Past Plant Diversity, Climate Change and Mountain Conservation

Abstracts Volume

MARCH 11-15, 2019 - University of Cuenca, ECUADOR

Venue: Auditorium Claudio Cordero, Faculty of Economics

Oral Presentations

Monday 11 March 2019
Past climate changes and habitat threats on mountain plant species

Keynote: Paul J VALDES *and Taraka DAVIES-BARNARD*
University of Bristol, UK and University of Exeter, UK.

p.j.valdes_at_bristol.ac.uk

Modelling Past Climate, Vegetation and Biodiversity

There is now increasing evidence that improved understanding of current vegetation and biodiversity depends on better knowledge of past change. Palaeodata provides essential information but will always have limited spatial and temporal coverage. Modelling can deliver important extra information but often works at spatial scales too large for ecological studies. The talk will present new climate model simulations for the last deglaciation and Holocene, combined with statistical downscaling methods to provide a high temporal and spatial resolution reconstruction of climate and vegetation since the Last Glacial Maximum, 21,000 years ago. The talk will also show results from a novel biodiversity model using a plant functional trait approach called JeDi-DGVM (Jena Diversity-Dynamic Global Vegetation Model).

Matthieu CARRÉ[1,2], *Moufok AZZOUG*[3], *Paul ZAHARIAS*[4], *Abdoulaye CAMARA*[5], *Rachid CHEDDADI*[6], *Manuel CHEVALIER*[7], *Denis FIORILLO*[8], *Amadou T. GAYE*[9], *Serge JANICOT*[1], *Myriam KHODRI*[1], *Alban LAZAR*[1], *Claire E. LAZARETH*[1], *Juliette MIGNOT*[1], *Nancy MITMA GARCIA*[6], *Nicolas PATRIS*[10], *Océane PERROT*[6], *and Malick WADE*[11].

[1]*Sorbonne Universités (UPMC, Univ Paris 06)-CNRS-IRD-MNHN, LOCEAN Laboratory, Paris, France.* [2]*CIDIS-LID-Facultad de Ciencias y Filosofía-Universidad Peruana Cayetano Heredia, Lima, Perú.* [3]*Département de génie des procédés, faculté de technologie, Université de Bejaia, 06000 Bejaia, Algeria.* [4]*ISYEB – UMR 7205 – CNRS, MNHN, UPMC (Université Paris 6), EPHE – Muséum national d'Histoire naturelle, Sorbonne Universités, Paris, France.* [5]*Institut Fondamental d'Afrique Noire, Université Cheikh Anta Diop, Dakar, Senegal.* [6]*CNRS-UM-IRD-EPHE, Institut des Sciences de l'Evolution de Montpellier, Montpellier, France.* [7]*Institut des Dynamiques de la Surface Terrestre, University of Lausanne, Switzerland.* [8]*CNRS-MNHN, Archéozoologie, archéobotanique: sociétés, pratiques et environnements, Paris, France.* [9]*Institut polytechnique, Université Cheikh Anta Diop, Dakar, Senegal.* [10]*IRD-CNRS-UM, Hydrosciences Montpellier, Montpellier, France.* [11]*Laboratoire de Physique de l'Atmosphere et de l'Ocean Simeon Fongang, Université Cheikh Anta Diop, Dakar, Senegal.*

Evidence of abrupt anthropogenic aridification in western Sahel from a 1600-year paleoclimate record

As climate model uncertainties remain very large for future rainfall in the Sahel, a multi-centennial perspective is required to assess the situation of current Sahel climate in the context of global warming. We present here the first record of hydroclimatic variability over the past 1600 years in Senegal, obtained from stable oxygen isotope analyses (δ18O) in archaeological shell middens from the Saloum Delta. During the preindustrial period, the region was relatively humid, with maximum humidity reached during the period from AD 1500 to AD 1800, referred to as the Little Ice Age. A significant negative link is observed at the centennial scale between global temperature and humidity in the Sahel that is at odds with the expected effects of latitudinal shifts of the intertropical convergence zone during the last millennium. In the context of the past 1600 years, the Western Sahel appears to be experiencing today unprecedented drought conditions. The rapid aridification that started ca. AD 1800 and the recent emergence of Sahel drought from the natural variability point to an anthropogenic forcing of Sahel drying trend. This new

long-term perspective suggests that the recovery of Sahel rainfall in the last decade may only result from short-term internal variability, and supports climate models that predict an increase of Sahel drought under future greenhouse climate.

