Local incentives and national tax evasion: The response of illegal mining to a tax reform in Colombia – Santiago Saavedra

National governments can only tax the economic activity they either directly observe or that is reported by municipal authorities. Illegal mining, a very common phenomenon in Colombia, changed with a tax reform that reduced the share of revenue transferred back to mining municipalities. To overcome the challenge of measuring illegal activity, we construct a novel dataset using machine learning predictions on satellite imagery features. Theoretically we expect illegal mining to increase because the amount required to bribe the local authority is smaller after the reform. Using a difference-in-differences strategy, with Peru as the control, we find that illegal mining increased by 1.41 percentage points as share of the mining area. In addition, we provide evidence that illegal mines have more harmful health effects on the surrounding population than legal mines. These results illustrate unintended effects of tax revenue redistribution.

Do we overestimate rice production in the future? – E. Marie Muehe

With more than half of the world’s population consuming rice daily, it is crucial to ensure rice production in the future. Our current assessment of climate change impacts on rice productivity, however, is only based on increased annual temperatures and atmospheric CO2 conditions, and it does not consider the presence and continuous input of toxic arsenic into paddy soils. Thus, the goal of this study was to determine whether and to what extent climate change and elevated soil arsenic levels affect rice plant growth and grain production. To this end, we performed greenhouse studies exposing rice plants to different climate conditions and soil arsenic concentrations. We show that the mobility of arsenic in the soil increases with higher temperature and CO2, leading to increased accumulation of arsenic in the plant. Moreover, a substantial decrease in rice grain productivity is observed when soil arsenic is coupled with projected future climates. Our findings provide important advancements in predictions of future rice grain production and quality, that will need to be addressed to sustain food quality and quantity.

Repeated helicopter-based surveys of fugitive hydrocarbon emissions from tight oil operations: Persistence and driving factors – Jacob Englander

A recent study used helicopters and optical gas imaging (infrared-based) to study hydrocarbon leaks [1] across numerous oil and gas producing basins. The appearance of leaks appeared to have small statistical correlations with factors such as age of wells, production rate, or water production. However, there have not been few if any attempts to observe the presence of leaks over time. In this work, we used the same helicopter-based optical gas imaging techniques to revisit wells in the Bakken formation that had previously been measured in 2014 [1] in this study, we visited 353 of the total 683 well pads in Bakken from the original study, and we also visited 50 randomly selected well pads that were newly developed between studies. We first examine the presence of leaks as a function of different factors, including: operator, number of wells, tanks, and treaters on a well pad; and numerous other possible emissions drivers. In addition, using the previous years observations as our prior, we conducted a Bayesian analysis to determine the likelihood of finding a leaking or non-leaking well pad and compared the observations to a Monte Carlo simulation of randomly distributed leaks. We find that the overall prevalence of observed emissions was similar for each year (11% for 2014 observations and 10%, for 2015 observations). We also find whether a pad was found to be leaking in the first observation year had a statistically significant influence (4.9σ) on the presence of a leak in the following observation year.
Similar levels of persistence are also apparent for non-leaking well pads.

**Reduced-order modeling approaches for geological CO2 storage** – Bo Guo

Carbon capture and storage (CCS) has been identified as the only technology that can significantly reduce anthropogenic CO2 emissions while allowing continued use of fossil fuels. CCS involves permanent storage of the captured CO2 into deep geological formations, leading to a flow system of two fluid phases (injected CO2 and displaced resident salt water) that requires modeling tools to simulate injection and migration of both fluids. While high-fidelity full three-dimensional (3D) multiphase flow models are available, their application for practical analysis is challenging due to their high computational costs and the huge uncertainty of subsurface geological data. In this presentation, I will introduce an alternative computationally efficient reduced-order modeling approach. The reduced-order model assumes vertical pressure equilibrium (due to strong buoyancy of CO2) and a macroscopic sharp interface between CO2 and salt water, which simplify the 3D two-phase flow system into a 1D nonlinear advection-diffusion equation. Such simplifications allow us to solve the system analytically and perform detailed analysis of fluid flow behaviors and CO2 storage efficiency, as well as leakage risk assessment. Overall, the reduced-order approach allows fast simulation, risk assessment, and uncertainty quantification for CO2 injection and migration in the subsurface.

