CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Roya Ahmadi

Project Number
S1101

Project Title
A Data Analysis Approach to Wildfire Prediction

Abstract

Objectives/Goals
In order to prevent wildfires, this project develops a mathematical model to predict the ignition of a wildfire based on fire indicator factors including relative humidity, temperature, dew point temperature, and wind speed, which can be measured frequently through deploying small sensor devices in diverse geographical locations. The data measured is then transmitted to data collection centers for further analysis to accurately predict the possibility of the spark of a fire.

Methods/Materials
A computer study was performed to benchmark the proposed mathematical model to the existing prediction formulas The Angstrom Index and The Nesterov Index using existing data from the National Weather Service.

Results
The result of this study indicated that using the proposed model, the wildfire risk could have been predicted for the 2003 Cedar Fire and the 2017 Thomas Fire up to ten days before they occurred, with severe levels of risk five days before the fire occurred. This was a much earlier and accurate prediction when compared with the existing wildfire prediction methods, which rely on limited in-person field measurements performed by environmental agency personnel.

Conclusions/Discussion
This project will expand to include small sensor devices that measure fire indicator factors and transmit the measured data along with a sensor ID/location and the time of the measurement, to data collection centers, for which high level architecture has already been completed.
It is envisaged that for matters of practicality, the sensor devices are operated by small, solar-power rechargeable batteries, creating a self-sustained system, free of maintenance needs for at least five years. The benefit of the proposed system includes (a) providing time for firefighters to be deployed to the high risk locations ahead of time, enabling them to stop wildfires as they spark, preventing them from spreading and causing damage and casualties; and (b) warning residents in advance, allowing them to evacuate areas at high risk of fire.

Summary Statement
In order to prevent wildfires, this project develops a mathematical model to predict the ignition of a wildfire based on fire indicator factors, measured frequently through deploying small sensor devices in diverse geographical locations.

Help Received
I received high level guidance on the practicality and marketability of my project from my biology teacher, who aided me in recognizing my project constraints after I presented my idea.

Name(s)
Christopher Anklam; Haroun Khaleel; Jaeson Kim

Project Number
S1102

Project Title
Treatment of Contaminated Groundwater with a Bioinspired Complex-Nanoparticle Hybrid Catalyst System

Abstract

Objectives/Goals
Growing scarcity of high-quality drinking water supplies across the globe heightens the need for innovative and sustainable technologies for drinking water decontamination and water-waste reuse. Perchlorate, a chemically inert but toxic oxyanion, has been widely detected in groundwater supplies and agricultural products in Southern California as a result of source water contamination from improper disposal of explosive materials, use of contaminated fertilizers, and natural atmospheric processes. Other known contaminants in groundwater, such as NDMA and TCE that are connected with health concerns, have further accentuated the demand for developing effective technologies to remove ClO4- and related recalcitrant contaminants from groundwater.

Methods/Materials
Two separate experiments were conducted to compare the catalytic treatment of ClO4- in two different water matrices: DI water artificially spiked with ClO4- and raw groundwater. Briefly, 100 mg of Pd/C and 0.25 mg of NH4ReO4 stock solution were mixed together in a solution of 50 mL of DI water/50 mL of groundwater in a 50-mL round bottom flask capped with a rubber stopper. Collected aliquots of suspension were immediately filtered and analyzed (using ion chromatography) for residual ClO4- concentration at specific time intervals after initiating the batch reaction. A total of three trials were conducted for each water matrix.

Results
The catalyst system successfully completed ClO4- reduction in both the DI water and groundwater matrix. In the DI water matrix, the catalyst reduced ClO4- to 1.02% of the original concentration in 60 minutes. In the groundwater matrix, the catalyst reduced ClO4- to 1.74% of the original concentration in 120 minutes. The experiments also revealed that the catalyst reduces ClO4- more thoroughly in DI water than it does in groundwater. In DI water, 99.9% of the perchlorate was reduced while only 98.3% of the perchlorate was reduced in the groundwater matrix.

Conclusions/Discussion
The results disproved our hypothesis. The catalyst system showed a slower rate of reaction in the groundwater matrix relative to the DI water matrix. This may be due to the fact that the groundwater matrix contains numerous contaminants in addition to perchlorate which may also react with the catalyst. However, demonstrating the catalyst's success provides an alternative method that is more efficient in treating contaminated groundwater.

Summary Statement
The project demonstrates the success of a new catalyst system in treating perchlorate contamination in groundwater more efficiently.

Help Received
Kamron Saremi taught how local water treatment facilities use different methods to treat contaminated groundwater, and their limitations. Dr. Jinyong Liu taught the fundamentals of the catalysts systems and also supervised the experiment at UCR.

Name(s)
Kaitlyn A. Arst

Project Number
S1103

Project Title
Using Earth-Friendly Biodegradable Fiber Matting Berms to Reduce Soil Erosion

Abstract

Objectives/Goals
The purpose of this study was to determine whether earth-friendly biodegradable Coconut Coir, Straw and Raffia each rolled onto jute fiber matting and made into berm covers could be used to prevent wind soil erosion degradation. If so, which soil biodegradable berm cover is most effective in controlling wind soil erosion? This research is divided into two phases. Phase one is conducting a wind simulation test. Phase two is determining a plant germination experiment.

Methods/Materials
Soil was divided into 4 containers. Coconut Coir, Straw and Raffia berms were prepared and were tamped on top of the soil of its respective container. One container, as the control had no augmented surface cover placed on the soil. All 4 containers were angled to model a slope. Using a 150 p.s.i. 6 gallon air compressor a consistent medium flow of wind simulation was conducted daily for 2 weeks. An Anemometer was used to test the wind speed and the climate temperature. After each cycle of wind simulation, runoff soil was collected from each container, dried, sieved and weighed. Nitrogen, phosphorous, potash and pH balance levels of the soil content were tested. After 14 days of wind simulation, 25 seeds of Pisum sativum var. macrocarpon were planted in its respective receptacle to test soil quality. Each day the seeds that sprouted were recorded.

Results
Soil with the biodegradable Raffia berm cover was the most effective in controlling wind soil erosion with an 11.2 grams average soil run off. The control soil with no soil additives had a mean average of 169.1 grams soil run off and it was over 323% more soil runoff than the Raffia berm. The control plant also had the lowest germination rate after 21 days with 60% growth while the Raffia Berm plants had a germination growth rate of 96%. The pH balance tests of the soil ranged from Alkaline level 7.5 to 7.0 Neutral levels. The N, P and K content ranged from surplus to depleted.

Conclusions/Discussion
The results demonstrated the Raffia berm was most effective in reducing wind soil erosion and indicated this stabilizing cover can be used as an earth-friendly alternative for effectual management of soil erosion. Straw would be the next option when evaluated with the Coconut Coir, which had greater quantity of soil runoff and lower seed germination. The study showed wind soil erosion is more prevalent when the soil does not have a Coconut Coir, Straw or Raffia berm cover.

Summary Statement
I determined whether novel biodegradable lightweight jute fiber matting berm covers could be used to reduce wind soil erosion.

Help Received
I designed and built the berms by myself after an internet search on technique. My mother reviewed my results.

Name(s)
Sasha Avakyan

Project Number
S1104

Project Title
Reverse Eutrophication of Freshwater Samples Containing Spirogyra Using a Liverwort Moss Specimen

Abstract

Objectives/Goals
The purpose of this experiment was to support the idea that cheap species of plants found almost anywhere in the world can serve as mechanisms for nutrient reduction in an effort to reduce the harmful effects of water over-enrichment. It was hypothesized that if the Liverwort specimen is present in a sample of water containing Spirogyra, the water's levels of nitrogen and phosphorous will decrease.

