



Physical and Mathematical Sciences

Andrea Lopez, Adriana Lomas, Raju Bista, David Saldana

Tree - ring climate response of Abies spectabilis from the sub - alpine forest of Dhorpatan Hunting Reserve, Western Nepal Himalayas

Faculty Mentor: Parveen Chhetri

Previous studies have shown a high correlation between tree-ring growth and climate. However, none have been recorded that focus on the radial growth pattern of *Abies spectabilis* (Himalayan silver fir) from the Dhorpatan Hunting Reserve (DHR). We collected sixty tree ring cores from thirty trees from the Rugakharka area of the DHR at an elevation range from 3,533 m to 3,609 m. Tree rings cores were safely stored and air-dried for an extended time. Then samples were mounted onto a grooved wooden frame and sanded down to increase the visibility of the rings. The Velmex TA tree-ring measurement system was used to measure the ring width. We used visual cross-dating, and COFECHA statistical program was run to cross-check for any errors that needed to be corrected. Then ARSTAN software was used to remove non-climatic signals to create the Ring Width Index (RWI) for analyzing the ring width pattern and climate response analysis. A 143 years (1873-2015) chronology was developed. The final trend of the Ring Width Index is mostly stable between 1930-1960 and starts fluctuating from 1960 to the present day. This is a young set of core samples due to the intervention of locals using older trees for timber.

Ricardo Claustro, Beatriz Guerrero, David Saldana, Raju Bista

Tree-Ring Growth Pattern of Betula Utilis at Treeline Ecotone at Dhorpatan Hunting Reserve, Western Nepal

Faculty Mentor: Parveen Chhetri

Many studies have documented a strong acceleration of tree growth in recent years in sub-alpine forests due to changes in climate. To investigate how tree-ring growth of *Betula Utilis* (Birch) is responding to a warming trend, we collected 40 cores from 20 trees in the Dhorpatan Hunting Reserve treeline ecotone in western Nepal, at an elevation of 3750 - 3900 meters. After sanding these cores with various sandpaper grits, ring widths were measured using the Velmex measuring system. Then, cross-dating-related errors were addressed by using COFECHA software, and visual cross-dating of individual ring chronology was generated from a dplR package (Dendrochronology Program Library in R). Bad cores were removed from further analysis, and 18 cores were used for generating our chronology. Finally, the ARSTAN program was used to remove non-climatic signals. A 68-year (1948-2015) chronology was developed, in which we did not observe any significant increase in growth trend in last few decades. In fact, the chronology fluctuated with time, showing narrow ring widths in 1968, 1989, 1999, and 2011, and wide ring width in 1960, 1994 and 2007. Our January temperatures have strong positive correlations with ring width index. Other temperature and precipitation related variables have no significant correlation with ring width index.



Orji Ezieme

Invasive Species are Taking Over our Preserves

Faculty Mentor: Parveen Chhetri

Invasive plant species are significant threat to the sustainability of nature preserve in Palos Verdes Peninsula, California. These invasive (non-native) species compete with native plants for space, aesthetic beauty, resources and also harbor predators. Acacia cyclops commonly called Western wattle is one dominant invasive species threatening the preserve. Acacia goes further to increase the fuel load in the incidence of fire hazards. This paper focuses on the identification of these invasive species, mainly Acacia, mapping them using NASA ESRI collector, and processing the data in ArcGIS to have base information for strategic planning. I worked with Palos Verdes Peninsula Land Conservancy (PVPLC) for the project. Palos Verdes Peninsula Land Conservancy, (PVPLC) was founded in 1988 to preserve the peninsula, contribute to the quality of human life and residential safety, and provide valuable corridors for animals, and native plant habitat. The projected outcome of the research will guide PVPLC and the City of Rancho Palos Verdes to commence a reasonable project of removing the invasive plants to save the preserve. Modeling will be designed to start from areas of highest fire risk. If the invasive species are not mapped and taken away, the lives of residents will be at a higher risk of fire hazards, more predators will be harbored, and the invasive species will certainly dominate the Peninsula at the expense of our lovely native species.

