Clean Cut Quarterly

NJARNG Sustainability Newsletter

In collaboration with Rowan University

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IMAGE: CITY OF NEWARK

A Concrete Matter

How this common building material is actually contributing to earth's changing climate. Story on **page 1**.

Read about how New Jersey is curbing emissions from diesel school buses on **pages 2 and 3**.

IMAGE: RUTGERS

IMAGE: NJ DEP

How to celebrate Earth Day during a pandemic. See **page 6**.

Friendly Foundations

By: *Parth Patel*

NJDOT

When the Manahawkin Bay Bridge span was replaced, a concrete beam bridge (left) replaced the steel girder bridge (right).

Concrete is everywhere—almost all modern man-made structures involve the use of concrete. Due to its strength, durability, and fire resistance, concrete is used for a myriad of things including highways, buildings, dams, and bridges. An estimated 2 billion tons of concrete is manufactured each year worldwide, making it one of the most used substances in the world. However, it may be surprising to find out that concrete does have an impact on the world's climate issues.

When concrete is manufactured, the mixing and curing processes release vast amounts of carbon dioxide (CO2), a greenhouse gas, into the atmosphere. Carbon in the atmosphere is a driver of climate change.

According to a 2018 study by the London-based think tank Chatham House, concrete accounts for 8 percent of global carbon emissions. For comparison, the largest contributors are the electricity and transportation sectors which account for 28 and 29 percent of global carbon emissions, respectively. The contribution from concrete is comparable to that of the agriculture industry, which accounts for 9 percent. Locally, the story about concrete is more stark—12 percent of annual carbon emissions in New Jersey come from concrete.

Carbon's Climate Impact

Over the past several decades, climate change has become a significant human interest, especially since more people are learning about the impacts such as the melting of the Antarctic ice caps and glaciers through the media. The effects carbon emissions have on the climate can cause potentially irreversible damage to the ecosystem we inhabit—the impact on our land, water, and air will induce many problems for humankind.

Greenhouse gases are responsible for trapping heat in the earth's atmosphere. This heat will continue to increase over time as carbon emissions grow. This feedback is worrying because climate change can cause our fertile soils to stop yielding crops, our sea levels to rise, and devastating unwieldy wildfires to occur. A combination of these effects will eventually make our planet uninhabitable.

Concrete Alternatives

Substitutes for concrete are continuously being researched and developed for commercial use. Most of these alternatives are suitable for less structurally demanding projects, such as driveways and walkways since many of these alternatives can't hold high compressive strengths compared to traditional concrete. A student at Coahuila Autonomous University in Mexico developed a new pavement for roads, one that would not need to be filled time

'Concrete' continued on page 2

and time again like traditional pavement. His alternative uses recycled tires to form rubberized roads. This idea could potentially reduce the amount of concrete used to repair damaged pavement, overall reducing the amount of concrete used annually.

Consumption is increasing

We can use the country's cement consumption to understand how much concrete the U.S. may consume on a yearly basis. According to the database, Satista.com, the U.S. has increased cement consumption by 30 percent over the past ten years. If concrete consumption continues to increase at the same rate, we can expect concrete's carbon impact to be 8 percent larger in the next few years. Most concrete replacements are in their infancy phases, yet there is much potential in this field of study. Replacing concrete with renewable and recycled materials may help in the fight against carbon emissions and climate change. ■

A Quiet Threat

By: Brandon Reyes

Some of the greatest threats to Earth aren't always visible. In fact, an invisible threat—climate change—has led to mass wildfires, frigid winters, and rising sea levels. One driver of climate change is emissions from vehicles that add greenhouse gases and other pollutants to the atmosphere. The necessity of school buses in the U.S. is unquestioned, as more than 25 million students ride the bus every day, and over 500,000 school buses are in use. Buses are an undeniably practical and cost-effective way to transport students to and from school. In this article, the emissions from public school buses are discussed, as well as ways to mitigate this issue.