Methods/Materials
In this study, two different environmental situations were mimicked: a eutrophic body of water containing Spirogyra (algae) and a eutrophic body of water containing Spirogyra and a live Liverwort, a species of flat-leafed moss. These two samples underwent the same conditions including temperature, volumes of water, and exposure to light, when cultivated in a 7-day period. The samples were tested for N and P using test tablets.

Results
After allowing substantial growth, samples were collected from each container, and after testing, the container with the liverwort moss showed noticeably fewer amounts of both N and P. The results from the experiment show that a certain species of moss, specifically the liverwort, can play a key role in the mitigation of eutrophic bodies of water due to their method of nutrient absorption.

Conclusions/Discussion
The practical implications of this study's findings, which show that the liverwort absorbs excess N and P, include possible large-scale ecosystem projects like artificial wetlands. Nevertheless, further research into the compatibility of this species of moss in certain ecosystems in which eutrophication is present is desirable to extend the knowledge of its possible outcomes. Overall, these finings have the potential to enrich future research in order to reduce the harmful effects of eutrophication on the welfare of surrounding people, flora, fauna, and the ambiance of the environment.

Summary Statement
In this study, I tested the effects of the liverwort moss' presence in a eutrophic sample of water to assess whether this plant serves as a mechanism for excess nitrogen and phosphorus absorption.

Help Received
Mr. William Lapin, my biology teacher, reviewed my final paper.

Name(s)
Isabella R. Blanco

Project Number
S1105

Project Title
A Study of the Effectiveness of Commercially Available Soil Erosion Control Products

Abstract

Objectives/Goals
The objective of this experiment was to determine the most effective soil erosion control products under wind erosion simulations and also subsequently how effective these control products were at their price points.

Methods/Materials
For this experiment, I used six different types of geotextiles which are all commercially available. These geotextiles were provided by Pacific Soil Stabilization. An additional control product I used was a Xanthan Gum solution. I used a large, industrial fan set on its highest speed to simulate wind erosion for the soil. I placed each container of soil with one of the control product and also one with no control products. I placed the containers in front of the large fan and turned it on for five minutes. I weighed the containers and recorded their change in soil mass after each trial. I repeated this procedure for twenty trials.

Results
After conducting twenty trials and calculating the percent change in soil mass, the most effective geotextile in the simulations was geotextile (G2) Landlok 450. This geotextile was composed of a dense web of crimped polypropylene fibers and had a an average percent change in topsoil mass of -0.149%. The price points of each control product were also analyzed to their change in soil loss. When compared to prices, it was geotextile (G4) Excel CC-4 that was the best performing geotextile. This shows that between price points and effectiveness that there are two effective methods to controlling soil erosion.

Conclusions/Discussion
It can be concluded that the best performing geotextile was the Landlok 450 in terms of retaining the most soil. However, Excel CC-4 was also the most effective in terms of cost. This shows that there are multiple control products that can be effective. This also brings an economical application that expands our knowledge on soil erosion control products and their cost effectiveness. This study is valuable to farmers, home owners, and environmental agencies who need an affordable practical, and effective solution to preventing soil erosion.

Summary Statement
I conducted a wind erosion simulation to determine which commerically manufactured, soil erosion control products are the most effective in retaining its soil and cost effective.

Help Received
My Summer Science Institute Advisor, Mr. Magni, helped secure the donated geotextiles for this experiment. He also helped to analyze the data from the experiment. However, I logged the data and conducted the experiment on my own.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Elizabeth A. Burket-Thoene

Project Number
S1106

Project Title
Is It Really Biodegradable?

Abstract

Objectives/Goals
The objective of this experiment is to determine whether or not a specific type of biodegradable plastic eating utensil can begin to biodegrade within a limited amount of time with one additional element (besides water, soil and microorganisms) and to discover which additional element heat or worms (which primarily provide aeration), will affect the decomposition of the utensil most.

Methods/Materials
3 planters (about 6 liters each), 13 liters of soil, 3 biodegradable eating utensils (heavy duty corn starch), infrared heat lamp, water, thermometer, milligram scale, Red Wiggler worms

The utensils are placed in each planter and data is collected daily. Once a week each spoon is measured in weight and visually examined for any changes.

Results
All of the utensils increased in weight. The biodegradable plastic eating utensil in the heated planter had the most changes visually and in terms of weight. The utensil in the control planter and the planter with worms increased slightly in weight but had no visible changes in appearance.

Conclusions/Discussion
Although there were various limitations in this experiment that could have altered the outcome, such as the duration of the experiment, the brand of biodegradable eating utensil used, the temperatures of the soil, and the type of worms used (for aeration), the data suggests that this utensil advertised as biodegradable cannot decompose with only two elements (water and heat or water and worms) instead of all three. Whether or not this same utensil could potentially decompose at home using water, heat, worms and more time is unclear from this research.

Summary Statement
This experiment was designed to determine whether or not a biodegradable plastic eating utensil can really biodegrade.

Help Received
None. I designed, researched and conducted the experiment myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Yeji Cho

Project Number
S1107

Project Title
The Effect of Carbon Sources on pH Fluctuations Caused by Nannochloropsis oculata

Abstract

Objectives/Goals
Biofuel producers have begun to use carbon sources as a method of stimulating continuous growth of algae through a combination of heterotrophic and photoautotrophic growth. This continuous growth of algae has the potential to stabilize the pH of water in which microalgae is grown. By stabilizing and raising pH, microalgae can be implemented as a means of ameliorating the effects of ocean acidification. This project explored the effect of carbon sources (glucose, fructose, and glycerol) on the pH fluctuations caused by growth of marine microalgae Nannochloropsis oculata.

Methods/Materials
Four flasks were established with a 2:1 ratio of water and microalgal cultures. Each flask received micronutrients at the beginning of trials, and received light in a 12-hour cycle. Carbon sources were added at concentrations of 0.1 g/L, and pH probes were used to monitor flasks throughout the 7-day trials. Hemocytometer counts were used to measure algal concentrations every three days.

Results
Glycerol tended to have the highest pH at the end of trial periods, and also had the greatest growth. On average, glycerol surpassed the next highest pH by 0.212, and did not fluctuate in pH after the first three days. The control, glucose, and fructose flasks fluctuated based on light/dark cycles, rising to around 8.7 at night, but falling by about 0.2 during daytime.

Conclusions/Discussion
The addition of glycerol resulted in stabilization and increase of pH. Throughout this experiment, glycerol was able to prevent fluctuations in pH based on light/dark cycles. The flask treated with glycerol also generally had the most efficient growth of microalgae, as seen in the high concentrations of Nannochloropsis oculata. The positive correlation between microalgae concentration and pH presents new insight into the potential of the biofuel industry as both a cleaner source of fuel and as a means of alleviating the negative effects of ocean acidification in marine environments.

Summary Statement
This project evaluated different carbon sources for their ability to increase and stabilize pH while optimizing growth of marine microalgae, Nannochloropsis oculata.

Help Received
I designed and performed the experiment myself. I received guidance from the staff at Cabrillo Marine Aquarium, and used their facilities and equipment.