Vanessa Hinojosa, Briana Ramirez, Faviola Martinez

Markov Chains, Directed Graphs, and Google

Faculty Mentor: Kristen Stagg

Our research investigates applications of linear algebra and graph theory that we use in our everyday lives. Are you actually deciding the website you've clicked on or has Google predetermined it for you? How does Google Maps calculate the fastest route to your destination? These are examples of applications of graph theory that you unconsciously use. Our project explores the mathematics behind such algorithms by using Markov chains, weighted and directed graphs, and matrices.

Anahi Hernandez, Aya Yoshimura, David Studway, Reyna Mata

Approval Voting in Education

Faculty Mentor: Carolyn Yarnall

Approval Voting is a system of voting in which each person votes for all candidates that they approve of and the winning candidate is the one who receives the most votes. We can model this mathematically as follows: each person has a set consisting of all objects (e.g. candidates, times) they are voting for and we measure the amount of overlap between the sets. The maximum amount of overlap is called the “agreement number”. We computed the agreement number in two different settings. One in which we applied it to scheduling. In this situation the agreement number would represent the number of people available to meet at the same time. The second situation in which we applied the agreement number was in data analysis in testing. The agreement number in this situation would represent the number of the most common misconceptions. If not everyone could meet at the same time or if there was more than one common misconception, how many different meeting times would be needed so that everyone could attend or review problems would have to be retaught? This number is called the “piercing number”. For scheduling meetings, the piercing number determined the minimum amount of meeting times necessary for everyone to attend. Whereas in data analysis, the piercing number determined the minimum amount of misconceptions you need to cover, in order to address at least one misconception for each person. We explored different approval voting settings (discrete and continuous) and determined bounds for the agreement number and piercing number.

Raju Bista

Treeline physiognomy in relation to species and physiographic variability in the Nepal Himalayas

Faculty Mentor: Parveen Chhetri

Studies have highlighted changes in recruitment pattern, radial growth and range dynamics in treeline ecotone in Nepal Himalayas in response to ongoing climate changes. However, only a few studies have considered tree physiognomies in the sensitive treeline ecotone. This study aims to provide further insight into the treeline phenomenon, analyzing the stand structure characteristics of three different treeline tree species (*Abies spectabilis*, *Pinus wallichiana* and *Betula utilis*) at three different sites across the Nepal Himalaya (respectively in the Eastern, Central and Western Nepal). Trees of all life forms (tree, sapling, and seedling) were sampled for morphometric features (basal diameter, crown cover, and height) and tree cores (from the tree base for age estimation) from altogether eight 20-meter wide vertical transects along forest line to tree species limit. Tree advancement appeared to halt by the 1950s. The basal area increment rate was higher in the eastern site. We found site-specific and species-specific stand structure and dynamics. Climate warming may have a disproportionate influence on different treeline ecotone. Site-specific stand structure dynamics explain why treeline do not respond uniformly to increasing temperature. It invokes, in further studies, the incorporation of tree’s morphometric adaptation traits, interactions between species genotype and the environment

Elvis Carrillo

A Story of California's Seismic Hazards: Studying Historical and Simulated Earthquakes Through Geovisualization Platforms

Faculty Mentor: Parveen Chhetri

In the last ~150 years, there have only been a few large M6+ earthquakes in California that resulted in casualties, damage to infrastructure, and economic losses. Large earthquakes such as the M7.9 1857 Fort Tejon Earthquake, M7.9 1906 The Great San Francisco Earthquake, M6.7 1994 Northridge Earthquake, and the M6.4 & M7.1 2019 Ridgecrest Earthquake Sequence, are historical markers that impacted major cities across California. The recent Ridgecrest earthquakes reminded the public that California is tectonically active and that they are at-risk for potential seismic events. Previous earthquakes (historical and recent) can be analyzed using earthquake risk models to understand their potential impact if they were to occur today. We utilize spatial storytelling through the implementation of geovisualization software, such as ESRI's ArcGIS and StoryMap platforms to convey seismic and scientific information to the public. StoryMaps are interactive visual aides that communicate the impact of ground motion for each historical and simulated earthquake. Utilizing ShakeMaps from the United States Geological Survey (USGS) we examine these historical earthquakes using FEMA's hazard and risk analysis model, HAZUS, which estimates social and economic losses based on the 2010 United States Census. We identified 14 large historical earthquakes from 1857 to 2019 with a M6.2+ that occurred on active faults; as they may rupture at any given moment impacting Northern and Southern California. Our earthquake information technology approach, using scientific models, FEMA tools, and geospatial analysis tools transformed seismic data into a resource that can be used to educate and communicate seismic risk and hazards to the public.

