Project ID: 271

SR - Earth and Environmental Sciences

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Advisor: Michelle Mardahl

How Does Ocean Acidification Affect Survival Rate of Sea Snails?

Ocean acidification is a byproduct of climate change which is a prevalent problem in the world that can have detrimental effects to the ecosystem.

Problem statement: How does acid in the oceans affect the development of sea snails? The effect of Ocean acidification was tested using the target organism of sea snails used in this study to see the impact of ocean acidification on marine organisms.

Procedure: Sea snails were placed in containers of different pH units of 5.8 (experiment group), and 8.4 (control group) for 19 days in order to see the effect of the acidification. Data collection occurred over 3 weeks, every 3-5 days based on growth rate, survival rate, and qualitative data of the state of the snail's shells.

Results: After 19 days, snails in the control pH (8.4) had a 100% survival rate. Snails in the Experimental pH (5.8) has a 33% survival rate with a standard deviation of 23.57. Average Growth Rate of Snails in the control pH was 33.33% while snails in the experiment had almost 2/3 slower growth rates being 11.67%.

Conclusion: Ocean acidification is causing developmental issues in sea snails including almost 2/3 slower growth rate and even death. Due to organisms being interconnected through a food web, it is very likely that if ocean acidification was proven to kill sea snails, then the food chain would be disrupted. If there is a lower pH level in the water in which sea snails live in then, their development (Survival rate and Growth) will decrease due to them becoming more vulnerable to the more acidic waters.

Project ID: 272

SR - Earth and Environmental Sciences

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Advisor: Jennifer Ekstein

Tijuana v San Diego: Ocean Water Pollution

We recently discovered the broken water cleaning plant was releasing sewage into the ocean and since we live in San Diego, we want to investigate this local issue and see if our own beaches were being impacted by the pollution as we live close to the border alongside Tijuana, Mexico.

Procedure: We tested the water from the beach of Tijuana, specifically in Playas, Tijuana, and then from beaches in San Diego which were Imperial Beach & Coronado Beach. With equipment provided by our instructor that tested dissolved oxygen (DO), pH, turbidity, and ammonium, each beach was tested with three trials where each trial tested the four different measurements of water that leads to twelve different results from each beach. For each tool, the water is either inserted into it or the tool is inserted into sample of water where it lasts at least five minutes until the results don't alter anymore.

Results: Average pH found in the world's ocean water is 8.1, the average DO is 7.5 mg/L, the average ammonium amount is 0.21 mg/L, average turbidity is 4.

> Average pH percent change (± 0.1%): in Tijuana was -1.11%; -0.25% in Imperial Beach; +0.37% in Coronado Beach.
> Average DO percent change (± 0.1%): in Tijuana was +31.47%; +47.45% in Imperial Beach; +41.2% in Coronado Beach.
> Average ammonium percent change (± 0.1%) in Tijuana was +3114.3; +4309.5% in Imperial Beach; +4771.4% in Coronado Beach.
> Average turbidity percent change (± 0.1%) in Tijuana was +418.3%; +422.5% in Imperial Beach; +685% in Coronado Beach.

Conclusion: It was predicted that Tijuana would cause high pollution levels including high turbidity, high pH, high ammonium, and low DO. There were high pollution levels except for the DO meaning the water can be inhabited. However, there was high ammonium meaning there is nitrogen that can be found in fertilizers & high turbidity signifying lots of particles like dirt, sand, & chemicals. This demonstrates that pollutants from Tijuana accumulate especially the nitrates & particles that increase the turbidity up from Tijuana's beaches up to Imperial Beach and then to Coronado Beach. This may be possible through San Diego's adding its own pollutants to the amount of pollution on the San Diego coast or overall just adding up from Tijuana where it may stay there for a while and at some point start decreasing after San Diego's beaches.

Project ID: 273

SR - Earth and Environmental Sciences

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How Does Increased Population Affect PM2.5 Levels in China, from 2000-2022?

Background: As populations are increasing in China, so do the levels of pollutant PM2.5, which are small particles released from coal-produced production sites, that can lead to further complications for citizens. Since China is the largest exporter for goods, their factories are running in order to keep up with those demands, and if this were to continue, PM2.5 levels would keep rising.

Method: By researching through secondary websites, I was able to obtain the information I needed in order to complete this experiment. Once I had acquired all the data, I then proceeded to do some calculations to determine the correlation between the two variables, urban population and PM2.5 levels, in China.

Results: After completing the calculations, the correlation between urban populations and PM2.5 levels is a moderate negative correlation of -0.7407. This indicates that as the population is increasing, PM2.5 levels are decreasing. Also, the average emissions of the pollutant have decreased about 5.89% since the Clean-Air Act, which shows how much it reduced the production of PM2.5 in China.