Name(s)
Rachel Eizner; Lisa Leung

Project Number
S1108

Project Title
Replacing Plastics: Innovating Biodegradable Bio-based Films, Part II

Abstract

Objectives/Goals
The objective of this engineering project was to increase the water resistance to less than 35% mass loss and test the biodegradability of the protein-based films created in last year's project.

Methods/Materials
The base films were formed from distilled water, 80% casein protein concentrate, and glycerol, and were dried for 48 hours on a Teflon-coated pan. To improve water resistance, three measurements (.05 grams, .1 grams, .15 grams) of pectin or ferulic acid were added into the base solution and compared against each other. These water-resistant films were weighed before and after being submerged in water to test mass change. To test biodegradability, the base films and the ferulic acid films (the best performing films) were planted in bean, marigold, and cilantro pots and given 14 days to grow and biodegrade.

Results
The experimentation finds that 0.05 grams of ferulic acid added to the base casein solution performed best in water resistance, losing on 28.4% of the initial mass as compared to the 75.9% mass loss the normal casein films had. All films were able to fully biodegrade within 14 days of plantation. Bean plant growth increased 397% and 433% with the ferulic acid films and the base casein films respectively. Marigold growth was shortened to 69% and 35% of control plant size by the casein and ferulic acid films. Cilantro plant growth was shortened to 73% of original plant size for the casein films, but grew 118% of its original size for the ferulic acid films.

Conclusions/Discussion
The water solubility of normal casein films is decreased by 47.5% with the addition of 0.05 grams of ferulic acid. The films do not stunt plant growth. Instead, they decrease height in flowering plants, and tremendously increase growth in bean and cilantro plants.

Summary Statement
We created biodegradable, protein-based films, improved their water resistance, and tested their biodegradability and effects on environment.

Help Received
No help was received. All research, experimentation, and analysis was student conducted.

Name(s)
Christopher Fakhimi; James Jolin

Project Number
S1109

Project Title
Worms: The Bioremediation Solution of the Future

Abstract

Objectives/Goals
The purpose of this experiment was to determine which type of worm - Z. morio, T. molitor, T. obscurus or G. mellonella - is most effective at degrading polystyrene (PS) and if, in fact, gut bacteria are depolymerizing the PS molecules.

Methods/Materials
We set up terrariums with worms and polystyrene (PS) in each and monitored consumption and worm attrition over a period of 31 days. Then, we measured the CO2 emissions of worms reared on antibiotics and PS, using CO2 sensors and biochambers, to determine if bacteria were degrading PS molecules. Finally, we cultured worm gut bacteria in bacterial cell culture flasks with a carbon-free medium and PS, plated the bacteria on agar plates, incubated the bacteria for 48 hours at 37C, extracted the bacterial DNA with a DNA extraction kit, and amplified the Exiguobacterium sp. strain YT2 bacterial DNA using universal 16s primers, TAQ Master Mix, and Thermal Cycler. Amplicons were sequenced at an off-site sequencing facility.

Results
An analysis of variance (ANOVA) data test of PS consumption (n=4) and worm attrition (n=4) resulted in p-values lower than the alpha standard ($p<0.05$), showing a significant difference in both tests. Z. morio consumed the most polystyrene, with 25.23% consumption, and also had the least death, with 12% attrition. DNA sequencing revealed that 40% of Z. morio gut bacteria DNA is similar to Exiguobacterium sp. strain YT2. Additionally, Z. morio, reared on PS, ceftriaxone and gentamicin antibiotics, produced on average 36.5% less CO2 (ppm/h) than specimens without antibiotics. Microbes were present in the Z. morio guts and were suppressed by antibiotics.

Conclusions/Discussion
The alternative hypothesis was supported; worms, specifically Z. morio, can serve a viable role in bioremediation. Hypothetically, 10,000 Z. morio specimens, which are not difficult to rear, could eat 150 grams of PS. Effective and fast bacterial cell culturing could provide a means of polystyrene degradation. Easy PS-degrading microbe DNA isolation and amplification could provide further research about the proteins that encode PS degradation.

Summary Statement
This project supported, using various scientific disciplines, the conclusion that Z. morio most effectively degrade PS and gut microbes play a role in PS molecule depolymerization.

Help Received
We received no institutional assistance in our project. Thomas Reynolds, PSM did mentor and assist us in our school laboratory during the implementation of biotechnology. Otherwise, we performed all other procedures.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
John Ha

Project Number
S1110

Project Title
Generating Energy from Microbes: An Approach to Recycling Domestic Wastes

Abstract

Objectives/Goals
The objective of this research is to find the best design for a small scale anaerobic digester which could effectively transform biomass into biofuel using the least amount of outside energy.

Methods/Materials
Measured the most efficient environment for anaerobic digesters to produce energy by setting up two batches of anaerobic digesters in cold and warm environments. The warm batch was heated up by an U.V lamp and the cold batch was placed in room temperature. The warmer temperature should be around 32 - 38 celsius while the colder temperature should be around 18 - 22 celsius. Each batch had 5 anaerobic digesters. Attach a balloon to the top of every digester to collect the biogas produced. Measure the circumference of every balloon every 12 hours and record the data. Use Sketchup afterwards to produce the most effective anaerobic digester based on the results.

Results
The results demonstrated that the warmer digester produced significantly more biogas than what the colder digester produced under a four day period. The warmer digesters produced a combined amount of 1168.8 ml biogas while the cold digesters produced a combined amount of 275.4 ml biogas. The graph shows an exponential trend throughout the warmer digesters while the colder digesters fluctuates in the amount of biogas produced per day. The results will therefore prove that anaerobic digesters function best under temperatures of 31 - 37 celsius as opposed to room temperatures of 18 - 22 celsius.

Conclusions/Discussion
This conclusion based on the results proved my hypothesis correct. The bacteria which are in charge of digesting foods in the anaerobic digesters are mesophiles and they are most suited to temperatures of 30 - 45 degrees. The apex of mesophilic reproduction and occurs around 31 - 37 celsius and they subside after that level is reached. Temperatures below that also decreases the productivity of mesophilic bacteria. Anaerobic digesters must therefore maintain their temperatures between 31 - 38 celsius to produce the most effective results. Therefore this justifies the need of warmer regions in the U.S to construct Anaerobic Digesters to harness the energy from organic wastes. Or else this biogas would be released into the atmosphere was wasteful and potentially harmful greenhouse gases.

Summary Statement
I used bacteria to harness energy from organic wastes in an attempt to decrease greenhouse gas emissions as well as to reduce the growing amount of landfills in the U.S.

Help Received
I received minimal help from my parents throughout my science fair project. Apart from driving me places such as Walmart and Home Depot to get materials. I finished the project on my own. I however must give credit to both my history as well as science teachers in inspiring me to work for the betterment

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Kastine Hiltman; Madison Perkins

Project Number
S1111

Project Title
Backyard Brew

Abstract

Objectives/Goals
The object of this study is to determine if potable water was not available could you use materials in a common backyard to filter bacteriological and suspended contaminates from raw water to make it safe to consume. Potable water standards used for this experiment are total coliform <1.0 CFU/100 ml and turbidity < 5.0 ntu.

Methods/Materials
A premeasured turbidity and coliform of raw water was poured over 8 backyard materials (rubber bark, woof chips, coal, pea gravel, sand, granite rock, lava rock and pine needles). The effluent from each filter media was collected. Turbidity was measured using a turbidimeter to determine suspended contaminant removal and 24 hour Idexx colilert tests were ran to determine bacteriological removal. Each filter media test was ran ten times and an average turbidity and coliform were recorded.