Luis Vega

Transmitting Data Using Visible Light Communication LIFI

Faculty Mentor:

For this project, I would like to provide insight on LIFI's capability in the wireless communication field. In addition, I will elaborate on the implementation, application pros and cons of using LIFI as a transmission medium, the difference between LIFI and WIFI (as network mediums) and how LIFI can be used to manage the IOTs.

People are no longer bond by distance to communication, and access to information, lies at the palm of your hand. The Internet is a global medium communication of the 21th century. Services such as education, banking, communication, commerce and social interaction all happens through the internet. Access to this resource is paramount and connecting to the internet with a high-speed connection is even more important. To maintain the high-speed connectivity, there must be a lot of the available bandwidth. Currently Wi-Fi is used to broadcast data using the radio wave spectrum. However, the radio wave spectrum has its limitations. With the advent of the internet of things, will be over 100 billion devices connected to the internet. To keep-up the rate of IOT devices, industries that utilizes wireless networks must use all bands of the radio wave spectrum; even, the bands that are used for emergency communications are limited by the size of the Radio Wave spectrum. In wireless communication, 802.11 utilizes the frequencies ranging from 2.5 ghz to 5ghz. However, more infrastructure will be needed, in order to maintain high speed connectivity. to keep up with the current paste of IOT, we will need to implement the use of LIFI (Light Fidelity) and added to our existing infrastructure. LIFI implementation will provide pre-existing infrastructure with higher bandwidth (Since the visible light spectrum operates in the THz), and it created secured pathways for accessing data, it is my belief that LIFI can be used to usher in the next phase of wireless communication.

Miriam Weinberg

The Presence of Methanol in Hot Drinks Created with Aspartame

Faculty Mentor: Barbara Belmont

Aspartame, a methyl ester of the aspartic acid/phenylalanine dipeptide, is a sugar substitute used in Equal, a brand of artificial sweetener. As a peptide, consequences of aspartame being exposed to high temperatures or a high pH can involve its hydrolysis into its amino acid components, aspartic acid and phenylalanine, and methanol. When ingested, methanol causes depression of the central nervous system, as well as an assortment of metabolic disturbances through its conversion to formaldehyde, which is further converted to formic acid. Although consumption of a minute amount may not be harmful, the toxicity effects of methanol can be initiated with the ingestion of even 10 mL of pure methanol. The objective of this experiment was to determine the extent to which methanol, one of aspartame's hydrolysis products, could be detected in an average-sized hot drink sweetened with Equal packets. This involved the creation of a sample of boiled water and Equal packets (mimicking the conditions of coffee or tea preparation) and running it through GC-MS to determine its methanol signal area. A calibration curve was created using the methanol signal areas of five standards of different known methanol concentrations, and the linear regression equation derived from the calibration curve was used to calculate the sample's methanol concentration from its methanol signal area. While more research needs to be done in order to confirm a specific quantitative measurement, the data suggest that methanol is present at low concentrations in freshly made hot drinks that contain aspartame.