Conclusion: As stated from my hypothesis, the increased control of PM2.5 has been beneficial for both the citizens in China and for the environment. With the help of the Clean-Air Act that was implemented in 2013, many of the citizens are being cautious on how they contribute to pollution, which resulted in a moderate negative correlation of 0.7407 and a reduction in the PM2.5 levels in China.

Project ID: 274

SR - Earth and Environmental Sciences

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Advisor: Jennifer Ekstein

How Does One Country's Socioeconomic Status Correlate to Their Carbon Emissions?

Background: More developed countries (MDCs) and less developed countries (LDCs) are both responsible for the problem that is climate change, but historically MDCs have much higher carbon emissions. This is due to their overuse of fossil fuels and their higher gross domestic production (GDP). MDCs are responsible for the majority of carbon emissions, while LDCs are the ones who are forced to deal with the effects, including rising sea levels, unusable drinking water and food, and natural disasters.

Procedure: Research the GDP of several countries including the United States, China, Madagascar, and Rwanda"from the years 2000-2015. Research the carbon emissions from these countries from the years 2000-2015. Compare the correlation between the country's GDP and their measured carbon emissions.

Results: The results, as provided by using the Pearson's Correlation Coefficient, show that in most of the countries there is a positive correlation between the GDP and the carbon emissions of a country. In the United States, there appears to be a negative correlation by -0.7751. This means there is no obvious correlation between the two variables. While this does not necessarily support my hypothesis, if you look at the graphs full of data, you can see that the number of carbon emissions don't shift often. They are always in the 5 billion metric tons range. In China, there is a high correlation between GDP and carbon emissions. You can see this through the positive indication by the line going up and r being equivalent to 0.9756. This means that in China as GDP increases, so do carbon emissions. In Madagascar, there is a high correlation between GDP and carbon emissions. r = 0.9685, meaning that the line is positive and "increasing", so the GDP and carbon emissions in Madagascar have a positive correlation. In Rwanda, there is a high correlation between the GDP and the carbon emissions. The r = 0.984 and this means that there is a positive correlation between the GDP and the carbon emissions in Rwanda.

Conclusions: Research supports a correlation between a country's GDP and their carbon footprint as the more developed a nation is, the more energy they consume. Less Developed Countries (LDCs) produce less carbon emissions since they have lower GDPs and their activities consume less energy. More Developed Countries (MDCs) with higher GDPs are overwhelmingly responsible for the carbon emissions that disproportionately affect LDCs. The data shows that the GDPs of all the countries focused on in this study: the United States, China, Madagascar, Rwanda are increasing over time and their carbon emissions are also increasing. This finding is more dramatic with the US and China, which are considered to be MDCs, and they are contributing more to the overall carbon emissions that affect the entire planet, but especially LDCs.

Project ID: 275

SR - Earth and Environmental Sciences

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How Does Eutrophication Affect Porpoise Populations in the Baltic Sea?

Hypothesis: The decrease of population size in native porpoises in the Baltic Sea is directly correlated with its eutrophication status.

Procedure: Used 8 steps including research on native Phocoena Phocoena porpoise populations in the Baltic Sea as well as nitrogen inputs from Sweden and Finland into the Baltic Sea reading only reliable sources.

Results: The correlation between nitrogen inputs and porpoise populations using Pearson's Correlation Coefficient was $r = 0.2837$. Since the correlation is very close to 0 it is weaker and because r is positive the correlation is positive. The strength of the model is represented by r^2. With r^2 being so low at 0.0805 the strength of the correlation between porpoise populations and nitrogen inputs is practically non-existent and very weak. Since both the strength of the model r^2 and the correlation r by itself are so low it is hard to say eutrophication has an impact on porpoise populations.

Conclusion: Since there is a positive correlation it means when the data for nitrogen inputs were higher in the following years the porpoise populations were lower. Though there was a positive correlation with the higher numbers often occurring during or before nitrogen heavy years the data still shows a decrease in porpoise populations. The data makes sense because while the input of nitrogen of one year had no effect on that year's porpoise population number it did have an impact on future population numbers due to the nitrogens accumulations.

Project ID: 276

SR - Earth and Environmental Sciences

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Canopy: A Deep Learning Approach To Rainforest Deforestation Detection And Response

Rainforests are vital ecosystems that play a crucial role in the health and well-being of planet Earth. They are home to a staggering array of plant and animal species, while also serving as critical carbon sinks, helping to regulate the Earth's climate and mitigate the impacts of global warming. Unfortunately however, mass deforestation in the past decade from human activities have become an ever increasing threat to these precious ecosystems. This project hopes to address the issue of deforestation, by developing a machine learning model to aid in its detection and response utilizing widely available satellite imagery.