Results
The test results indicate that coal had the best turbidity removal rate of 37% and pea gravel had the best coliform removal of 45%. Sand had the best overall contaminants removal (turbidity and bacteria) than any other filter media. None of the filter media samples came close to meeting potable drinking water standards.

Conclusions/Discussion
Water treatment is complicated process that can not just be replicated at home. There is a vast array of different contaminants in the water and there is not a specific filter media that can remove them all. Most important aspect of potable water is coliform removal.

Summary Statement
If potable water was not available could you use materials in a common backyard to filter bacteriological and suspended contaminates from raw water to make it safe to consume.

Help Received
My dad demonstrated the proper lab technique in setup and reading Idexx colilert tests. City of Fairfiled allowed laboratory access and provided testing equipment.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

Jonghyun Hong; Jad Soucar

Project Number

S1112

Project Title

An Alternative Approach to Synthesizing Concrete,Using the Salt Water Carbonate Buffer System, and the Cocolithophore

Abstract

Objectives/Goals

The concrete industry creates over 86.7 million metric tons of concrete every year, and unfortunately emits over 3 billion tons of carbon dioxide as well. In order to minimize the carbon dioxide emission from the concrete production industry, our project sought to find an environmentally sustainable method that would allow for the formation of a zero emission calcium carbonate based concrete. The main target was to achieve a form of calcium carbonate crystallization around a series of aggregates, to not only create a firm concrete like structure, but also eliminate the mining and burning of limestone.

Methods/Materials

Numerous combinations of CaCl2, Ca(OH)2, and Mg(OH)2 were dissolved in solutions and placed in a modified vacuum/gas chamber with different aggregates (such as sand and gravel). The chamber was then vacuumed out, and saturated with CO2 to promote the formation of carbonate. After multiple trials, we experimentally determined the correct ratio of calcium chloride, magnesium hydroxide, water, carbon dioxide, And aggregate ,to maximize the amount of calcium carbonate created. The calcium carbonate then fused together the aggregate, to create a concrete like structure.

Results

The experimentally determined ratio for the ingredients CaCl2, Mg(OH)2, Ca(OH)2,CO2 and water in moles is, 6.25 / .6 / 2.5 / 192.5 / 1. With this ratio, we gained the ability to synthesize a calcium carbonate-based concrete that could withstand a substantial amount of pressure. When testing the "hardness" of the newly synthesized concrete according to the Moh's test of hardness, our concrete received an average of 7-8.

Conclusions/Discussion

We predict that the addition of carbonic anhydrase and cocolithophore will catalyze the saltwater carbonate buffer system and the formation of calcium carbonate, to create more a more durable concrete structure. Additionally the E.Huxleyi strand of cocolithophore will provide the calcium carbonate within the concrete, a unique microscopic spherical shape, which would increase the strength of the concrete. Conclusively our novel process to create concrete will be applied instead of concretes such as Type l (cinder blocks, benches), and V1 concrete (decorative) and Insulator-based concrete.

Summary Statement

We created inudstrial grade concrete out of carbon dioxide and various other ingrediants, to effectivly remove carbon from our atmosphre and toxic metals from our enviorment.

Help Received

We designed and developed our prodceudre and the machine necasary to complete it, with the feedback of Prof. Jamil Momand in the department of Chemistry & Biochemistry at Cal State LA.

Name(s)
Patrick J. Kim

Project Number
S1113

Project Title
Optimizing Cultivation of Chlorella vulgaris in Various Photobioreactor Systems and Municipal Wastewater Concentrations

Abstract

Objectives/Goals
Among the scientific community, there is growing agreement that microalgal photobioreactors are among the most effective systems for biomass generation and carbon capture to lower atmospheric carbon dioxide levels. However, further optimization of growth is required to provide more effective solutions. Current literature mostly focuses on closed photobioreactor systems with carbon dioxide bubbling and, if utilizing wastewater, pure wastewater as a nutrient source. This study aims to investigate the ideal type of photobioreactor and wastewater concentration to maximize microalgae growth in small-scale municipal wastewater filtration systems.

Methods/Materials
The green microalgae Chlorella vulgaris was cultured in four 30-liter photobioreactor systems: closed and open-air, with and without carbon dioxide bubbling and pH monitoring. Periodically, turbidity was recorded and Guillard's formula was added. Separately, C. vulgaris was cultured in seven 300-milliliter samples of various concentrations of distilled water and treated municipal wastewater from the Hyperion Water Treatment Plant. The turbidity and pH of each sample were collected and recorded regularly.

Results
The system that yielded the most biomass was the open photobioreactor with carbon dioxide bubbling and pH monitoring, generating a turbidity value of 180 NTU after 21 days. The wastewater sample microalgae grew sinusoidally, with considerable asymptotic variation after an initial period of similar growth. The optimal wastewater concentration for culturing was the 83% concentration, with an asymptotic turbidity value of 763 NTU.

Conclusions/Discussion
The results show algal growth dominance in photobioreactor systems with an additional carbon dioxide source and installed degassing mechanism. In addition, the data support a culturing concentration of around 80-85% municipal wastewater over 100% wastewater or distilled water. Hence, developing and implementing algal photobioreactor systems in water treatment plants can take advantage of these discoveries both to capture carbon and to purify wastewater, lowering levels of atmospheric carbon dioxide and mitigating the potential risks of marine algal blooms caused by wastewater pollution.

Summary Statement
This study concluded that photobioreactor microalgae growth may be optimized with a regulated degassing mechanism, an additional carbon dioxide source, and, in systems utilizing wastewater, continuous replacement of diluted wastewater.

Help Received
Dr. Ochan Otim aided me in collection of the wastewater from the Hyperion Water Purification Plant, obtaining instrumental analysis of the treated wastewater, and reviewing experimental procedure. He also gave me access to the lab. My parents helped in driving and gathering necessary materials.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Laura A. Krasnow

Project Number
S1114

Project Title
Studying the Biodegradation of Low-Density Polyethylene by Marine Bacteria

Abstract

Objectives/Goals
It was hypothesized that bacteria collected from plastic incubated with ocean water, collected from Scripps pier, are capable of biodegrading plastic.

Methods/Materials
A sample of surface ocean water was used and eight pieces of low-density polyethylene(LDPE) were incubated for approximately one month. From the plastic pieces, 16 species of marine bacteria were isolated. Each isolate was added to a test tube containing filtered sea water and a piece of LDPE. The independent variable was the different isolated bacteria strains and the dependent variable was the weight difference measured. The experiment was done in triplicate. The control for the experiment included three test tubes with only plastic and filtered sea water. The plastic was weighed before and after being inoculated with the bacteria to measure the weight difference. The isolates were identified by using 16S rRNA gene sequencing. The isolates, which were mostly from the Alteromonas genus, were incubated with strips of LDPE for either two weeks or four weeks and the weight loss of the plastic piece was measured.

Results
The results were inconclusive. None of the plastic pieces had a statically significant weight decrease that would identify one bacteria capable of degrading plastic. However, one of the bacteria identified as part of the Alteromonas genus, had a weight decrease in both the two week set and the four week set.

Conclusions/Discussion
Although, no particular genus of marine bacteria was found to have a statistically significant ability to degrade LDPE, this experiment identified key bacteria that can be found on plastic floating in the coastal Pacific Ocean. The knowledge of what bacteria is found on plastic can be beneficial when studying how to use marine bacteria to mitigate plastic pollution.