**Where Can Clean Technology Help? Machine Learning to Identify Environmentally At-Risk Communities in the United States** – Shiran Shen

Inspired by CalEnviroScreen, an environmental health assessment tool used to identify environmentally at-risk communities in California, we calculate pollution burden scores at the census tract level for the entire contiguous United States. Pollution burden is a composite score that encompasses 12 environmental (air, water, waste) indicators. We combine actual pollution burden indicator data with predicted statistics using machine learning. We create a novel National (Lower 48) Pollution Burden Map using ArcGIS (URL: http://arcg.is/2gWq4xp).

**The Inconvenient Truth of the Political Pollution Cycle: Theory and Evidence from Chinese Prefectures** – Shiran Shen

While scholars have theorized and documented extensively about political business cycles in democracies, still little is known about political cycles in autocracies, nor about their environmental consequences. In this paper, I extend the political business cycle approach to delve into how career incentives of local political leaders influence environmental policy implementation in China. This sheds new light on the critical question: Why has pollution been a problem (and even a crisis) when the national government made achieving environmental standards a high priority? Using remote sensing technique to generate high-resolution satellite estimates for air pollution and economic measures, I find that there is temporal variation in pollution levels that suggests a link to tenure patterns, a phenomenon that gives rise to what I call the theory of “political pollution cycle.” There is more pollution in later periods during the tenure of career-minded prefectural leaders in China, which suggests that there is a tradeoff between economic growth and environmental protection, and that the nature of that tradeoff tips in favor of economic growth the closer local leaders are toward the end of their tenure and are up for rotation evaluation by their political superiors. This paper seeks to make three primary contributions. Theoretically, I document the existence of politically induced economic and environmental cycles that are underpinned by career incentives at the local level in a unitary communist system. Empirically, I measure the unintended effect of political cycles on an important case of policy implementation: air pollution control.
Normatively, I quantify the human costs of such unintended political pollution cycles.

**Roll-to-Roll Transfer of Electrospun Nanofiber Film for High-Efficiency Transparent Air Filter** – Jinwei Xu

Particulate matter (PM) pollution in air has become a serious environmental issue calling for new type of filter technologies. Recently, we have demonstrated a highly efficient air filter by direct electrospinning of polymer fibers onto supporting mesh. Furthermore, we demonstrate a high throughput method based on fast transfer of electrospun nanofiber film from roughed metal foil to a receiving mesh substrate. Compared with the direct electrospinning method, the transfer method is 10 times faster and has better filtration performance at the same transmittance, owing to the uniformity of transferred nanofiber film (>99.97% removal of PM2.5 at ~73% of transmittance). With these advantages, large area freestanding nanofiber film and roll-to-roll production of air filter are demonstrated.

**Understanding Gender Differences in Environmental Engagement** – Sandra Nakagawa

Prior research has shown that men often report lower levels of environmental engagement than women. One reason for this may be that environmental issues are often associated with traditionally feminine roles: caring for others, adjusting one’s everyday habits, and emotions like worry and fear. I propose that both the gendered beliefs that individuals hold (i.e., endorsement of traditional gender roles) and the gendered framing of environmental issues can be used to explain men’s lower levels of environmental engagement. To test these claims, I draw on data from three sources: the 2012 American National Election Study (ANES), an online survey conducted on Amazon Mechanical Turk, and an online AMT experiment. Results suggest that gendered beliefs do explain men’s lower levels of environmental engagement and framing messages to appeal to men can help reduce gender differences in sustainable practices.

**Whose job is it, anyway? Perceptions among future business leaders of environmental sustainability and business** – Jennifer Wang

There is increasing recognition of the critical role that businesses need to play in addressing environmental issues, particularly through private sector leadership. Businesses are also recognizing that training future businesses leaders to act on environmental concerns requires specific skills and knowledge. Yet business schools – often a pivotal intervention point in business leadership – are generally ill-prepared to address or introduce sustainability issues in their workplaces. I present evidence that MBAs’ role expectations of what it entails to be a business person may be a critical barrier to MBA student engagement, particularly given that most students attribute business engagement with environmental sustainability to by some form of individual passion, rather than to business-compatible reasons. Finally, I show that the business school context and social interactions impact how students form these views about the integration of sustainability and business.