Images from both Planet's Flock 2 satellites and NASA's Landsat dataset were collected and augmented with the Normalized Difference Vegetation Index (NDVI). Several state of the art convolution neural networks were then subsequently trained using transfer learning on the collection of satellite imagery and ensembled together to create a single model. Finally, the model was deployed and hosted online publicly to allow individuals to upload imagery and receive predictions from the model.

Compared to existing solutions, the model proved to be far more cost effective, requiring only $34.24 dollars in total while also being more accurate, achieving a state of the art result of 93.1%. Additionally the model showed promising results of its feasibility on a global scale and relative speed, performing inferences on 40,478 images in 4 minutes and 42 seconds.

This project demonstrated the feasibility of a deep learning model to address deforestation on a global scale.

Project ID: 277

SR - Earth and Environmental Sciences

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How Do Major Development Projects in Otay Ranch Neglect Environmental Issues

San Diego, a city located in California, is considered to be one of the most driest and hottest desert area ever located in North America.This fact becomes alarming as California experiences some of the worst wildfire rates. Ultimately, as the population in California grows, urbanization begins to increase, which leads to new construction taking place. In San Diego, the county of Chula Vista has a place where I call home. Specifically in the Otay Ranch region. Ultimately, will major development projects located in Chula Vista County become affected by environmental issues? The hypothesis is that developments will in fact be affected by issues concerning the environment impacts.
Procedure: Research Data was used from the period 1939 to 2022. The independent variable was the projected population of the Otay Ranch region while the dependent variable was the Land and Surface temperature. From 1939 to 2022, this time frame was controlled so the research wouldn't be biased nor out of bounds. This period showed, the specific effects of environmental issues over time during the 83 years. There were also variables such as the number of housing units, Growth Population Change, and the number of acres burned in the United States. All of these variables providing a sufficient outcome as to whether or not a change would be made over the time. To find a change, the pearson correlation coefficient was used to determine the outcome.
Results: There was a correlation value of 0.7, which meant a significant relationship existed between the two variable points.
Conclusion: It was predicted that major developments in Chula Vista County would be affected by environmental issues. Based on the correlation value of 0.7, it provides the reasoning that there's a significant relationship for the two variables. This is significant because it shows how regions have increased impacts that can be affected by temperatures. It also shows how climate change has been a prevalent factor and will only continue to grow worse in the near future. With the projected population of Otay Ranch, rates of temperature will grow worse and impact how development projects may want to continue into the future.

Project ID: 278

SR - Earth and Environmental Sciences

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Human Population in Mexico's Effect on Forest and Biodiversity in Mexico

Populations have been known to have an affect on the biodiversity and forest of areas. With so many variations in population numbers and biodiversity, this research will focus on Mexico. Mexico being top 10 for population and 5th country in biodiversity, it was one of the best choices. The hypothesis is that population will cause a negative impact on biodiversity.

Procedure: I gathered research data from the time period 2001-2022. The increase/decrease in forest will be dependent on the human population growth in Mexico. The time period of 2001-2022 was controlled to allow the research to be unbiased and so it wouldn't be all over the place. Within these years the uncontrolled variable will be forest fires. These variables combined will allow us to determine whether or not there will be an increase or decrease in biodiversity due to the human population growth in Mexico.

Results: The correlation value between the population in Mexico and biodiversity ended up being -0.0000445, this means that there was a weak relationship between the two variables. Conclusion: It was predicted that the biodiversity in Mexico would be affected by the population. Based on the correlation value of -0.000045, it provides reasoning that there isn't a strong relationship between the two variables. This means that there are other factors other that have a stronger relationship to the variable of biodiversity.

Project ID: 279

SR - Earth and Environmental Sciences

Alexander Roman

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The Effect of California Value Redemption Programs on the Environment

What I first did in for my research experiment was boil down the factors that I wanted to focus on. What I found most important was how this specific type of plastic. The problem I am examining is whether or not the the California Redemption Programs or in simpler words, recycling programs, actually help the problem in reducing plastic waste and helping with the problem of pollution. The whole point of these programs is to help reduce the amount of plastic waste that is spread across the entirety of California. I hypothesized that the CRV programs will be proven to be effective because they take plastic bottles and items out of oceans and actually try to help the environment. My first step for this meta research project is to acquire a range of years the CRV has been active. Next I will record the different factors that play a role when it comes to the CRV programs. I am going to use 20 different years to outline the growth or decline of recycling in just two decades. This allows me to look at a wide scale if the CRV has actually helped improve with recycling or the exact opposite. After I obtain all of the data, I will create a chart which shows the calculation formula that I will be using and with that formula I will calculate the standard deviation. Once the standard deviation is found that will determine if the CRV is effective or not when it comes to reducing plastics. After I calculated all my data with the standard deviation with the Pearson's Correlation Coefficient formula, it was determined that the standard deviation was 0.2809. I concluded that as the standard deviation was not close to 1, which the closer to 1 the more effective it is, overall that the CRV programs have not helped whatsoever.