A diesel school bus undergoing maintenance. NREL

Running on Diesel

Taking public transportation such as school buses is a great way to reduce the number of personal vehicles that are on the road that burn fuel. However, the large number of school buses with diesel-engines in operation over the years means that the historic annual emissions are very high, and continue to be high. When diesel fuel is burned, it releases carbon monoxide (CO), which reacts with chemicals found in the atmosphere that contribute to climate change. Although CO is not a greenhouse gas according to the American Chemistry Society (ACS), it does alter the lifespan of these gases, which leads to an increase in greenhouse gases in the atmosphere. When CO is released into the atmosphere, it breaks down hydroxyl, a chemical compound that influences the lifetime of methane, a major greenhouse gas. As more CO is released from diesel fuel, more methane gas is stored in the atmosphere.

School buses are notoriously inefficient, with diesel school buses averaging about 8.4 miles per gallon. This inefficiency leads to greater fuel consumption and thus more pollutants such as CO are emitted from the tailpipe. Diesel fuel is, however, more energy-dense than its counterpart—it contains about 15% more energy per unit volume than gasoline. But this high energy density comes at a cost. According to the U.S. Environmental Protection

'Buses' continued on page 3

Agency (EPA), in 2008, diesel school buses, on average, emitted 2.312 grams of CO for every mile driven. Accounting for all 500,000 school buses on the roads (and assuming an average bus route of 31.73 miles), is equivalent to approximately 6.6 million kilograms of carbon monoxide per year. This is equivalent to the weight of about 440 traditional school buses!

Luckily, with the advancement of diesel technology, school buses are slowly but surely becoming more efficient. The 2017 Federal Emissions Standards required engines in standard U.S. school buses to be cleaner-burning. According to Thomas Built Buses, a manufacturer of school buses, two common diesel engines, the Cummins B6.7 and the Detroit DD5, have CO emissions of 0.04 and 0.3 grams per brake horsepower-hour. This means that for every hour one of these engines are running, it will release a small amount of CO for the amount of horsepower it is producing. These numbers exceed the current federal emissions standards of 15.5 grams per brake horsepower-hour by over 99%.

With the advancing technology for school buses, it is apparent that companies are taking notice of the pressing issues that emissions pose for the environment. However, there are still a large number of buses that are on the roads that have yet to be updated or replaced. The EPA recommends that buses built in 1998 or earlier be considered high priority for replacement. Many buses on the road today that were built between 1998 to 2010 are of a lower priority to replace. Although newer school buses are on the horizon, older ones are being retrofitted with idle and emissions reduction technologies as well as having their engines replaced with more efficient and clean-burning ones.

As buses are replaced, the state of NJ and nonprofit organizations are encouraging the adoption of electric buses. The Mid-Atlantic Electric School Bus Project (MEEP) is loaning e-buses to interested school districts to test drive on their routes in lieu of traditional diesel fleets. The pilot program is running during this school year and next.

At a standstill: the Issue with Idling

While diesel engine emissions improve, still lingering in the U.S. is a large problem that not only involves the bus, but the behavior of the driver. School bus idling is a significant issue when it comes to emissions reduction. According to a study by the Georgia Institute of Technology on school bus idling and emissions, school buses idle for approximately 5.6 minutes per idle event and 33,531 times per year for a regular school week. That equates to 3,130 hours of idling per school year per bus. In this study, emissions from various studies in the EPA Motor Vehicle Emissions Simulator were modeled for different school buses in Cobb County Georgia and determined that emissions for the 1,150 bus sample group release 54,612 kilograms (60.2 tons) of CO annually. He then modeled the case where all idling events greater than five minutes in length were eliminated. This scenario led to a reduction in CO emissions by more than half. If idling was prohibited over five minutes, only 28.2 tons or 25,583 kilograms of CO would be emitted per year.

Moving forward, techniques to reduce idling emissions that reduce idling time greater than five minutes should be implemented nationwide. New Jersey has implemented a school bus idling law that aims to reduce these harmful emissions. The NJ law states that “with a few exceptions, diesel school buses are prohibited from idling for more than three minutes” and only allowed to idle a maximum of 15 minutes in an hour if the bus is “actively loading and unloading passengers-even though NJDEP recommends no idling” [1]. Although there are stringent laws that aim to reduce idling that come at a cost (or ticket), many school bus drivers are the ones responsible for this reduction. While the adoption of electric school buses with near-zero emissions may be on the horizon, until then, school districts in NJ must do their part to reduce idling. ■