**Gauging potential schistosomiasis exposure in northern Senegal from activity-specific water contact activities** – Andrea Lund

Thirty years after the construction of the Diama Dam triggered an epidemic of human schistosomiasis along the Senegal River Basin, this region remains a hyper-endemic area for human schistosomiasis with prevalence of infection in affected communities often exceeding 50%. The persistence of disease despite mass drug administration underlines the importance of the human-environment interactions that leave rural populations chronically exposed to reinfection through their daily economic, household and hygienic activities. The goal of this study was to estimate the body surface area exposed while performing seven different water contact activities common in
Brief interviews were conducted with residents in 5 villages along the lower basin of the Senegal River and 10 on the Lac de Guiers. For each water contact activity, adult male and female interviewees were asked to indicate the parts of the body that come into contact with water while performing that activity. Answers were registered on a diagram used to measure burn size, from which percent body surface area exposed could be calculated. Activity-specific body surface exposure data were complemented by published data on the time-demands of each activity in the northern Senegalese context. Time and body surface area data were then combined to compute an activity-based exposure metric.

Our analysis showed that there is some community-level variability in the nature of water contact, mostly driven by environmental characteristics of water points, type of irrigation infrastructure and fishing practices. Anyway, commonalities in water contact behavior across communities were more pronounced than differences. We thus argue that an exposure metric derived from known time and body surface area demands of different activities could be usefully employed to better understand the schistosomiasis risk as a function of the types of water contact activities performed by different members of the population.

DATA VISUALIZATION FOR NATURAL CAPITAL DECISION SUPPORT – Charlotte Weil

In order to develop approaches to manage environmental assets sustainably and take nature more into account in major decisions, natural capital assessments reveal the specific benefits provided by nature. Effective communication, including clear visualization of natural capital assessments results, is crucial to influence decision-makers (make informed and sound decisions). However, no methodology guidance document yet exists to support analysts in synthesizing their results, and tools are scattered. The present work aims to fill this gap. First, it gathers the existing knowledge on design strategies for displaying complex information through a literature review and surveying analysts in the field. Complex information refers here to the specificities of natural capital data, i.e. typically multiple versions of spatial data, pertaining to several objectives and scenarios, accounting for uncertainty. Secondly, this work scopes the gaps in the field by analyzing and prioritizing the visualization needs, through a survey and interviews. These lead to the development of a toolbox to guide analysts in their task of communicating natural capital information.

Furthermore, an innovative tool to display natural capital results, combining knowledge from previous points in the form of a user-friendly, ready-to-use (prototype of a) web application is suggested. In an interactive dashboard combining multiple linked views, this tool allows visualization of tradeoffs between objectives, comparison of scenarios and assessment of uncertainty.

Foreign Aid or Foreign Agents? The Rise of Legislative Restrictions on Foreign Funding to NGOs – Michelle Reddy

This paper investigates the rise of legislative restrictions on foreign funding to NGOs, a global trend occurring not only in aid-dependent, undemocratic regimes but more recently in consolidated democracies with developed economies as well. Given the difficulty of large N analysis to differentiate between these various cases, I created a dataset of 63 countries with legislative restrictions. I then use computational techniques to investigate similarities within and across regions. Using historical analysis, I trace the origins of the first instances of legislative restrictions, discovering neighborhood effects as well as instances of restrictions in democracies. Overall, I find that legislative restrictions on foreign funding to NGOs are largely driven by perceived threats not only to authoritarian control, but to executive power more broadly. By collapsing the wide variety of cases into regime type, and within regime type, differentiating between resource-rich countries and countries proximate to or experiencing recent crisis, my framework accounts for the rise of legislative restrictions.
restrictions across diverse political and economic contexts. Most countries in the dataset are aid-dependent and/or with an economy dependent on natural resource extraction. In response to resource extraction, local NGOs begin to mobilize, with the support of international environmental NGOs, leading to anxious rulers to limit foreign funding to NGOs. It hopes to draw from the audience guidance on next steps on civil society networks and relationships between local and global NGOs and overall examine interrelationships between international environmental NGOs, multinational companies, and civil society in industrializing countries.