***Darwin PUCHA-COFREP**, Miryam Chalán, Lourdes Guamán, Silvana Patiño, Ariana Cueva and Jordy Alvarado*
Laboratorio de Dendrocronología, Carrera de Ingeniería Forestal, Universidad Nacional de Loja, 110111 Loja-Ecuador.
darwin.pucha_at_unl.edu.ec

Tree-rings as clues to get historical climate records in southern Ecuador

To know the climate behavior and their impact on forest ecosystems is a key for a sustainable forest management. However, their variations throughout the time are not well understood, and much less in tropical ecosystems. In this study we tried to disentangle these interactions of last decades through dendrochronological methods. We did it with increment cores obtained from trees of a dry (*Acacia macracantha*), andean (*Juglans neotropica*), and humid (*Cedrela montana* and *Cordia alliodora*) forest in southern Ecuador. In the Laboratory of Dendrocronology at the Universidad Nacional de Loja the samples were prepared, and annual tree-rings were measured. Noticeable differences were found in the annual tree growth variation between forest ecosystems. The most clear and common variations between trees were found in the dry forest ecosystem, followed by trees from Andean and Humid forest respectively. In these preliminary results, we found the precipitation as the main driver for annual tree growth in the dry forest. However, in the Andean and humid forest were the water is not scanty, trees showed similar variations as the dry forest on their annual tree growth. This indicates, that tropical trees are very sensitive to climate variations and tree-rings records could be a good alternative to reconstruct climate in past decades.

***Catalina GONZÁLEZ-ARANGO** [(1),] Natalia PARDO [(2)], N. Melissa MARTÍNEZ [(1)] and Tomás BRAVO [(3)]*

[1]Departamento de Ciencias Biológicas, Universidad de los Andes, Bogotá-Colombia. [2]Departamento de Geociencias, Universidad de los Andes, Bogotá-Colombia. [3]Habitante de la Vereda El Silencio, Tablón de Gómez, Nariño-Colombia
c.gonzalez2579_at_uniandes.edu.co

Revisiting paleoecological evidence in the search for past volcanic eruptions in the northern Andes

The northern Andes of South America is a highly complex region in terms of its geology, biodiversity, climate and cultural history. A vast collection of palynological records in the area has provided a comprehensive understanding of the response of vegetation to climate variability at different time-scales. However, despite the area comprises more than 20 active volcanoes that have modified landscapes for millennia, the impacts of volcanism on terrestrial ecosystems have been rarely addressed by paleoecologist in the region. Here, we provide information on early successional pathways developing on volcanic substrates in the tropical Andes of SW Colombia based on local knowledge, observational descriptions, and vegetation plots that might be used to interpret palynological records in similar volcanic settings. Furthermore, we synthesize all the available C14 dates derived from volcano-borne charcoal and paleosoils buried under tephra all over the region for the Holocene and compare them to existing, well-dated, palynological records. We found that many sites might actually contain “hidden” information on the response of vegetation to volcanism and could potentially inform on the timing and intensity of past eruptions. Volcanism should be then considered as one of the primary factors promoting temporal and spatial environmental heterogeneity in the area with important implications for the maintenance of tropical biodiversity.