Summary Statement
I obtained marine bacteria found on plastic, isolated and idenified them, and tested their ability to biodegrade plastic by testing the weight decrease of a LDPE plastic piece after a two week and four week isolation.

Help Received
I was able to use Dr. Bowman's lab at the Scripps Institute of Oceanography. He provided me with resources and advice. My advisor at the lab was Natalia Erazo, and she helped me throughout this experiment with instruction.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

Jashandeep S. Lobana; Abraham E. Rubalcava

Project Number

S1115

Project Title

Phytoremediation of Lead through Arabidopsis thalania

Abstract

Objectives/Goals

The objective is to discover a plant, either naturally or through genetic engineering, that can effectively uptake lead from contaminated soils. The goal is to see whether or not the Arabidopsis strains, Columbia and Landsberg, have the ability to withstand 0.8 milli-molar or higher lead solutions.

Methods/Materials

Fume hoods, .008M Lead II Nitrate Solution, Laptops with Temperature Recording Software, Arabidopsis Columbia and Landsberg seeds, Lab-Grade Potting Soil, Distilled Water, Grow Lights regulated by Day-Night Timers.

Results

After two weeks of growth, the treated groups under both strains were introduced to the lead solution for a one-week period and observations were recorded. The treated groups for both strains evidently withstood the .008M Lead solution, as there were no observed changes or alternations in growth rate and structural development.

Conclusions/Discussion

The two treated groups successfully survived the treatment phase of our project and continued to grow past the extent of our experiment. This leads us to believe that the Arabidopsis species has a strong chance to potentially endure even higher concentrations of lead to where they can tolerate real-world levels of contamination.

Summary Statement

We tested the phytoremediative abilities of the Arabidopsis species, in regards to lead contamination, to extract the abundance of lead in contaminated sites and reuse it as recyclable material in industry.

Help Received

My partner and I devised the experiment. Professor Dr. Springer and her PhD Candidates, Mr. Schwartz and Ms. Toth from the Botany Department at UCR provided professional assistance to determine and obtain the selected plant of study. Ms. Schweiger and Mr. Mazzulli mentored and provided the necessary

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Ryan Mei

Project Number
S1116

Project Title
Atmospheric Water Generation Using Hygroscopic Substances

Abstract

Objectives/Goals
The objective of this project is to create a device that uses cheap and readily available materials to extract moisture from the atmosphere and produce clean water without fuel or electricity. Current methods either require exotic materials, humid air that is near dew-point, or large amounts of external energy input.

Methods/Materials
Three substances (calcium chloride, silica gel, and montrimorinlite clay) were tested for their for their ability to absorb and release moisture. The weight of a glass dish of each substance was measured on a scale before and after 48 hours in the atmosphere, and after being heated on a hot plate.
Based on the results, a solar atmospheric water generator was then constructed using the silica gel. Materials and tools used included a plastic tub, PET plastic sheets, aluminum foil, mylar, hot glue, a hand saw, and power drill. The mass of water collected each day was measured with a scale.
Subsequent versions experimented with fans and thermoelectric elements.

Results
Though calcium chloride absorbed the most water, it released the least water. Silica gel proved to be the material most effective at absorbing and releasing moisture.
Using silica gel, the device was able to generate 8 grams of water per 100 grams silica every 24 hours, on average.

Conclusions/Discussion
Based on test results, silica gel shows great promise as a material for water generation. The device would need 25 kg of silica gel in order to generate the 2L/day of water needed to survive, which would cost significantly less than conventional methods of atmospheric water generation (silica gel costs about $0.55/kg) and require no electricity or fuel. A full-scale device to provide to provide enough drinking water for one person every day would cost around $45.

Summary Statement
I created a low cost device to produce drinking water from atmospheric moisture.

Help Received
Ms. Angela Merchant of Henry M. Gunn High School allowed me to use the scales and hot plates in her classroom. My father helped me use the power tools to build this project.

Name(s)
William G. Milosevich

Project Number
S1117

Project Title
The Use of a Greywater System and Fish to Produce Organic Fertilizer

Abstract

Objectives/Goals
The purpose of this experiment was to create a water system that cleans greywater, transfers the water to a fish pond, and extracts the fertilized water from the pond to saturate plots of grass and rosemary bushes. My project consisted in studying if the fertilized water from the pond helped the plants grow quicker and taller than the greywater-supplied plants.

Methods/Materials
This system was built using plastic bins for the tanks and filters, pvc pipe, four pumps, and subterranean drip tubing. The filters used silt fabric, three one-pound carbon bags, and zeolite crystals. The plants tested were 12 rosemary bushes placed inside 12 1ft x 1ft plots of grass. The six plots of grass and six rosemary bushes were watered with the fish-fertilized water, and the other six plots and bushes were watered with greywater. Each set of plants were watered for 15 minutes every other day with water pumping at 0.9 gph. This supplied each plot with 0.225 gallons of water.

Results
The growth rates of the plants were compared using a Student T-Test. The p-value for the grass was 0.628 and the p-value for the rosemary was 0.826, providing evidence towards the null hypothesis. The water system could keep the ph at 7.0-7.2, ammonia levels at 0.25-0.50 ppm, nitrite levels 0.50-1.00 ppm, and nitrate levels to 0-5.0 ppm in the fish pond.

Conclusions/Discussion
I was successful in creating a working water system that cleaned greywater with the aid of acclimation chemicals. The system kept the water at a pH level of 7.0-7.2 and keeping ammonia, nitrite, and nitrate levels at a low ppm, allowing for a safe environment for the fish. These results suggest that a system similar to the one this could be used in public areas to supply fertilized water to lawns and spaces with lots of vegetation.

Summary Statement
My project is creating a water system that cleans greywater, and supplies it to a fish pond as fish-fertilized water is removed and is used to water plants.

Help Received
I had minimal help with the assembly of the water system. I needed help learning the tools I would be using as well as attaching the pipes to each other, which I received from a mentor. I also needed help in making sure my data was interpreted correctly, which I received from our statistics specialist at school.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Ahmed A. Mohamed

Project Number
S1118

Project Title
H2U: Water Solutions for the Modern Household

Abstract

Objectives/Goals
The average American homeowner uses an average of 360 gallons of water per day. About 40% of that water is devoid of any toxins or impurities (Green). An additional 35% can be easily purified. That amounts to 270 gallons of clean, reusable water that is poured down our drains. The state of California is currently regressing into a drought, yet our water conservation efforts remain sedentary. Without advancements, our supply of water will quickly dwindle. The goal was to develop a device that could identify the filterable/clean water, and divert it into a holding tank for reuse throughout the home.

Methods/Materials
Turbine: Developed using CAD and CFD software. Water System: Developed through the study of hydroponic systems. Used an Arduino, pH sensor, and an electric conductivity sensor. The Arduino was used to process the results of the sensors and control multiple solenoid valves used to control the flow of the water. Filter: A traditional carbon filter was made, and tested in order to discover it's limitations.

Results
Turbine: A standard inline Turgo turbine was developed which was able to produce 10 watts and 11.5 volts. Water System: The sensors had to be placed in separate tanks as the conductivity sensor was affecting the results of the pH sensor. The system is able to accept and divert 2 gal/min. Filter: The filter was able to filter out 99% of all liquids between 6-9 pH and 2-4 ms/cm.