Negotiating Indigenous Knowledge at the Science-Policy Interface – Sibyl Diver

Indigenous communities are seeking to engage more effectively in environment policymaking that impacts Indigenous lands and resources, in part, by creating their own science programs. Yet existing scholarship rarely examines how environmental policymaking is shaping and shaped by Indigenous knowledge. In addition, studies of how Indigenous knowledge or Traditional Ecological Knowledge (TEK) interfaces with environmental science and policy decisions often overlook political challenges, such as ongoing conflicts over Indigenous lands.

Through a case study of the Xáxli’p Community Forest, involving twenty years of negotiations between the Xáxli’p Community and Ministry of Forests in British Columbia (B.C.), Canada, this work examines Indigenous knowledge production processes that are linking TEK and Western science in a political context. This study addresses a gap in our understanding of how and why some Indigenous peoples are effectively linking knowledge systems to engage in environmental policy-making, despite the challenges of doing so.

Mercury in the Peruvian Amazon: A review of mercury contamination and exposure research in Madre de Dios – David Gonzalez

This presentation will review mercury research in Madre de Dios, a district in the southeastern Peruvian Amazon with a highly active artisanal and small-scale gold mining (ASGM) sector. Workers in ASGM use elemental mercury (Hg) in the gold extraction process, leading to high risk of contamination. Mercury released from ASGM accumulates in waterways, where it is converted to highly bioavailable methylmercury (MeHg), which in turn accumulates in river fish. This poses a risk to public health in regions such as Madre de Dios, where residents regularly consume wild caught fish. This presentation will review the current state of research into mercury in Madre de Dios, with a focus on human exposure risk. High Hg concentrations have been found in various media in Madre de Dios, including air near gold shops and sediments collected in rivers and oxbow lakes. Numerous fish species studied in Madre de Dios have been found to have elevated Hg concentrations, with some specimen far exceeding national and international limits. Three human exposure studies report elevated Hg levels in children and adults living in mining communities and the city of Puerto Maldonado, the district capital. Two additional studies (including one conducted by the presenter) focused on women of childbearing age, a population of concern, and found that the majority of study participants had high mercury levels. Findings published by the research community have contributed to local and national dialogues within Peru regarding mercury and public health.

Operando X-Ray Spectromicroscopy of Lithium-Sulfur Batteries – Elizabeth (Beth) Miller

Li-S batteries are an attractive “beyond Li-ion” technology that achieves high capacity via chemical transformation rather than Li intercalation. Earth-abundant, low-cost elemental sulfur is reduced through a series of soluble Li polysulfides (Li2Sx, 2 ≤ x ≤ 8) to a final solid discharge product, Li2S. However, Li-S suffers from unrealized theoretical capacity and rapid capacity fade.
due to loss processes that are not well-understood. Deciphering speciation and the distribution of dissolved polysulfides in the electrolyte during cycling is imperative for realizing the potential of Li-S. Here we present operando characterization using sulfur K-edge X-ray absorption spectromicroscopy performed at the Stanford Synchrotron Radiation Lightsource at SLAC National Accelerator Laboratory. Cells consisting of a sulfur/carbon cathode, Li anode, and 1 M LiClO4 + 0.5 LiNO3 in 1,3-dioxolane/1,2-dimethoxyethane electrolyte were discharged, and maps were collected at energies sensitive to the expected sulfur, polysulfide, sulfate, and sulfide species by tuning the incident X-ray energy. Typically, operando X-ray characterization is conducted perpendicular to battery electrodes, providing an average of the chemistry through the entire stack. The novel cross-sectional geometry demonstrated here provides a spatially-resolved picture of sulfur diffusion between the electrodes, which cannot be achieved by typical characterization methods. From this information, we can observe a spatially heterogeneous and chemically diverse system to gain insight into how sulfur speciation contributes to capacity fade.