[1] Patel, D. (2018, December 06). Avoiding bus idling " New Jersey Education Association. Retrieved February 20, 2021, from https://www.njea.org/avoiding-bus-idling/

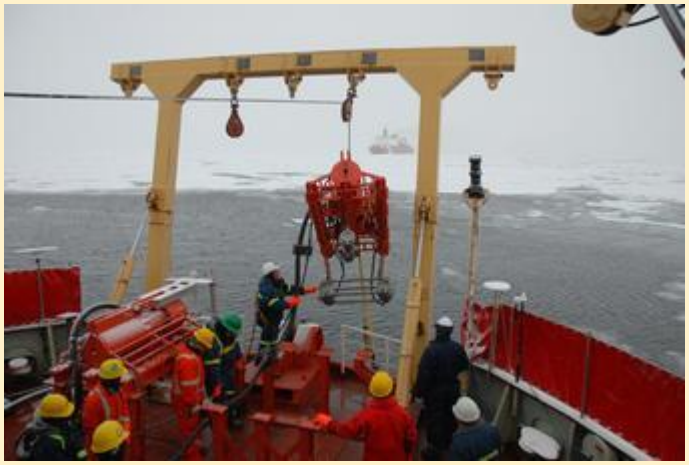
Drowning Out The Noise

By: Maximillian Husar

Earth's oceans are the most illustrious and vast displays that mankind has ever known. Each one holds a multitude of species of underwater fish, mammals, reefs, and other sprawling ecosystems that are still being discovered today. However, different forms of pollution such as waste, plastics and changing water temperatures have endangered many aquatic species. The most elusive, yet very damaging, type is noise pollution.

Cantankerous Cacophony

Research on Marine Noise Pollution (MNP) has been difficult to pursue due to many factors within the oceans. Among these factors are the variations in species, migration patterns, water depth and frequency of the noise. Nevertheless, there is evidence that shipping traffic, pile driving during construction, the blast of air cannons during seismic exploration, and drilling for oil and gas are responsible for many maladies that are present in the water. According to a 2020 study by a French research group, these are defined as "behavioral alterations (e.g. swimming and gregarious patterns, anti-predator responses, mating and spawning patterns), auditory damage, communication masking (mostly intra-specific), changes in habitat use (e.g. shelter frequentation), migration and displacement (e.g. towards less noisy places), stress-related physiological responses, internal and/or external non-lethal injuries to immediate death (e.g. as a consequence of severe internal organ damages)."



USGS

An air cannon, also known as an air gun, being lowered into the water for the purpose offshore seismic exploration to locate oil and gas deep below the ocean floor.

Concern over MNP has grown recently with the increase of offshore activity by fossil fuel companies. In 2017, the Trump Administration expanded the areas that these companies could explore in and drill for oil and gas (O&G). The executive order also expedited the permitting process and O&G lease sales. Reports arose that "five companies are in the process of seeking permits to carry out seismic mapping with the air guns all along the Eastern Seaboard, from Central Florida to the Northeast, for the first time in three decades." These companies construct seismic maps of the ocean floor and sedimentary layers below with the use of air cannons. For months, the air cannons fire at intervals of 10 seconds at very low frequencies. These frequencies disorient sea life within a radius of 4,000 kilometers from the blasts with the added assault of killing native zooplankton.

Fortunately, new methods and practices have been developed to better suppress MNP in the oceans. An alternative to air cannons, named marine vibroseis, have been shown to produce very minimal levels of noise and are more accurate than traditional sources. Further incitement is still needed to increase both the production and adoption of the device to replace air cannons.

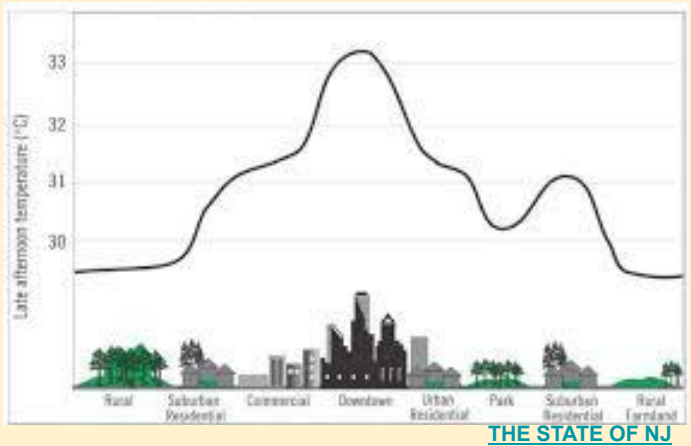
One highly-regarded method in funding to reduce MNP is the polluter pays principle. In this case, revenue from levies would be used to develop alternative technologies as well as to study the impact of seismic surveys on marine life. By taking these measures, we are able to not only better understand and protect our oceans, we will also uphold greater standards in how we coexist with outside environments. ■