Jason Williams

*Stereochemical Assignment of Macrocyclic Pithecolobine-class Alkaloids from *Albizia gummifera**

Faculty Mentor:

Albizia gummifera (J.F. Gmel.) C.A. Sm. (Leguminosae) is a medium or large tree native to tropical Africa, with the genus as a whole also occurring widely in South Asia. The tree has reported uses in Kenyan traditional medicine for the treatment of bacterial and parasitic infections, including malaria. Other ethnomedicinal uses include general use as a fever reducer and pain reliever. Pithecolobine type alkaloids from this genus, known as budmuchiamines, were first isolated by Pezzuto and coworkers in 1991. Subsequently, over the span of two decades, additional analogues were reported by independent groups. In this work, we review all budmuchiamine alkaloids isolated to date and focus on elucidation of a long unsolved stereocenter at the C-6 ϕ -position of budmuchiamine L4, 6 ϕ x-hydroxybudmuchiamine-C, and 6 ϕ x-hydroxy-5-normethylbudmuchiamine-K. *A. gummifera* DCM soluble extract (N118499) obtained from the NCI Active Repository program was used to dereplicate these known budmuchiamines. Mosher's analysis is currently underway to determine the absolute configuration at the C-6 ϕ -position. Extract N118499 was screened in an in-house sulforhodamine B assay against U87 brain glioma cells and exhibited cytotoxicity with 18% cell survival at 20ug/ml."

Jennifer Trim

A Framework for Building Partner Capacity to Combat Nuclear Terrorism

Faculty Mentor: Antonia Boadi

The prevention of subversive actors or groups from acquiring or detonating radiological or nuclear devices is a national priority. International smuggling and trafficking in radioactive and nuclear material has dramatically increased within recent years.

This research presents a resource allocation approach for enhancing the capacity of partner nations to support the interdiction of contraband nuclear materials. The problem of resource allocation is structured as a decision problem in which a partner-nation's economic, financial and political risk profiles are parameterized for alignment with operational priorities. The partner-nation's risk profiles are used to characterize and parameterize the decision metrics. The Analytic Hierarchy Process is utilized to solve the resource allocation decision problem. The proposed methodology is flexible enough to support a broad range of threat scenarios."

Jose Garfias, Nadia Hirbawi

Theoretical Study of 3FC-TZN and its Host-Guest interaction in the Determination of Stable Electroactive Materials

Faculty Mentor: Kenneth Rodriguez

Reliable theoretical ^1H NMR, HOMO, and LUMO is computed for the molecular recognition (Host-Guest) and its role on redox activity, the 2,4,6-Tris(p-ferrocenylanilino)-1,3,5-triazine (3FC-Tzn) with cucurbit[n]uril that has been synthesized experimentally. The Density Functional Theory (DFT) of B3LYP/6-31G* method is used to optimize each molecule and then optimize both structures together using the DFT calculations with the M062X/6-31G* method in the solvent of DMSO. These results are used to compare the computational calculations with the experimentally synthesized Host-Guest. These theoretically calculated values are within a 5% relative error when compared to the experimentally chemical shift. The 3FC-Tzn is a star shaped molecule with three repeating units of p-Ferrocenylaniline groups connected by central triazine core. The 3FC-Tzn is used as a guest to form a Host-Guest complex with cucurbit[n]uril. The cucurbit[n]uril is a macrocyclic molecule and acts as host to form an intercalated Host-Guest complex with neutral and cationic molecule. In artificial system, redox active compounds have been used in batteries, sensors, and solar cells. Such redox active compounds have been known to play an important role in nature and systems that are artificial. Many enzymes regulate their activities through redox process naturally. It has been reported several redox active compounds in the literature. Among them, Ferrocene has attracted more attention because of its low oxidation potential as well as its reversible one electron transfer process. Ferrocene is an organometallic complex with an iron (II) that is sandwiched between two stacked cyclopentadienyl rings. Having been synthesized from commercially available Ferrocene and cyanuric chloride that was characterized by different spectroscopic techniques, such as NMR, Mass Spec, IR, and UV-Vis and compared to reliable computational modeling.