Electrical Resistivity Tomography for Mapping Saltwater Intrusion in Coastal Aquifers – Meredith Goebel

Coastal regions represent a complex dynamic interface where saltwater intrusion moves seawater landward and groundwater discharge moves freshwater seaward. These processes can have a dramatic impact on water quality, affecting both humans and coastal ecosystems. The ability to map the subsurface distribution of fresh and salt water is a critical step in predicting and managing water quality in coastal regions. This is commonly accomplished using wells, which are expensive and provide point information, which may fail to capture the spatial complexity in subsurface conditions. We present an alternate method for acquiring data, long-offset Electrical Resistivity Tomography (ERT), which is non-invasive, cost effective, and can address the problem of poor spatial sampling. Demonstration of this method in the Monterey Bay region shows that while the inverted ERT resistivity profiles correspond well with existing data sets and geologic interpretations in the region, the spatial complexity revealed through the ERT data goes beyond what is known from traditional data sources alone. This leads us to conclude that this form of data can be extremely useful in informing and calibrating groundwater flow models, making targeted management decisions, and monitoring changes in subsurface salinities over time.

Spatial Analysis for Determining the Cause of Oil Seeps in the Midway Sunset Field, In the Midway Sunset Field in Central California, operators inject steam into the shallow diatomite formation to lower the viscosity of heavy oil and flow it out of wells. The steam injection has created oil seeps and sink holes, posing a hazard to field workers. In 2011, a sink hole resulted in the death of a contractor’s employee. In collaboration with the California Department of Conservation (DOC), I am conducting a study of the area in order to further understand the fluid conduits and pathways of injected steam. It is unclear whether the occurrence of the seeps is due to leakage through old improperly abandoned wells, flow along naturally occurring faults, high pumping pressures, structurally controlled flow patterns or high injection volumes, among other possible factors. Spatial analysis has been performed to study the statistical relationship between the occurrence of oil seeps and possible causative factors. Production, injection, and geological data from over one thousand wells have been used in this analysis. Logistic regression and classification trees both point to a strong spatial correlation between old plugged wells and occurrence of oil seeps, as well as presence of natural fractures. Research is still underway to perform spatial-temporal analysis of steam injection history and onset of oil seeps to statistically understand the connectivity of fluid in the subsurface. The aim of the study is to better
understand the subsurface in order to come up with solutions that will allow continued oil production in the area while ensuring safety. Would be happy if there were people in the audience who have previously conducted spatial-temporal studies and would like to collaborate – provide advice.

Detection of Soil-Transmitted Helminths on Hands and Produce in Rural Kenya – Lauren Steinbaum

Approximately one-quarter of the world’s population is infected with at least one species of soil-transmitted helminth (STH). Soil is a well-known STH transmission pathway, while the role of food and hands in STH transmission is not well understood. We collected and processed mother or caretaker hand rinse and garden-grown produce rinse samples from 116 rural households in Kakamega, Kenya in an area previously identified to have high STH egg contamination in household soil. Ascaris was the only STH species detected; 0.9% of hand rinse, 3.5% of leafy produce, and 1.8% of root produce samples had Ascaris eggs. Hands and produce were more likely to be contaminated from households that had STH eggs previously detected in the soil. Our results indicate household garden-grown produce and mothers’ hands can transmit Ascaris eggs, however they appear to have a minor contribution to STH transmission in this setting.

Regularization in Hierarchical Time Series Forecasting With Application to Electricity Smart Meter Data – Jiafan Yu

Accurate electricity demand forecast plays a key role in sustainable power systems. It enables better decision making in the planning of electricity generation and distribution for many use cases. The electricity demand data can often be represented in a hierarchical structure. For example, the electricity consumption of a whole country could be disaggregated by states, cities, and households. Hierarchical forecasts require not only good prediction accuracy at each level of the hierarchy, but also the consistency between different levels. State-of-the-art hierarchical forecasting methods usually apply adjustments on the individual level forecasts to satisfy the aggregation constraints. However, the high-dimensionality of the unpenalized regression problem and the estimation errors in the high-dimensional error covariance matrix can lead to increased variability in the revised forecasts with poor prediction performance. In order to achieve better stability and prediction accuracy, we present a new hierarchical forecasting algorithm that provides sparse adjustments while still preserving the aggregation constraints. We formulate the problem as a high-dimensional penalized regression, which can be efficiently solved using cyclical coordinate descent methods. We also conduct experiments using a large-scale hierarchical electricity demand data. The results confirm the effectiveness of our approach compared to state-of-the-art hierarchical forecasting methods, in both the sparsity of the adjustments and the prediction accuracy. The proposed approach to hierarchical forecasting could be useful for energy generation including solar and wind energy, as well as numerous other applications.