Project ID: 280

SR - Earth and Environmental Sciences

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Good on Land and Bad in Water: Effects of Fertilizer-Rich Runoff on Algal Growth

Farms that use fertilizer on their crops cause runoff into nearby lakes and rivers, tremendously increasing the growth of algae. In turn, this causes eutrophication and dead zones, which negatively impact all marine life. In order to find and bring awareness to the most growth-encouraging nutrient concentrations towards algae growth, I decided to test out five different fertilizers in different dilutions to simulate runoff in lakes. I hypothesized that the highest concentration of the phosphorus-rich fertilizer would cause the most algal growth. The independent variable in this experiment were the fertilizer/dilution combinations chosen. The dependent variable was the amount of algae growth after 15 days. The control variable was a cup of lake water without any fertilizer in it.

Procedure: I collected water from Dixon Lake because my research showed that Dixon Lake has negligible levels of nitrogen, phosphorus, and potassium. Then, I acquired five fertilizers with different NPK (nitrogen-phosphorus-potassium) ratios. After adding the different dilutions to the cups, I monitored the algae for the next 15 days before recording their final growth.

Results: The results showed that the second lowest concentration (0.625x) of phosphorus-rich fertilizer caused the most growth, with a maximum of 450% growth. The fertilizers with high nitrogen content promoted the growth of mold rather than algae; all algae in the nitrogen-rich fertilizer and nitrogen/phosphorus mixture were killed and resulted in -100% growth. The algae put in potassium-rich fertilizer ranged from -100% growth up to 250% growth. The equal concentration of NPK fertilizer exhibited -100% to 100% growth.

Conclusion: My hypothesis was partially refuted. The phosphorus-rich fertilizer did cause the most growth, but instead of the 3.90x dilution, it was the 0.625x dilution that ended up with the highest average growth. This suggested that an optimal dilution of a specific nutrient in fertilizer- in this case, 0.625x of phosphorus-rich fertilizer- is required for algae to grow significantly and rapidly. The results also suggest that high amounts of nitrogen in fertilizer runoff cause algae to die off.

Project ID: 281

SR - Earth and Environmental Sciences

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Fast Screening of Chemical UV Filters in Contaminated Water

Chemical UV filters, including avobenzone, oxybenzone, are commonly used in Sunscreen and other cosmetic products. Chemicals UV filters residual have been found in oceans, waste water, and other aqueous systems. Those aqueous systems were also reported to have negative impact on environment, including marine life and human health. Current detection methods for these chemicals requires complicated sample preparation and advanced lab instruments. This project develops a simple method to quantitatively detect the total amount of chemical UV filter pollutants in aqueous environment. Under the UV light, the aqueous solution with chemical UV filters shows different brightness comparing to clean water because of UV absorbance from UV filters. The brightness levels are correlated with UV filter concentrations in the solutions. To confirm this hypothesis, a series of water samples were prepared with different concentrations of sunscreen that had chemical UV filters. The images of each sample under 315 nm UV light were captured by an iPhone. The average grayscale intensities of each image were measured using MATLAB.Clear correlation was demonstrated between UV filter concentrations and grayscale intensities. The linear correlations were established at low (0 to 268ppm) and high (268 to 2680 ppm) concentration ranges, respectively. This method was then applied to three ocean water samples collected around San Diego. Low level of UV filters signals (~35ppm) were detected in two ocean samples based on correlation equation. Further experiment also demonstrated that physical UV filter (TiO_2 etc.) does not interfere the detection of Chemical UV filters due to low solubility in water. In summary, a hand-held and fast method was developed to quantitatively screen total chemical UV filters in aqueous solution with detection limit as low as 23.8ppm. This method can be used for on-the-spot contamination evaluation of chemical UV filters in aqueous solutions.

Project ID: 282

SR - Earth and Environmental Sciences

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Prevalence of Microplastics in Local Waters: A Quantitative Study

Microplastics are a byproduct of modern polymer technology, and are known to leach into the environment. They are more commonly present than previously thought. My goal was to measure the prevalence of microplastics in coastal waters in San Diego County. My hypothesis was that ocean waters would have a varied prevalence of microplastics, based on geographic location and human activity.