Michael Franco, Annette Zaragoza, Holly Keedy

Reclaiming Water on the CSUDH Campus

Faculty Mentor: Parveen Chhetri

Stormwater runoff from a large urban complex poses a myriad of issues that if ignored result in an environmental and financial impact that may go unappreciated because of the infrequent rains experienced in southern California. Consequently, stormwater management must be incorporated into new construction projects rather than retrofitting to reduce cost and overall construction time. Utilizing modern environmentally conscious materials and architecture can provide a long-term solution to reduce and adequately manage stormwater runoff. The goal of this project was to investigate the water on CSUDH campus when it rained. To do so, we investigated the permeability on campus in the form of bioswales and normally permeable surfaces such as dirt. In addition, we also investigated the water loss via roof runoff. To understand and comprehend the information collected, a permeability map of the campus was created using Geographic Information Systems (GIS) to illustrate areas where proper water utilization could be put in place. This comes in the form of productive water management and storage. To achieve the goals of this project, we utilized GIS platform (ESRI ArcMap) to illustrate and compute the campus' general permeable surface area, locations of roof water runoff and spotlight high permeable locations where water conscious solutions could be put in place.

Karlee Rivera

Does proximity to fault line affect the property value in Los Angeles County?

Faculty Mentor: Parveen Chhetri

Los Angeles is located on the active transform San Andreas fault. The San Andreas fault slices California in half and creates smaller surrounding faults all over Los Angeles. Every resident in the area of Los Angeles is at risk of dangerous earthquakes because of proximity to the fault line. Before purchase of the property, the buyer should know if a fault line is near them. The purpose of this study is to examine if there is a correlation between fault lines and property values. The study area is three cities in Los Angeles County: Carson, Inglewood, and Norwalk. The research method used USGS locations of active and hazardous fault lines and property values from LA County GIS Database. Geographic Information Systems (GIS) was used to create maps of both fault lines and property values of the three cities. The property values to the location of the fault lines did not overlap on the GIS maps. We did not find a significant relationship between fault lines and surrounding property value. However, the ties for property value was related to major highways and significant locations. Therefore, this shows the proximity to a fault line will not significantly affect the property value. Residents and business owners did not let fault line affect their decision making in where to live or start a business. Future research can explore whether the locations on or near a fault line have earthquake-safe buildings or effective emergency plans. Another inevitable question can be whether people located on the fault line know, care, or were not informed that their property is at high risk of earthquakes.

Ivy Rea

Factors affecting vegetation recovery after 2017 Thomas fire in Ventura County, California

Faculty Mentor: Parveen Chhetri

California wildfires play a significant role in the chaparral ecosystem. The chaparral is a biome that is adapted to infrequent fires, also, making it one of the most vulnerable biomes to wildfires. To investigate the factors that affect vegetation recovery after the major fire, we selected a 2017 Thomas fire of Ventura county. Ventura county falls within the coastal chaparral region, and in 2017 the Thomas fire burned 281,893 acres of land. This project investigates the recovery after the fire by looking at the roles played by topography, soil profile, fire intensity, and land use within the burned area. Land use information was considered to determine the anthropogenic effects on chaparral vegetation recovery. To investigate such factors, we used Landsat satellite images, ASTER Digital Elevation Model (DEM), GIS layers, and GPS data. The methodology followed two main steps: bimonthly Normalized Difference Vegetation Index (NDVI) generation, topographic variables generation from DEM, and identify high and low vegetation recovery zones. We found that fire intensity, topographical (elevation, slope, aspect), and edaphic (soil type, soil depth) factors control the recovery of the vegetation.

Isam Nungaray

Impact of one-meter sea-level rise on Huntington Beach, CA

Faculty Mentor: Parveen Chhetri

As our planet's average global temperature is on the rise, sea-level rise will impact coastal cities home to 470 to 760 million people. To understand how sea-level can impact the coastal cities, I am studying the effects of sea-level rise in the city of Huntington Beach, CA. I am using Geographic Information Systems (GIS) and Remote Sensing (RS) approach to understand the impact of a one-meter sea-level rise on the coastal areas of Huntington Beach. I created the maps showing the affected areas of the high tide after a one-meter sea-level rise. The sea-level rise simulation shows the inundated areas as well as the approximate effected area. As ongoing research, my goal is to create an evacuation route for the city of Huntington Beach, CA and provide an estimated cost of the impact.