Tracking vertebrate biodiversity in Monterey Bay by metabarcoding environmental DNA (eDNA) – Collin Closek

The oscillation between the dominance of Sardinops sagax (pacific sardine) and Engraulis mordax (northern anchovy) has been documented in the California Coastal Ecosystem for more than 100 years. These two species are strong drivers of trophic interactions in the region. As part of the Marine Biodiversity Observational Network (MBON) initiative, we used archived filtered seawater samples collected late-summer to mid-fall over a span of 8 years (2008-2015) from Monterey Bay, CA to examine the change in marine vertebrate environmental DNA (eDNA). Water samples were collected from the surface at Station C1 (36.7970, -121.8470), a nearshore location in Monterey Bay. Sample water was then filtered and the filter was archived at -80°C. DNA was
extracted from the filters, and the 12S rRNA gene present in mitochondrial DNA was PCR amplified using primers designed to amplify 12S rRNA genes from marine vertebrates. The amplicons were subsequently sequenced with an Illumina MiSeq and the data processed using an analysis pipeline for sequence annotation. More than 30 fish genera were noted in the sequences from 2008-12. Anchovy and Megaptera novaeangliae (humpback whale) were present in temporal patterns similar to those noted during visual observations where anchovy and humpback whale were more abundant during the years of 2013-2015 than the other years. This study demonstrates our ability to detect megafauna and fish species that are important to the Monterey Bay ecosystem from coastal water samples and determine community structural differences over time.

Assessing the effectiveness of a large Marine Protected Area for reef shark conservation – Tim White

Large marine protected areas (MPAs), which prohibit fishing, have recently been established throughout the world at an unprecedented pace, yet the value of these reserves for mobile species conservation remains unclear. Reef shark populations continue to decline within some of the largest MPAs (some twice the size of Texas), fueling unresolved debates over the ability of protected areas to aid mobile species that transit beyond MPA boundaries. We assessed the capacity of a large MPA to conserve grey reef sharks - a Near Threatened species with poorly understood movement patterns - using multiple types of shark tags and an innovative vessel tracking technology. We found that the 54,000 km2 U.S. Palmyra Atoll National Wildlife Refuge in the central Pacific Ocean provides substantial protection for grey reef sharks, as two-thirds of satellite-tracked sharks remained within MPA boundaries for the study duration. Additionally, we detected virtually no fishing effort within the refuge and significant effort beyond the MPA perimeter. However, our results also highlight limitations of place-based conservation as some reef-associated sharks moved surprising distances into offshore waters (over 900 km from any reefs) and fishermen operating beyond MPA boundaries captured 2% of sharks that were initially tagged within the MPA.

Restoring Resilient Reefs in a Changing Climate – Megan Morikawa

Climate change will produce winners and losers in our coral reef ecosystems. To predict this, we must improve upon tools to unveil diversity in climate resilience while simultaneously disentangling acclimatization from adaptation. Here we test if prior knowledge of a coral’s experimental heat tolerance or microhabitat allows us to predict colony-level differences in thermal tolerance that are retained after transplantation & acclimatization. In American Samoa, we collected information about microclimate and acute stress performance for 80 coral colonies across four species and transplanted 800 fragments of these coral into a common garden nursery. From a natural bleaching event that occurred in our nursery, we evaluate how the bleaching severity experienced by the entire stock correlated with original colony performance. We demonstrate that coral not only retain their relative thermal resilience, but that knowing microhabitat or experimental stress tolerance can predict individuals within species that will bleach substantially less in a natural bleaching event. Knowledge of microhabitat structure or variation in experimental stress tolerance provides tools for active management to protect and restore reefs before the worst impacts of climate change.