Conclusions/Discussion
The turbine is able to generate 11.5 volts consistently, thus, I had to trickle charge the battery, have two separate batteries, and have one running the system while the other is slowly charged. I estimate that if the systems usages were to remain consistent and the device were to be used at an average of 20 mins per day, then the batteries would have to be switched every two weeks, and would have to undergo a full charge (through a wall socket) at least once a year.

Other than the maintenance requirement, the system works as needed. The charcoal filter is able to accept water within 6-9 pH and 2-4 ms/cm. This means that roughly 60-70% of the water that goes down sinks, showers, and washing machines (the drains accounting for 80% of all household water wasted) can be filtered and reused. And if one device is attached to these drains, the average household would save 170 to 200 gallons per day. That is 62,000 gallons per year, about half of their yearly water usage.

Summary Statement
An automated way of filtering and reusing grey water within the home.

Help Received

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Saurabh Narain

Project Number
S1119

Project Title
Mesh Network Based Wildfire Monitoring and Prevention System

Abstract

Objectives/Goals
In 2017, California faced one of the most devastating fire outbreaks in the history of the state, destroying 1.3 million acres of land and stripping thousands of people from their homes. The losses due to the fires have amounted to an astounding $13 billion. The damage that Californians have faced, has prompted me to design a simple, inexpensive, and reliable wildfire monitoring and detection system to prevent wildfires and minimize losses.

Methods/Materials
The wildfire detection system is a smart solar powered wireless device based on a microcontroller in a mesh network. These network devices monitor flame, temperature, humidity, and smoke and relay the data to nearby mesh nodes. The mesh nodes are connected to a central wireless router and extend the network to monitor a hazardous area. The router is connected to the internet and pushes captured data to the cloud for analysis and detection.

Results
During the testing phase, I found that the fire detection device could accurately obtain data regarding flame, temperature, humidity, and smoke and was able to provide mobile alerts. The sensor was tested in various conditions to ensure accuracy. Even when some of the mesh nodes and sensors were down, other nodes and sensors continued to successfully send data to the cloud.

Conclusions/Discussion
I have made a mesh network of sensors that can effectively detect fires by collecting data on flame, temperature, humidity, and smoke across a vast area. Additional variables can be added to the wildfire monitoring system to further enhance the detection mechanism. An infrared image sensor can be used to visually confirm that a fire is present. Furthermore, a GPS can be implemented in each of the microcontrollers to allow for fire personnel to easily locate the exact location of the fire. Research shows that wildfires are currently detected through the sole use of an infrared camera. My project builds on such detection mechanisms by adding sensors that measure temperature, humidity, flame, and smoke simultaneously through a mesh network, allowing for expandability and reliability. Through the creation of an inexpensive and reliable smart device, future wildfires can be detected and prevented, saving billions of dollars and ensuring public safety.

Summary Statement
I have made a mesh network of sensors to effectively detect wildfires and send a notification for early prevention.

Help Received
None. I created and programmed the mesh network sensors myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
William Olsen; Garrett Takei

Project Number
S1120

Project Title
Engineering Your Bathroom to Conserve Water

Abstract

Objectives/Goals
The prototype product consisted of a Shower water diversion module to divert water from the shower into the toilet tank and a Toilet tank filling module that allows the toilet tank filling to to be regulated. Cost vs complexity trade-offs and safety were the main criteria in the 4

Methods/Materials
Micro-switches, Time delay Relays, DC power supply
Solenoid valves, Metal pipe and plastic tubing installed into existing shower and toilet tank were used in the design process to save the 2 gallons of water wasted during the heat up cycle of a shower. The prototype product consisted of a Shower water diversion module to divert water from the shower into the toilet tank and a Toilet tank filling module that allows the toilet tank to be empty when needed. Cost, complexity and safety were the main criteria in the prototype design comparisons. We considered multiple prototype options and the safety concerns in the design process at a minimal cost < $100. Additional water savings features for the future are enabled by the toilet tank module.

Results
4 Prototypes were considered in the design phase to use solenoid valves to divert water into a toilet tank with a modified filling valve, so the tank would remain empty to capture stagnant cold water from the shower hot water line. Testing of multiple house configurations showed that >75% of the warm up cycle water can be captured by a 2 gallon toilet tank.

Conclusions/Discussion
Droughts in CA can impact, reduction in Water Reservoir reserves, Soil compaction within Wells, Sea Water intrusion into land, Reduction of water allocation for wetland or fish restoration. Our mitigation water diversion prototype if installed in 90% of the single family homes in CA, could conserve 46M gallons per day and 16.8 Billion gallons per year.

Summary Statement
This environmental engineering prototype diverts clean water from the shower to the toilet tank to save 46M out of 68M gallons usable water that goes down the drain every day in California during the warm up cycle in a shower.

Help Received
One partner consulted Mrs. Dorothy Lubin on the environmental impact of a drought and while we built our prototype, Mr. Christopher Olsen assisted in soldering, wiring, and piping.

Name(s)
Melanie E. Quan

Project Number
S1121

Project Title
Microplastics, Macro Problem: A Novel Technique to Remove Microplastics from Water Using a Modified Electrostatic Filter

Abstract

Objectives/Goals
Microplastics are an increasingly problematic aspect of plastic pollution with an estimated 83% presence in tap water worldwide. Currently, there are no feasible water treatment options to remove microplastics from water that are both effective and economical. After learning of the beneficial effects electrostatic smoke precipitators have on ash removal in power plants, I applied concepts found in these filters and applied them to a novel microplastic filter. My hypothesis was that a stronger charge of the electromagnets used in my filter design would remove more microplastics from the water.

Methods/Materials
To test this, I constructed five variations of filters, each having two pieces of mesh attached to electromagnets. Each filter had electromagnets at different strengths, dependent on the number of coils. The five filters tested had varying numbers of coils of 0, 50, 100, 150, and 200. To determine the filters' effectiveness on different sized microplastics, I tested my filters with two different sized microplastics of 1058.330 microns and 264.583 microns. After constructing the filters, I used a 9V battery as the power source to charge the electromagnets. I then filtered one gram of microplastics suspended in 200mL of distilled water through each filter for five trials, doing this for each of the two different microplastic sizes.

Results
The data from the tests proved my hypothesis correct and consistently showed a positive relationship between the strength of the electromagnets and the amount of microplastics captured. The data shows that the filter with 200 coils on the electromagnet filtered an average of 24.5% of the large microplastics and 14.88% of the small microplastics, while the filter with no electromagnetic strength removed 1.7% of the large microplastics and 0.6% of the small microplastics.

Conclusions/Discussion
This research proved a way to successfully filter out microplastics from water using pre-existing and low-cost technology. There was a direct correlation between the strength of the electromagnet and amount of microplastics captured. Given that a 9V battery was the power supply used, it is logical that a stronger power source would remove more microplastic. This research shows potential in both commercial and industrial levels, with potential applications in a variety of settings, from household appliances to large-scale water treatment facilities.

Summary Statement
I created a novel electrostatic water filtration technique that removes microplastics from water.

Help Received
None. I designed, built, and performed the experiments myself.

Name(s)
Anna T. Rioux

Project Number
S1122

Project Title
Turning Farm Waste into Usable Energy: Investigating Energy Production of 3-D Printed Microbial Fuel Cells

Abstract

Objectives/Goals
The purpose of this experiment is to economically engineer and test 3-D printed Microbial Fuel Cells (MFC) in a series connection for use in large scale application like a dairy or wastewater treatment facility. I hypothesized that CAD 3-D printing software can be used to design an MFC that will be able to produce a measurable amount of energy. Furthermore, I hypothesized 3-D printed MFCs will produce a greater amount of energy in series connections than by themselves.