I collected 13 samples: 1 deionized water as my control, 3 field blanks, and 9 samples of coastal water. I had 3 sampling locations (Oceanside, Encinitas, Mission Bay) and took 3 replicates and 1 field blank for each location. I filtered these samples using vacuum filtration to capture residues above 5 Î¼m. I then analyzed the residues on the filter using a compound microscope, drawing qualitative conclusions about the composition of my samples. Using FTIR spectroscopy, I quantitatively determined the sample composition, identifying more than 100 types of plastics. Each sample took 2+ hours to process. I conducted all experiments, including filtering, microscopy, and spectroscopy at the Algalita marine research center in Long Beach.

Across all 12 collected samples, polymers occupied the highest area fraction of the filters (average 58.24%, 68.47%, and 56.17% in the Oceanside, Mission Bay, and Encinitas samples respectively). Within the broader group of polymers, plasticizers and synthetic fibers held most of the area percentage and particle quantities in the samples. Fibers such as rayon and nylon made up the majority of the Mission Bay samples (average 32.75% area) while plasticizers occupied a larger area percent in Oceanside and Encinitas (average 21.68% area in Oceanside samples, 29.47% in Encinitas).

In conclusion, I found that ocean waters and surrounding air had a high concentration of microplastics, with some variation based on location validating my hypothesis. My findings strongly suggest that our use of polymers in daily life needs to be mitigated to reduce the output of microplastics into life-giving ocean waters before irreversible damage is done.

Project ID: 283

SR - Earth and Environmental Sciences

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The Number of Honey-producing Bee Colonies Versus Climate Change from 1974 to 2007

WITHDRAWN FROM GSDSEF

Honey-producing bees have a significant impact on agriculture and humans. How does the increase in climate change affect honey-producing bee colonies? My hypothesis is that as climate change increases, honey-producing bee colonies will slowly start to decrease. Look through 15 years of data, average temperature, and the number of honey-producing bee colonies. Relate these two data points in the bar graph to determine if the increase in temperature affects bee colonies in a positive or negative way. Throughout the 15 years (1974-2007) the average temperature has slowly increased. Leading through this, as the average temperature increases honey-producing bee colonies decrease by around 2.3% every year. It was predicted that with the increase in temperature, the number of honey-producing bee colonies will decrease. Based on the results of my research I have concluded that throughout the 15 years that the average temperature of the world had increased which then led to the main source of decrease in honey-producing bee colonies. Climate change increases extreme rainfall, wildfires, and floods which cause a disrupted foraging pattern, destruction of bee habitats, and decreased food for the colonies.

Project ID: 284

SR - Earth and Environmental Sciences

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Utilizing 3D-Printed Engineered Living Materials to Break Down Environmental Pollutants

Textile dyes have been a leading environmental pollutant for decades. Although methods have been derived to break down these dyes, none are sustainable, controllable, or renewable. The hypothesis is that by harnessing the power of cyanobacteria in a man-made matrix to synthesize an enzyme capable of breaking down these textile dyes, the dyes can be broken down in a controlled and sustainable manner.

Project ID: 285

SR - Earth and Environmental Sciences

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How Does Water Quality Differ in San Diego Lakes in Densely Populated Areas as Opposed to Less Populated Areas?

In my project I studied how water qualities differ in lakes throughout San Diego in densely populated and less populated areas. To do this I tested 5 variables in 4 lakes throughout San Diego. The variables were nitrates, nitrites, pH, free chlorine, total chlorine, and total hardness. The lakes were Lake Jennings, Lake Kumeyaay, Lake Murray, and Otay Lakes. At the beginning of this study I hypothesized that lakes in less populated areas (Otay Lakes and Lake Kumeyaay) would have better quality than those in more densely populated areas (Lake Jennings and Lake Murray). However, this was wrong.

I tested multiple lakes for multiple variables to get a broader sense of how the quality differs and to see which lake has the best quality. So to test this I used Insta-Test Analytic - Driving Water 6 strips. I did one strip per lake for five days (too see consistency in results and get a more well rounded view). I then document my results to compare at the end of all testing. I got a wide range of results and so they differed a lot. However it's hard to tell which has the best quality by first glance since on average most results weren't the recommended safety guides.

To answer the main question of my project the quality of lakes differed a lot and a lot more than I expected. In fact many didn't land in what is considered safe. Only two variables had lakes that landed within the safe range (total chlorine, and pH.) And the lakes in less and more densely populated areas had the same amount of lakes and variables within the safe average.

Project ID: 286

SR - Earth and Environmental Sciences

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How Does Increased Pet Ownership Harm Marine Life?