Automatic Detection of Wheat Rust Epidemics in Southern Ethiopia with Satellite Imagery – Reid Pryzant

Agricultural monitoring, particularly in the developing world, can help support organizations in combating famine and humanitarian efforts. This project is concerned with improving the monitoring of
an ongoing wheat rust epidemic in Southern Ethiopia. Ethiopia is the largest wheat producer in sub-Saharan Africa, feeding some 5 million households. Repeated rust epidemics have occurred in the past two decades; the 2013-14 outbreak triggered yield losses in excess of 90% for some districts. With this work, we aim to detect and predict rust outbreaks at high spatial and temporal resolution using remote sensing data. We forego hand-crafted features traditionally used in the remote sensing community in favor of modern representation learning approaches, namely Long-Short Term Memory models.

**Hand- and Object-Mouthing by Rural Bangladeshi Children 6-20 Months Old:**

**Importance of Including Food-Related Contacts** – Laura Kwong

Children are exposed to environmental contamination through mouthing of hands and objects. However, few mouthing studies quantify hand- and object-mouthing associated with eating, which may result in underestimation of children's total exposure. Eating-related exposures may be particularly important in settings where children eat or are fed by hand. We collected activity data from young children in rural Bangladesh to quantify their frequency and duration of mouthing, including feeding-related events. The study objective was to assess the contribution of feeding-related hand-to-mouth and object-to-mouth contacts to children's total exposure through mouthing. We video recorded the activities of 28 rural Bangladeshi children aged 6-20 months over six consecutive hours and used computer software to record all observed mouth contact with hands and objects, including utensils used for eating. We also reviewed the videos to better understand sources of contamination associated with feeding events. All children used their hands for eating and/or were fed by hand during observation, and all but two children also used eating utensils. Food-related contact with the child’s own hand or a caregiver’s hand accounted for more than one-third of total hand mouthing. Mouthing of a caregiver’s hand was nearly 50% of all food-related hand mouthing. Mouthing eating utensils accounted for ~15% of the frequency of mouthing all. Video recordings showed that children did not wash hands before eating. Children were also observed eating off of earthen floors and consuming food that had fallen into the dirt. In contexts where children eat or are fed by hand, excluding eating periods from mouthing exposure studies may substantially underestimate exposure due to hand-mouthing and underestimate exposure due to mouthing of potentially contaminated utensils. Washing children's hands before eating and preventing them from consuming exposure.

**Multiple use land allocation lowers deforestation in Peru** – Christa Anderson

This research assesses how overlapping land use allocations incentivize or dis-incentivize deforestation in the Peruvian Amazon. Initial results show that across all land use allocations, deforestation rates are lower in overlapping allocations than in same-type non-overlapping allocations. These findings provide evidence in support of the hypothesis that multiple use management decreases deforestation. We consider overlapping land use allocations as multiple use allocations. These findings do not provide evidence in support of the hypothesis that insecure tenure increases deforestation. This analysis was done using propensity score matched difference-in-differences methods with 1-ha resolution deforestation data for 2000-2014, along with Peruvian government land use allocation data.

**Can corals reveal land-use change? Trace element and isotopic records suggest patterns of land-use change in the Republic of Palau** – Staci Lewis

Trace element and isotopic analyses of coral cores are used to test corals as recorders of multi-decadal land-use land conversion (LULC) in the Republic of Palau. Coral skeleton to reconstruct over two decades of sedimentation patterns in two of Palau's five
watersheds – Ngeremeduu and Ngerikiil. Coral cores (20-41cm in length) were sampled along a high-to-low sedimentation gradient: near major rivers (high-impact) and ocean (low-impact). Isotopic indicators of seasonality ($\delta^{18}$O and $\delta^{13}$C values (% VPDB)) were used to construct the age model for each core. Barium, one trace metal known to be a proxy for sedimentation, was measured in each core using a laser ablation ICP-MS. Finally, the Natural Capital’s InVEST sediment delivery model was paired with LULC analysis to examine the drivers of sediment delivery (i.e., farms and fires) within these two watersheds. Trace element data, including Barium to Calcium ratio, indicate a peak in sedimentation during 2006 and 2007, and in 2012. One core in the low sediment gradient suggests a gradual increase in sediment leaving Ngeremeduu Bay since 2004. These results correlate to large-scale road construction and corroborate previous findings that Ngeremeduu Bay has reached a tipping point of retaining sediment. More analysis, including more refined LULC analysis, is underway to verify these findings.