Methods/Materials
The research and design phase reviewed multiple CAD 3-D printing software programs to determine the most functional and economic tool for designing the MFCs. Using Tinkercad STL files were prepared for printing on Lulzbot Taz 4, a second model was printed on a Flash Forge Creator Pro. Alpha filament and PLA plastic materials were used to print the prototypes. Then, multiple trials were conducted using 45 mg of cow manure farm waste in the anode, and 35mg of saltwater solution in the anode chamber. Electrodes sized 3 cm x 3 cm were placed in the chambers, and an agar solution was used for the salt bridge. Twice daily readings were taken for amperage, volts and wattage.

Results
An MFC was printed using economical CAD software. However, due to printer limitations there were dimension constrains. The experimentation demonstrated that both the individual and series connected MFC could consistently produce measurable energy. However the individual MFC produced a greater amount of energy, 1.08 watts; in comparison the series connection yielded 0.88 watts. In general the individual MFC produced a greater amount of voltage, 154 mV versus 85 mV; but, a similar amperage between 4 and 11 mA for the individual and 1 to 5 mA for the series connection.

Conclusions/Discussion
A functioning MFC was engineered, and the results indicate that the individual MFCs are more efficient than the MFCs in series connection. The next step in this research would be to increase the size of the 3-D printed MFC, and make modifications to the salt bridge, from an agar solution to a proton exchange membrane to increase output. Additionally, development of a power management system, including a boost converter, for energy to then be stored in an external battery for future consistent flow of energy will be reviewed. These modifications will be necessary before applying this technology to a large scale use on a dairy or waste water treatment facility.

Summary Statement
Using CAD software I designed economical 3-D printed MFC prototypes to use in series connections for the purpose of creating an inexpensive way to turn farm waste into usable energy, for large scale use.

Help Received
I designed the MFCs prototypes using CAD software. Then, I submitted STL files to Doug Cairns of TCOE and Nelson Sebra of Fresno State#s Lyles Center, they printed my prototypes MFC on 3-D printers.

Name(s)
Vedha Santhosh

Project Number
S1123

Project Title
The Optimal Soil Stabilizing Biopolymer to Reduce Shear Induced Erosion and Improve Soil Productivity

Abstract

Objectives/Goals
The objective of my study was to determine the optimal soil stabilizing biopolymer to reduce shear induced erosion and improve soil productivity. I compared 3 vegetable based starches to test effectiveness of water retention, prevention of nutrient runoff, and promotion of plant growth.

Methods/Materials
Control: Untreated soil (not amended)
Independent Variables: Starch Based Soil Stabilizers
Dependent Variables: Resulting water retention, plant growth, nutrient runoff (N, P, K)
Phase I- 3 different types of soil stabilizing Super Absorbent Polymers(SAP)were produced using Corn, Tapioca, and Potato starch. Active ingredients used to increase cross linking and water retention were Carboxymethyl Cellulose and Aluminum Sulfate.
Phase II- The amended soil was tested for water retention and nutrient runoff. The water retention test measured how much water was retained by amended and stabilizer-free soil. Stabilizer free soil, retained the least water and started releasing water after only 20 mL. Tapioca Starch based SAP-amended soil was the most hydrophilic and retained most water since it started releasing water after 45mL. The nutrient runoff test measured retention of original Nitrogen, Phosphorus, and Potassium levels after using soil stabilizing SAPs.
Phase III- Pea plants were grown in amended soil and stabilizer-free soil. Optimal Starch Based SAP was determined by plant height and soil testing.Plants were watered 25mL every week after germination and observed.

Results
The results of my experiment confirmed my hypothesis; biodegradable SAPs were the best soil stabilizers. Plants grown in soil with Tapioca Starch based SAP grew tallest and healthiest (strong stalks, no breakages). Soil amended by Tapioca and Corn starch had increased water retention than potato starch. Plants grown with no stabilizers had lower height while the soil was dry and erosion-prone.

Conclusions/Discussion
Soil amended with Starch Based Super Absorbent Biopolymers especially tapioca starch is a renewable, sustainable, and biodegradable alternative to plants. Untreated soil is erosion prone, has low water retention, enables nutrient runoff, and inhibits growth.

Summary Statement
Soil amended with Starch Based Super Absorbent Biopolymers reduces shear induced erosion and improves soil productivity due to increased water retention and decreased nutrient runoff.

Help Received
This project was performed entirely at my home by myself. I researched on the internet about widely used methods of soil stabilization and alternate renewable resources.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Sriya Sridhar

Project Number
S1124

Project Title
Water Works: Setting Up a Wireless System that Monitors the Amount of Moisture in Soil to Conserve Water

Abstract

Objectives/Goals
The objective of my study is to accurately measure and monitor the amount of moisture in soil by setting up a wireless system and utilizing this data to conserve water.

Methods/Materials
Semtech LoRa wireless Gateway, moisture sensor, Windows 7 laptop, 2 potted plants, and a measuring cup to water plants. Measuring the amount of moisture in plant's soil, and comparing it to control variable.

Results
Based on my measured data, Plant #1 was watered 3725 mL (watered based on sensor values) and Plant #2 was watered 4650 mL (control variable without sensor) total over the course of 16 days. The amount of water that was saved was 925 mL. This amounts to a water conservation of about 24.83%.

Conclusions/Discussion
Based on the data obtained, I conclude that my results support my engineering goal. My goal was that the moisture sensor needed to detect the moisture levels in the soil and report back to the user through the sensor to the Semtech LoRa Wireless Gateway. This system is to be used to conserve water. The system worked well and the data was received reliably and accurately.

Summary Statement
I setup a wireless system that monitors the amount of moisture in the soil to conserve water.

Help Received
None. I set-up and performed the experiments myself.

Name(s)
Nesha Subramaniam

Project Number
S1125

Project Title
Low Cost Removal of Organic Nitrogen and Nitrate from Bovine Sewage Using Physical and Biological Methods

Abstract

Objectives/Goals
At dairies in California and around the world, bovine sewage is discharged to the ground or to percolation ponds resulting in nitrate contamination in groundwater. I investigated low-cost physical and biological means of reducing total nitrogen (TKN + nitrate) from bovine sewage to reduce the potential for nitrate contamination.

Methods/Materials
Bottle point adsorption batch experiments were conducted to measure equilibrium adsorption capacity of TKN, ammonia, and COD onto cotton fabric and crushed tumbleweeds. Two controls of filtered bovine sewage with no solid were also prepared. Packed bed columns were also set up to test the dynamic adsorption pollutant removal characteristics of cotton, tumbleweed, and chopped palm fronds. I set up columns of coarse, washed sand and measured a physical property of salt solution (specific conductance, EC) in the effluent "breaking through" a packed, porous column. I generated several breakthrough curves with high reproducibility.

I also set up packed columns of clayey-sand and silty sand to determine the dynamic flow properties of TKN, COD, ammonia, and nitrate in aerated bovine sewage through the media, to determine the dynamic removal characteristics of each pollutant.