Athena (Matthew) Tran

Olympic Recurve Analysis for Optimized Stabilization

Faculty Mentor: Jim Hill

There currently is no scientific consensus or publicly available manual on what an optimal stabilization set up is other than ""what feels right and gives one the best score"". Much in the same way the KSL shot cycle is based on science for optimizing the body and mind, this project is the attempt to optimize stabilization of the bow and body in the same spirit, through science. Archers may not feel that the suggested set up is for them—the same way not everyone likes the KSL shot cycle; however, this should be the most optimal.

Archery, like any technical sport, depends heavily on the physiology of the individual; therefore, the bows are balanced to the desired specifications of the individual. Olympic recurve archers have stabilizers to aid with the bow and body's balance and stability. From early analysis, there seems to be a relationship between stabilizer lengths and angles, bow CG, and bow mass with draw length, draw weight, and holding time.

What is important is the bow at full draw. Aiming occurs after this and is the last step before releasing the arrow. Analyzing kinematics of the bow as well as mathematically describing Laymen's terms (through variable isolation) shows how particular aspects affect the rest of the system. Understanding that allows for the manipulation of variables for desired results. In this case, it is to manipulate values of bow mass and CG based on the known values of draw weight, draw length, and holding time to find the best stabilizer lengths and angles.

Claire Ladan, Justin Hathaway, Omar Santizo

Hacking Electrochemistry: Improving undergraduate redox education using a student-built potentiostat

Faculty Mentor: Barbara Belmont

Electrochemistry provides a wide variety of quantitative methods for the detection of analytes significant to biochemical processes, pharmacology, environmental analyses, and clinical tests. Current electrochemical methods are costly, fragile, and unavailable to lower-division teaching labs. In fact, it is a scarcely addressed topic in undergraduate studies, despite being an ACS requirement. In this work, equipment typically used by the Maker Community has been modified to bring a cost-accessible electronic instrument into the undergraduate teaching lab. That brings Belmont Research Group's latest project: Potentiometric analysis of a biochemical redox analyte by cyclic voltammetry. Belmont Research Group has successfully developed a robust, low-cost potentiostat, fondly called the Teensystat, capable of detecting potassium ferricyanide, ascorbic acid, and acetaminophen. The Teensystat contains a Teensy microcontroller and Texas Instrument's LMP91000 that is coupled to a Pine Research carbon screen-printed electrode. The potentiostat probes a chemical solution with a voltage that sweeps over a specific range and rate, while monitoring the current flow as a result of the sweep. The resulting cyclic voltammograms characterize and quantify the oxidation-reduction chemistry of the analyte in the test solution. The two-lab period experiment presents students with an interdisciplinary approach to electronic interfacing, analytical electrochemistry, biochemistry, and human health. Via the experiment, students calibrate the device to determine an unknown concentration of a reversible, irreversible or quasi-reversible redox analyte of their choice. Students learn the theory and applications in the lab of redox reactions, cyclic voltammetry, and further make connections to the electrochemical aspect of human health.



Omar Santizo, Claire Ladan, Justin Hathaway

Ascorbic Acid Quantification by Cyclic Voltammetry Using a TeensyStat

Faculty Mentor: Barbara Belmont

Electrochemistry is a concept learned by undergraduate students in their general chemistry course. Redox reactions are the most common way a student will learn electrochemistry. Later in their college career, electrochemistry is forgotten and sometimes never showed again. The Belmont Research Group has developed a low-cost device that will demonstrate electrochemistry to students in their upper-division courses. This device, fondly called the Teensy Stat, is a potentiostat that runs a Cyclic Voltammetry (CV) experiment. The CV outputs allows the researcher to monitor the current generated by the redox reaction, relative to the voltage stimulating the reaction. The resulting cyclic voltammograms, are shown as oxidation and reduction graph or either an oxidation graph or reduction graph, depending on the solvent or analyte used. The first swoop of the CV will be oxidation because the analyte is donating an electron to the electrode. The second swoop of the CV will be reduction because the analyte is accepting an electron from the electrode. This device will give a better understanding of electrochemistry to the students before they have graduated from an undergrad institution.