Where should cows graze? Landscape management to promote livestock productivity and hydrological services in Peru – Perrine Hamel

Integrated watershed management allows policy-makers to balance competing objectives, for example agricultural production and protection of clean and abundant water sources. Because watershed functions are complex, science-based approaches are needed to support policy-makers in implementing their vision. In this presentation, I will demonstrate one optimization approach to support the development of a land management program in the Cañete watershed, Peru. We modeled the effect of grazing management on three services: livestock production, erosion control, and baseflow provision, and used an optimization routine to identify the landscapes that provided the highest level of services. Over the entire watershed, there was a trade-off between livestock productivity and the water services, but we identified locations that minimized this trade-off. Given the knowledge gaps in hydrological and ecological science, we assessed the robustness of the recommendations and showed that areas of minimal trade-offs were generally robust to uncertainties. Our work shows that simple models can provide useful information for investment in watershed services programs. I will discuss the challenges we faced, including the uncertainty related to water services and livestock production, economic valuation of all three services, as well as the difficulty to incorporate all constraints in the optimizer (e.g. political boundaries, number of animals, land tenure, grazing management practices).

Social development in immersive outdoor experiences – Indira Phukan and Lynne Zummo

Development of social ties and trust play an important part of the learning process in environmental education (EE) programs (Vygotsky, 1980; Wenger, 1999), which can, in turn, influence environmental education outcomes such as taking environmental action (Ardoin et al., 2016). There is also evidence that connectedness to nature contributes to the development of stewardship behavior and can be achieved through meaningful, immersive interactions in environmental education, of which the development of social ties and trust are also a very important part. Fostering positive feedback systems among the development of social ties, trust, and connectedness to nature could lead to increased stewardship outcomes in environmental education (Zylstra et al., 2014).

However, we do not yet know how these feedback systems operate in environmental education settings. This study examines how an immersive 14-day backpacking program in a national park influences the development of social ties, connectedness to nature, trust, and pro-environmental behavior. Using a pre- and post-survey, we examined the statistical significance of the
relationships between survey responses grouped into variables of trust, social ties, connectedness to nature, and taking action. Additionally, we measured changes in the variables for all students from pre- to post-test. We support and triangulate these results with qualitative field notes of observations throughout the program’s duration. These findings suggest the importance of social interactions in facilitating a meaningful immersive EE experience.

Designing preferred windows to maximize household ventilation in urban slums in Dhaka, Bangladesh - Jenna Forsyth

Bangladeshi children and adults suffer from a heavy burden of communicable diseases, especially acute respiratory infections. If designed properly, household windows may increase ventilation, reducing particulate matter and the transmission of respiratory disease inside the home. Moreover, well-designed windows could positively impact quality of life by bringing in natural light. Despite these potential benefits, many slum households lack windows that meet tenants’ preferences and enhance ventilation. Poorly designed or improperly positioned windows may provide no benefits if household members cover them up, and may even pose a security risk.

In this research, we sought a cheap solution that would create ventilation while preserving resident’s safety, comfort and privacy in two low-income neighborhoods in Bangladesh.

In addition to consulting analytical ventilation models, we constructed a quarter-scale model of a slum home, and used a particle tracer test to measure ventilation in the space for a variety of different window sizes and placements. The most effective solution (defined as the highest ventilation rate per square meter of aperture) was a perimeter of small holes ("vents") around the top of the structure, in addition to the door. The vents, about 7.5 cm in diameter at full scale, are not sensitive to wind direction (since they encircle the house), and eliminate many major concerns about safety and privacy, as they are too small for prying eyes or hands. We are still exploring the perspectives of tenants, landlords, and builders regarding these vents.