My project was done in order to tackle the question of "To what extent does increased pet ownership contribute to decreases in marine mammal populations?" I came up with this question after pondering on how pet waste contains harmful chemicals that get carried off in runoff, and I wondered if the increasing ownership of pets every year had a direct effect on mammal populations who are affected by runoff.

I hypothesized that the effect pets had on mammal populations going extinct was very small, especially in comparison to other issues killing marine life.

I first approached my topic by creating a google form and surveying my classmates on whether or not pets were common and if they disposed of pet waste correctly. This familiarized me on whether or not .

After this I did more research and created a chart comparing the growth in population of dogs and cats and the decline in endangered marine animal populations and compared the two. After finding the correlation coefficient between the pets and the marine animals I discovered that an increase in pet ownership does not affect declining marine animal populations to a high extent.

Project ID: 287

SR - Earth and Environmental Sciences

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Testing Low-Budget Water Purification Methods for Rural Areas using Physical Models

Obtaining clean water over the past century has become increasingly difficult due to climate change, drought, and overpopulation. This project aimed to uncover cost-efficient methods to purify water for rural areas. In order to obtain results, numerous unclean water samples were ran through differing water purification methods - sand filters, chlorine disinfection, and solar water disinfection - and the resulting properties after treatment were compared to tap water and the control group, which was untreated, unpurified water from the same source. The hypothesis is that purifying water through the low-cost methods of sand filtration and chlorine/solar disinfection will provide clean water that is drinkable.

Procedure: The sand filter was built using a drainage tank composed of rinsed layers top to bottom: a layer of pebbles, followed by coarse sand, then granulated activated carbon, fine filter sand, another layer of pebbles, and a cheesecloth to prevent the filter media from draining through. The samples were either filtered or not filtered, then some samples received chlorine disinfection of 4 ppm and some did not, further, some samples were placed into direct sunlight for disinfection for 8 hours. Results were obtained by using water quality test strips, digital meters, and bacterial test kits. Unclean water was obtained from the San Diego River and placed into 9 groups: 1) control/no treatment, 2) sunlight + filter, 3) sunlight + filter + chlorine, 4) sunlight + chlorine, 5) sunlight, 6) chlorine, 7) filter, 8) filter + chlorine, 9) tap water/no treatment.

Conclusion: The hypothesis was proven correct due to groups 3 and 8 providing water that is drinkable. Both of these groups were negative in bacterial presence, the TDS was reduced by 4.4% over the untreated sample, the hydrogen sulfide was reduced by 60% in sample 3 and 100% in sample 8, and the clarity of the water was changed in both from deep yellow to crystal clear. The sand filter was very effective at removing sediments and suspended particulates, while the chlorine was very effective at killing bacteria and reducing hydrogen sulfide levels, but the solar disinfection was ineffective in all aspects.

Project ID: 288

SR - Earth and Environmental Sciences

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Turning Crop Waste into Energy: Numerical Simulations to Study the Impact of Blending Methanol into Gasoline on Pollutant Emissions

Pollution from burning crop residue is a widespread issue. One way to resolve this problem is by converting crop waste into methanol, which can be used as fuel. Ethanol-blended gasoline is widely used and has been shown to reduce pollutant emissions. Can methanol blended fuels also be used, without a significant increase in pollution?

In this work, a numerical simulation study is performed to investigate the impact on pollutant emissions from burning methanol-blended gasoline fuels. A chemical kinetics software, Chemkin, is used in modeling detailed chemical reactions of methanol blends. The current study involved five different blending ratios (0 % to 20% methanol) and an equivalence ratio of 0.6 to 2.0 to cover a wide range of fuel-air mixtures. The kinetics simulations are done with detailed reaction data involving 73 compounds and 296 elementary reactions.

The exhaust gas for different blends is analyzed for temperature and pollutants. The simulation results show no noticeable difference in the pollutants emission due to blending as high as 20 % methanol and reduced carbon-monoxide emissions per kg of fuel. There was less than a 5 % increase in formaldehyde for fuel-rich blends.

The results showed the potential of methanol as an alternative blend in gasoline fuels with a minimal impact on emissions. Blended methanol fuel would allow harnessing the energy of the crop waste into useful energy. To adapt methanol as a viable blend, further studies are required to see how blending methanol instead of ethanol will affect flame speeds, ignition delays, and corrosion.

Project ID: 289

SR - Earth and Environmental Sciences

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Reducing Lead Contamination Through Hydroponically-Grown Mycorrhizal Plants

Lead is one of the most common heavy metal pollutants in water, causing an estimated 1 million deaths each year globally. Current methods to purify lead-contaminated water, such as reverse osmosis or carbon filtration systems, can cost thousands of dollars and generally require existing infrastructure, making it difficult to implement in lower-income areas without proper plumbing systems. My project examines the effectiveness of hydroponically-grown mycorrhizal plants for lead uptake.