Don’t Sweat It *By: Earnest Daniel III*

As the most densely populated U.S. State, New Jersey has many urban areas and cities that are considered heat islands. These heat islands cause problems in everyday life for residents in these areas. These higher temperatures make it uncomfortable and unhealthy for people who spend a lot of time outside including pedestrians and bicyclists or those who reside in unconditioned dwellings. Luckily, there are also ways to mitigate the effects of heat islands.

Pitfalls of Urban Land Use

A heat island is an urban area that retains more heat than surrounding rural areas. Urban areas are heavily developed, and the asphalt roads, pavements, parking lots, and buildings absorb more of the sun’s energy rather than reflect it. These surfaces hold onto the heat even after the sun goes down. This causes the air temperature to continue to be elevated throughout the nighttime. According to the EPA, “the heat island effect results in daytime temperatures in urban areas about 1–7°F higher than temperatures in outlying areas and nighttime temperatures about 2–5°F higher.”



THE STATE OF NJ

An example of a temperature profile showing the higher temperature in urban areas.

The density of urban areas and cities play a large role in impacting the temperature. The spacing of buildings within a city influences wind flow and the ability of urban material to absorb and release solar energy. In heavily developed areas, surfaces and structures obstructed by neighboring buildings become large thermal masses that cannot release their heat readily. In cities, since the buildings are built close together the heat they absorb will not dissipate into the environment, but will instead heat up the surroundings buildings.

The heat island effect is further increased in cities that have very few trees and other vegetation. Vegetation are natural heat mitigators and provide natural shade over materials that may absorb more of the sun's heat, such as sidewalks and streets . The lack of vegetative cover limits the potential for evaporative cooling to take effect in comparison to the typically more leafy suburbs and rural areas. Natural means of cooling cannot occur in cities with low amounts of trees and other vegetation.

To add, cities are major players in the climate change feedback loop. Due to warmer temperatures there is increased demand for energy to cool urban buildings. Producing this energy, in-turn, generates greenhouse gas emissions, which contributes to even warmer temperatures.

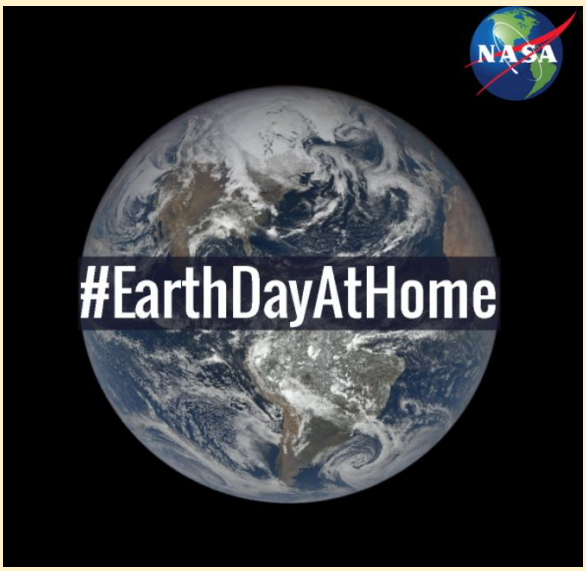
Cooling Cities Down

There are many ways to suppress the effects of heat islands. In some cities, trees are planted along sidewalks to create shade for pedestrians. Roofs can also be altered to help reduce the heat of the sun. Green roofs or Eco Roofs are roofs that have a layer of vegetation on top to keep the surface temperature of the roof lower. Another alternative is constructing roofs with more reflective materials or special coatings so that there is less absorption of the sun’s heat. Another way to combat the heat island effect are solar carports. A solar carport is a solar canopy over a parking lot that not only generates electricity from energy that is absorbed from the sun, but also provide shade, keeping the cars and asphalt cooler. Currently the NJARNG has solar carports installed at several sites—two at Sea Girt, one at JD-MBL JFHQ, one at Lawrenceville DMAVA HQ, and one at the Somerset Readiness Center. ■