Results
The cotton column had favorable adsorption characteristics for TKN, COD, and nitrate. Palm fronds and crushed tumbleweeds proved unsuccessful in dynamic adsorption columns because their effluents had much color (tannins) which show up in the COD analysis. In the bottle point tests, cotton removed TKN up to 6.43 mg/g cotton, but cotton showed no removal of COD. In our second batch aeration, we again showed significant reduction of TKN, COD, and BOD, and I generated nitrate at 6 mg/L -N. My clayey-sand column had significant removal of TKN, COD and BOD, but nitrate removal was inconclusive. In the silty-sand column, I was more successful passing sewage through it, and achieved significant removal of TKN, COD, BOD, and nitrate.

Conclusions/Discussion
Cotton fabric and simple aeration of bovine sewage can be effective, low-cost means of reducing total nitrogen (organic nitrogen and ammonia) and other pollutants (BOD and COD) before the sewage is released to a percolation pond. Creating anoxic conditions and the addition of a modest amount of sugar can stimulate the anaerobic bacteria to remove nitrate as the aerated sewage percolates through a silty sand.

Summary Statement
I investigated low cost physical and biological means of lowering total nitrogen in bovine sewage in order to prevent nitrate pollution.

Help Received
My mentor, Dr. Tom Browne, was very helpful in guiding my knowledge of TKN and BOD analysis. I used the Chem Lab at Victor Valley College, Babcock did analytical measurements.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Vasily A. Tremsin

Project Number
S1126

Project Title
Stop the Flame in Its Infancy! Multivariable Early-Warning System for Low-Cost Prevention of Wildfire Proliferation

Abstract

Objectives/Goals
In 2017, Devastating fires burned throughout the Napa Valley and Southern California, resulting in immense destruction, financial loss, and even casualties. In most present cases, firefighters are unable to identify wildfires until the flames grow into uncontrollable blazes. Thus, the main goal of the project was to create a low-cost, multivariable, distributed system for confident detection of wildfires that can be widely implemented for effective prevention of wildfire proliferation.

Methods/Materials
The present system consists of dispersed data acquisition devices that all wirelessly communicate with each other and a central workstation to provide comprehensive real-time monitoring of fire in the area. To confidently detect dangerous flames and evade false positives, multiple stages of verification are employed in order to use a variety of fire characteristics during detection (near infrared wide-band measurement, long-wave infrared thermal imaging, near infrared narrow-band imaging, smoke signature, and others).

Results
By using a variety of fire characteristics and environmental variables, the system was able to reliably detect small 1x1 meter fires from a large distance (70-90 meters). More realistic larger flames can be detected at much larger distances. The most probable false positives (e.g. direct sunlight, street lights, sky luminescence, car lights, etc) were proved to not set off fire warnings due to the system's multivariable verification algorithm. Various wildfire emission characteristics were studied to identify unique spectral features used in the detection method. Environmental factors such as wind patterns, temperature and humidity variation, are compensated by an algorithm that compares real-time readings to a calibrated baseline.

Conclusions/Discussion
The novel, affordable method of early-stage wildfire detection provided by this unique system will allow firefighters to contain fires before they transform into an uncontrollable inferno. Thus, the distributed system can save billions of dollars in fire damage and prevent future wildfire-related fatalities.

Summary Statement
I developed a novel, low-cost system that uses multiple fire characteristics and environmental variables to detect wildfires at their earliest stage, allowing firefighters to combat flames before they grow into deadly infernos.

Help Received
My high school science teacher (Mrs. Roxanna Jackman) provided advice on fire properties. My father helped me to borrow a spectrometer that was used to research spectral properties of various emission sources.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Alfred Vargas; Audrey Vargas

Project Number
S1127

Project Title
Solar Desalination Using a Parabolic Trough

Abstract

Objectives/Goals
Our objective was to construct a parabolic trough system that desalinates water at its maximum potential by analyzing the optimal position of the absorber pipe. We postulated that the focus point of the parabolic trough would be the point at which the device would most effectively desalinate water. Moreover, we decided to construct this device made from inexpensive materials in order to emulate people's necessities in developing countries and to show a solution to the water crisis.

Methods/Materials
Our device takes the form of a parabolic trough. Supported by a simple buttress system consisting of Polyvinyl Chloride pipes, a copper tube (absorber pipe) is located at an experimented distance from the metal parabolic trough (metal reflective sheet). We would then move the position of the absorber pipe.

Results
We moved the absorber pipe farther and closer to the focus point of the parabolic trough 0.16 cm. Our data shows that as the position of the absorber pipe is closer to the focus point of the trough, more water is desalinated. However, our results fluctuated numerous times. This can be justified by the changes in weather patterns and solar energy.

Conclusions/Discussion
Our experiment mostly supports our hypothesis because our results show a direct relationship between the amount of desalinated water to temperature and solar intensity. Moreover, as the position of the absorber pipe moved closer to the focus point of the parabolic trough, the device desalinated the salt water at its maximum potential. Furthermore, this is also supported by the Parabolic Reflective Property. This mathematical law, developed by mathematicians Pascal and Kepler, states that any type of ray entering the parabola will refract to the parabola's focus point and concentrate on that point. This is one reason why the device desalinated salt water efficiently near or on the focus point - the absorber pipe was placed on the focus point of the trough, and all of the infrared rays are concentrated on that point, exposing more heat to the pipe and the salt water inside of it. However, this device relies heavily on the sun as well as the environment, proving our hypothesis to be mostly valid because the weather influences the amount of desalinated water produced by this device.

Summary Statement
This project is about creating an inexpensive device, taking the form of a paraboloid, which desalinates saltwater using solar radiation.

Help Received
Our advisor guided us throughout the project giving feedback about our project. However, we performed the experiments, the design, and the data of the project.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Ashley Welch; Max Zinkievich

Project Number
S1128

Project Title
On Developing a More Environmentally Viable Method of Atmospheric Data Collection

Abstract

Objectives/Goals
This year we continue our endeavor to find a more sustainable way to collect atmospheric inversion data. The previous methods using a radiosonde and sounding system are very antiquated and costly. With this project we aimed to develop a less expensive and more sustainable method to collect the same data as a radiosonde. To eliminate the use of weather balloons and helium we are now launching our sensor suite with a drone, which can be brought to the desired height, and then brought back down so we can reuse the sensor suite and eliminate the litter. To avoid having to use a radiosonde we engineered a sensor suite.

Methods/Materials
We have made improvements on the sensor that we built last year, thus making it more sensitive to the data points that it is looking at and ensuring that it is a more durable piece of equipment with the addition of a 3D printed case. Updates to the software make it so that the sensor is able to store the data in a better file format, as well as incorporate the new and more high-sensitivity sensors.

Results
Overall, this year has been a year of refinement and fine-tuning, making sure that the launch of the sensor on the drone goes smoothly and we are able to collect high-quality data at a reliable rate.

Conclusions/Discussion
Through our trials we have found that the sensor suite and the drone are a reliable and sustainable method to collecting atmospheric inversion data. The sensor suite produces higher quality data as the radiosonde for this purpose, and it does not require the sounding system or antiquated computer software. The sensor suite is user-friendly, making it simpler for the team studying inversions and it can also easily be used in schools to educate the public about why he understanding the atmosphere is so important. The previous methods required a radio, and antenna setup that costs thousands of dollars. We were able to build the sensor suite for around two hundred dollars, which is the cost of one radiosonde. Our solution to this problem of wasteful atmospheric data collecting methods has been proven, through extensive testing, to be an accurate way to collect this data and also preserve our environment.

Summary Statement
We developed a sustainable method to collect data about atmospheric inversions.

Help Received
Grant from MBAPCD, Minor Assistance from members of the Air Quality Board