Procedure: Basil plants were grown hydroponically in deep water culture (DWC) systems. Arbuscular mycorrhizal fungi (AMF) inoculant was added to half of the plants, and all plants received the same low-phosphorus nutrient solution. Once mycorrhizal colonization is established, trace amounts of lead will be added to the hydroponics solution. ICP-MS will be used to study the kinetics of lead uptake and the total plant biomass will be used to measure the relative health of plants.

Results: Excess 5-0-1 FloraMicro nutrient mix led to build-up of minerals and salts in hydroponics systems. Mycorrhizal-inoculated plants had longer and thicker roots, with an average root length 2.11 inches longer than non-inoculated plants.

Conclusion: Quantities of nutrients and mycorrhizal inoculant are essential in successful mycorrhizal colonization and prevention of harmful build-up or precipitate. Further research will be conducted for analysis on lead uptake kinetics and plant response to lead-contaminated solution.

Project ID: 290

SR - Earth and Environmental Sciences

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Identification and Experimental Characterization of Plant Seeds as Effective Flocculants for Water Treatment

Access to clean water is a major crisis in many parts of Africa. Unclean water leads to the sickness and death of millions. Cheap, simple water treatment methods based on local materials can democratize clean water access. Moringa oleifera plant seed extracts are well known to treat water by aggregating particles. However, M. oleifera is not very common in central Africa where clean water is needed. I sought to find alternative seed extracts that could also treat water. Instead of a trial-and-error approach, I used bioinformatics to identify seed proteins with high similarity to M. oleifera's 2s albumin which gives its flocculating abilities. I discovered 20 plant seed proteins that had high similarity and identity to Moringa's CBP3. Structural analysis showed that these proteins have many arginines and glutamines, four disulfide bridges, and 3D structures like M. oleifera 2s albumin. I extracted seed powders from 6 plants and tested their flocculant behavior in dirty water compared to M. oleifera seed powder. I found that they achieved similar effectiveness to M. oleifera, but neither seed reduced the turbidity level enough to a safe drinking level. Overall, castor bean, rapeseed, and radish seeds (along with various other plant seeds) could be used to effectively treat water at practically zero cost and with minimal preparation. Additional research using different methods of preparation and different variables, such as antimicrobial activity, should be completed.

Project ID: 291

SR - Earth and Environmental Sciences

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Advisor: Jennifer Ekstein

The Effects of Petrol and Heavy Metals on Soil

Petrol, one of the most important but harmful resources but in the world, is used by the majority of the world and many industries rely on it. However, as the amount of petrol consumption increased and keeps increasing, it is important to study the effects that petrol has on the environment to not only humans, but also all forms of life. I predict that soil near petrol stations will be deteriorated and be harmful to all life due to the increased amount of pollutants and chemicals found in the soil, reducing the quality of life, biodiversity, and agriculture.

Procedure:

1. Prepare the testing beaker by mixing distilled water with the testing substance. 2. Insert the soil sample into the beaker and let it dissolve with the substance. 3. Insert the substance into 3 different beakers to test the nitrogen, phosphorus, and potassium respectively. 4. Test the pH on the sample without the substance by using the probe. 5. In another jar, put more soil samples and add pure distilled water, and let it soak. 6. Use the test strips to measure lead, mercury, etc. 7. Repeat for every sample collected. 8. Record the Results

Results:

There was an increase in heavy metals in the soil, but not by much

Lead Differential between Clean and Dirty Soil – 2400% increase

Copper Differential between Clean and Dirty Soil – 100% increase

Mercury Differential between Clean and Dirty Soil –100% increase

Conclusion:

While there was a change in Lead, Copper, and Mercury levels, it wasn't substantially noticeable. Additionally, there was no change in Nitrogen, Phosphorus, and Potassium levels, showing no difference between clean soil and soil used near petrol-heavy areas. This minimal change is most apparent in Copper and Mercury, where there is a difference of 0.1 mg/L or less. These results may be due to the amount of regulation surrounding contaminants such as petrol and oil, leading to an increase in substance amounts but not to the point where it is harmful to human life, however the same cannot be said for microorganisms inhabiting that soil.

Project ID: 292

SR - Earth and Environmental Sciences

Elena Marcuson

Grade 10

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Are Antibacterial Products Good?