Earth Day 2021

By: Patrick Marshall

Did you know that Earth Day takes place every year on April 22nd? The celebration of Earth Day started in 1970 and was used as a way to help keep the earth clean. The tradition started as a way to demonstrate support for environmental protection and keeping the environment clean. The main focuses of Earth Day movement are climate action, science, education, people, communities, conservation & restoration, and plastic & pollution.



NASA

This year, celebrate Earth Day at Home!

Go Green Online!

Today, people around the world participate in Earth Day to celebrate and spread awareness of how to help keep our Earth healthy. Each year, communities come together to plant gardens and assemble local and national clean up events, but this year might look a little different due to social distancing restrictions.

During the pandemic, one great way to celebrate Earth Day is with the use of social media. Sharing green tips on platforms like Instagram, Twitter, Facebook, Snapchat and Pinterest can be very effective to increase awareness or even inspire behavioral change in others. If you and your family clean up a park or beach, you can post videos.

While you're online, you can learn about some organizations that do great work in supporting a greener planet. Conservify and 350.org are non-profit organizations that work to spread awareness of critical global environmental issues and encourage action towards these issues. If you're interested in renewable energy, check out NJ Board of Public Utilities website on solar panels.

Swap Single-Use Items

Recently, several states have passed laws limiting single-use plastic along and many private companies implementing their own policies on plastic. Beginning in May 2022, plastic and paper single-use bags and food/beverage containers made from polystyrene foam will be banned in New Jersey. But you don't have to wait until then to invest in a few reusable bags and remember to bring them when you go grocery shopping. In addition, you can purchase metal straws and reusable tumblers and water bottles in efforts to help reduce your consumption of plastic.

U.S. EPA

This Earth Day, and every day, consider ditching the single-use plastic.

Even in a year when large events may be cancelled, the ways you can be involved in helping our Earth or being a part of Earth Day celebrations are countless; even if it is just picking up a piece of trash or turning off the light when you leave the room, please consider celebrating the earth in your own way this month and every month. ■

Meet the Editors

Earnest Daniel III

Mechanical Engineering, Senior

Ernie's early fascination with design led him to study mechanical engineering in college. In the Resiliency Clinic at the Rowan Sustainable Facilities Center, he was introduced to the Environmental and Civil engineering disciplines. During his free time, Ernie is very involved with fitness by going to the gym and competing for Rowan's Track & Field team.

Maximillian Husar

Civil & Environmental Engineering, Junior

Maximilian has always been interested in environmental issues as well as green infrastructure. When he's not busy with classes, his hobbies include watching movies, listening to music, and biking. Maximilian hopes to gain experience through a summer internship and enroll next year in graduate school to pursue an advanced engineering degree.

Patrick Marshall

Civil & Environmental Engineering, Junior

Growing up, Patrick always enjoyed his math and science classes much more than English or history and knew he wanted to do something with that knowledge. That passion led him to study engineering. He looks forward to one day working for a company that will help him achieve his goals of successfully designing and completing a project, with high hopes of becoming a PE (Professional Engineer). In his spare time, you can find Patrick playing video games, playing basketball with friends, or shredding the slopes in winter.

Meet the Editors

Parth Patel

Civil & Environmental Engineering, Junior

Parth has big ambitions, one of which is to make the world a safer place that can be inhabited as long as possible. Motivated by the daily climate disaster headlines, Parth wants to pursue a career that serves a larger purpose than him: to create a sustainable future for many generations to come. A future in which our children's children have no worries about the state of their planet. Parth hopes that his passion for environmental engineering and the sciences (and his work in Resiliency Clinic) is a step towards achieving this.

Brandon Reyes

Civil & Environmental Engineering, Junior

Brandon has always had a passion for building and being creative. He has always dreamed of becoming an engineer in order to turn his passion into a career. He plans on pursuing this path into structural engineering to build more efficient and eco-friendly infrastructure. In his free time, he enjoys photography, Philadelphia sports, and is an avid car enthusiast.

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