, with a recent National Cancer Institute review showing that these are not healthier or safer than non-filtered ones. Novotny and Slaughter therefore propose a ban on filtered cigarettes. Jonathan Samet from the University of Southern California and the editor of the article recently advised the California State Legislature that "-it is evident that filtered cigarettes have had little impact on the risks of smoking over the last half century."

Because existing anti-littering laws have not changed smokers' littering habits, Novotny and Slaughter ask for new environmental interventions and partnerships between tobacco control and environmental groups. They propose litigation to hold the tobacco industry legally responsible for clean-up and nuisance costs associated with their products, advocating the use of labels on cigarette packages about the toxicity of discarded butts, and a deposit-return scheme similar to that used for glass and metal beverage containers. Other options include requesting the industry to pay an advanced recycling fee or to take back all discarded tobacco waste products. "Tobacco waste products are ubiquitous, environmentally hazardous and a significant community nuisance," says Novotny. "With two-thirds of all smoked cigarettes, numbering

in the trillions globally, being discarded into the environment each year, it is critical to consider the potential toxicity and remediation of these waste products.”

(Source: Novotny, T.E. & Slaughter, E. (2014). Tobacco Product Waste: An Environmental Approach To Reduce Tobacco Consumption. Current Environmental Health Reports. DOI 10.1007/s40572-014-0016-x., http://www.brightsurf.com/news/headlines/96254/Ban_cigarette_filters_to_save_the_environment_suggest_researchers.html)

Draft guidelines for pre-processing and co-processing of hazardous and other wastes in cement plants as per Hazardous and Other Wastes (Management and Trans-boundary Movement) Rules, 2016

The draft guidelines for pre-processing and co-processing of hazardous and other wastes in cement plants as per Hazardous and Other Wastes (Management and Trans-boundary Movement) Rules, 2016 has been prepared by CPCB.

Recently notified Rules on management of Hazardous and Other Wastes, outlines the hierarchy of wastes management, wherein, prevention, minimization, reuse, recycling, recovery, utilisation including pre-processing & co-processing was envisaged prior to considering the option of disposal through incineration or secured landfilling. Substantial fractions of the industrial, commercial, domestic and other wastes contain materials that have the potential for use as an alternative raw material or as a supplementary fuel for energy recovery.

(Source: Central Pollution Control Board; <http://www.indiaenvironmentportal.org.in/content/439154/draft-guidelines-for-pre-processing-and-co-processing-of-hazardous-and-other-wastes-in-cement-plants-as-per-hazardous-and-other-wastes-management-and-trans-boundary-movement-rules-2016/>)

Order of the National Green Tribunal regarding pickling industries located in Delhi, 23/12/2016

Order of the National Green Tribunal in the matter of M/s Ashok Vihar Mitra Mandel Vs. The Govt. of NCT of Delhi & Ors. dated 23/12/2016 regarding pickling industries located in Delhi.

NGT directs the Chief Secretary of NCT of Delhi to take up a meeting of DDA, DSIIDC, Society running the plant, DPCC and the Applicant (M/s Ashok Vihar Mitra Mandel) may also be present, to take a decision as to whether the pickling industries should be closed in furtherance to the policy decision taken. And secondly how the

hazardous waste is to be dealt.

(Source: <http://www.indiaenvironmentportal.org.in/content/438528/order-of-the-national-green-tribunal-regarding-pickling-industries-located-in-delhi-23122016/>)

Order of the National Green Tribunal regarding hazardous waste being generated by the CETP, Ashok Vihar, New Delhi, 22/09/2016

Order of the National Green Tribunal in the matter of M/s Ashok Vihar Mitra Mandel Vs. The Govt. of NCT of Delhi & Others dated 22/09/2016 regarding hazardous waste being generated by the CETP, Ashok Vihar, New Delhi which is causing environmental hazards and the hazardous waste is being dumped indiscriminately even on the green belt of the area in question. The Court also took up the matter of pickling industries operating in Delhi. Counsel appearing for the DPCC submits that in terms of the order of High Court and National Green Tribunal, pickling industries have to stop their operations with effect from 23rd September, 2016. According to him in the master plan pickling activity has been reflected in negative category list of industries and, therefore, not permitted to operate in NCT of Delhi. National Green Tribunal asks the concerned Authorities including DPCC and Government of NCT of Delhi to enforce the order of the High Court and the National Green Tribunal not to allow pickling industries to operate in NCT of Delhi. This itself would result in reducing effluent load on the CETP as all these industries are located in the same industrial area where CETP is located and consequently reduction in generation of sludge. NGT asks Central Pollution Control Board to upgrade disposal facilities. The National Green Tribunal has directed Central Pollution Control Board (CPCB) to consider upgradation of treatment, storage and disposal facilities (TSDFs) in the country after a plea alleged that TSDFs were ill equipped to carry out environment-friendly disposal of compact fluorescent lamps (CFLs). The NGO, Toxic Links, contended before a bench headed by Justice U. D. Salvi that TSDFs were ill equipped to deal with “CFLs/Mercury bearing lamps” as per the Minamata Convention on mercury and there was a need to upgrade such facilities. Minamata Convention on mercury is a global treaty to protect human health and the environment from the adverse effects of mercury. Taking note of the plea, the NGT has asked the NGO to approach CPCB within a month for upgradation of TSDFs to handle mercury lamps and other allied products in an environment friendly manner.



Editorial Advisory Board

Er. K.P. Nyati

Environmental Expert & Former Head
Environmental Management Division
Confederation of Indian Industry (CII)
New Delhi

Er. N.K. Verma

Ex. Additional Director
Central Pollution Control Board

Dr. Rakesh Kumar

Director
CSIR-National Environmental Engineering Research Institute
(CSIR-NEERI), Nagpur

Dr. J. S. Pandey

Chief Scientist & Head, Climate Change Cell
CSIR-National Environmental Engineering Research Institute
(CSIR-NEERI), Nagpur

Our ENVIS team

Director

Dr. Rakesh Kumar

Guidance

Dr. J. S. Pandey

Project Personnel

Snehal S. Deshmukh, Programme Officer

Pranay Bankar, Information Officer

Firoz Baksh, IT Assistant

ENVIS Coordinator

Prakash Kumbhare

www.neerienvis.nic.in

Published by: ENVIS Centre on Hazardous Wastes, CSIR-NEERI
Sponsored by: Ministry of Environment, Forest and Climate Change, New Delhi
Printed by: Creative Images, Nagpur, Ph.0712-2542211