My project is to see whether or not antibacterial products are good because I have seen debate about whether or not they are good or bad. The argument is that most antibacterial products kill good and bad bacteria. And as we know good bacteria is vital for many living organisms. So I decided to test this using 2 types of plants, Curled Parsley and English Thyme. I'm using a common product which is soap. Plants A are given soap that kills 99.99%, then Plants B are given soap that kills only some bacteria, and Plants C are just given water. My hypothesis is that Plants A are going to be in the worse condition and Plants C in the best. So far I have been correct. I also test if its the soap hurting the plants but it isn't. Plants A are wilting or have black stems, then Plants B are in the middle, finally Plants C are perfectly normal. Something I didn't expect was that the English Thyme was more resistant to it and took longer to wilt.

Project ID: 293

SR - Earth and Environmental Sciences

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How Does Ecological Footprints in Brazil, Japan, and Singapore from 2010-2020 Correlate to Their Biodiversity?

The ecological footprints of Brazil, Singapore, and Japan show a lot about their biodiversity from the years 2010-2020. I predicted that the lower a country's ecological footprint is, the more environmentally aware they are having a wider range of biodiversity with a small biocapacity and vice versa, the higher a country's ecological footprint is, the more likely it has a damaged biodiversity and a larger biocapacity. To find out more information about my hypothesis, I obtained the ecological footprint information of Brazil, Japan, and Singapore from 2010-2020 and I obtained the biodiversity information of Brazil, Japan, and Singapore from 2010-2020. I was able to make 6 different charts based off of the information I collected, with 2 charts for each country. I then created 3 graphs, 1 for each country with the calculations I made comparing the ecological footprints per person and biocapacity per person from the years 2010-2020. I noticed that the smaller a country's ecological footprint and the bigger the biocapacity, the better the country is, just like Brazil. With Japan, they have a significantly low biocapacity per person and a relatively high ecological footprint. In Singapore, their biocapacity per person is even lower than Japan's and its ecological footprint per person is significantly larger as well, proving that both Japan and Singapore don't have as good an economy compared to Brazil.

Project ID: 294

SR - Earth and Environmental Sciences

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How Has Ocean Acidification Affected the Beaches of Southern California?

The average pH in the ocean is ~8.10. Data from official sources have indicated that the sea is acidifying to some extent all over the world. Some areas are worse while others are less intense. To what extent has ocean acidification affected the beaches of Southern California? The hypothesis is that the pH will be lower than 8.10 and more acidic because of the increasing effects of ocean acidification.

Procedure: Data was collected from 7 sites on different dates. In order from north to south 3 trials were conducted at Ventura County Line, Santa Monica, Long Beach, Trestles Beach, La Jolla Shores, Coronado Beach, and Imperial Beach. The same digital tester was used across all sites and displays up to the hundredth value.

Results: The average pH at each site.
VCL - 8.04
SM - 7.96
LB - 7.95
TB - 8.06
LGS - 7.98
CB - 7.98
IB - 7.97

Conclusion: The results from all seven sites show no significant effect of Ocean Acidification on the beaches of Southern California. The average across all beaches was calculated to be 7.99 which is a 0.11 difference when compared to the average pH of the ocean at 8.10. With the pH scale being logarithmic, the difference between both averages is still a somewhat effective change. The standard deviation of all the sites was 0.05 meaning there were no outliers.

Project ID: 295

SR - Earth and Environmental Sciences

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Advisor: Melissa Mayne

Rapid Detection of Microplastics in Water: A Novel Light Scattering Method Using Fluorescence Emissions

Microplastics have been identified as a rapidly emerging contaminant due to their increasingly widespread presence in ecological and environmental sources. Commonly used visual industry analysis methods requiring the physical filtration and manual examination of particles are error-prone and labor-intensive. Other chemical composition analysis methods (Raman, IR, FTIR spectroscopy) are expensive, multi-step procedures that also involve the filtration of particles.

A novel device NEREID that uses laser light scattering microscopy to detect particles in water samples was previously developed. This instrument can accurately report the counts and size of solid particles greater than 10 µm in water. In this study, NEREID was coupled with a selective staining method that enables microplastics to produce a unique fluorescence peak. This method can detect microplastics in liquid samples without requiring a physical filtration process.

A fluorometer was used to measure the fluorescence emission spectra of common contaminants in liquid samples, including different types of microplastics, bacteria, and sand. Distinguishing unstained contaminants through laser-excited emissions was not feasible. A commercially stained Nile Red microplastic sample showed a prominent fluorescence peak between 580 nm and 630 nm when excited with a 538 nm light. Adding an optical filter with a bandpass between 600 nm to 650 nm onto the NEREID microscope allowed the commercially stained microplastics to successfully be distinguished from other contaminants in water samples. Nile Red generally adheres to non-polar substances. A Nile Red staining procedure was developed using a 2 µm/mL solution and was confirmed to effectively dye non-polar PS, HDPE, and PVC microplastics. Contaminants such as sand particles, E. coli, and S. aureus remained unstained in liquid.