***Rachid CHEDDADI*[1]*, Majda NOURELBAIT*[1]*, Matthieu CARRÉ*[2]*, Enno SCHEFUSS*[3]

[1] ISEM, Université Montpellier, CNRS-UM-IRD, France
[2] LOCEAN, Université Pierre et Marie Curie, Paris, France
[3]MARUM, University of Bremen, Bremen, Germany

cheddadi.rc_at_gmail.com

The "African Humid Period" and the forest mountains in North Africa

Five fossil pollen records spanning at least the last 16,000 years over a transect in the Moroccan Atlas mountains were used to reconstruct the past climate changes in North Africa. The reconstructed mean January temperature shows a striking similarity with the Sea surface temperature changes in the Western Mediterranean Sea while the annual precipitation is well correlated with the reconstructed annual rainfall from marine records from the Atlantic Ocean off Africa.
The time span between ca. 15000 and 4000 BP in Northern Africa is known as the "African Humid Period" (AHP) with highest moisture values between ca. 11000 and 5000 BP. Fossil pollen records from the subtropical and Sahel belts indicate that plant species spread during the AHP from the tropics northward into the Sahel and Saharan belts. Scholars delineated the northernmost limit of the AHP between 25°N and ca. 31°N.
The five fossil records that we will discuss in this presentation were collected at latitudes higher than 31°N and yet they indicate concomitant increase of the annual rainfall with other records in northern Africa. These past climate reconstructions suggest that all of the Northern Africa, from the Equator up to the Mediterranean Sea (up to 36°N) was humid during the AHP. However, the timing of the beginning and the end of this extended AHP was not synchronous all throughout Northern Africa and the climate mechanisms that lead to such increase of moisture were probably different from the tropics to the Mediterranean borderlands. The increase of moisture (and temperature) during the AHP in North Africa is marked by a coherent dynamics and clear expansion of the oak, pine and Atlas cedar forests in the Atlas Mountains.

***Louis FRANÇOIS*[1]*, Alexandra-Jane HENROT*[1]*, Marie DURY, Alain HAMBUCKERS*[2]*, Anne-Marie LEZINE*[3]*, Jérémy MIGLIORE*[3,4]*, Marc PAILLET*[1]*, Franck TROLLIET*[1]*, Rachid CHEDDADI*[5]

[1] Unit for Modelling of Climate and Biogeochemical Cycles, UR-SPHERES, Université de Liège, Belgium.
[2] Behavioural Biology Unit, UR-SPHERES, University of Liège, Belgium.
[3] Laboratoire d'Océanographie et du Climat, Université Pierre et Marie Curie, Paris, France.
[4] Evolutionary Biology and Ecology, Université Libre de Bruxelles, Belgium.
[5] Institut des Sciences de l'Evolution, Université Montpellier, CNRS-UM-IRD, France.

Comparing statistical and process-based models to calculate the distribution ranges of Podocarpus and Afrocarpus species in central Africa and assess their response to climate change.

One of the major objectives of the VULPES project (VULnerability of Populations under Extreme Scenario, https://vulpesproject.wixsite.com/vulpes) is to study the impacts of climate change on several focal mountain forest tree species, which have today a fragmented distribution and are for most of them considered as near threatened, vulnerable or endangered according to the International Union for Conservation of Nature and Natural Resources (IUCN) red list. *Podocarpus latifolius* is among these VULPES focal tree species. It is classified as of least concern in the IUCN red list and grows in mountain forests of central and south Africa. Closely related species are those of the genus *Afrocarpus*, exhibiting the same kind of distribution in Africa. This distribution is relatively broad, since it extends from the Ethiopian highlands to South Africa for *Afrocarpus*, and from the East African Rift Mountains to Angola and South Africa, and to Cameroun for *Podocarpus*. However, today, the species are restricted to relict patches within the mountain forests and the Afro-temperate forests. Thus, understanding how these

species will respond to climate change is critical for their conservation, since migration towards new potential areas may not always be possible under rapid climate change and strong human pressures.
In this contribution, we compare simulations of the distribution ranges over central Africa of *Podocarpus* and *Afrocarpus* species obtained with the dynamic vegetation model CARAIB and with a niche-based logistic regression model. The niche-based model reproduces with relatively good accuracy the present-day distributions of both genera, with the exception that Podocarpus is predicted to be present on the Ethiopian highlands, and *Afrocarpus* in Angola, while they are not observed in these areas. The dynamic vegetation model is first run for both genera separately and the calculated net primary productivity (NPP) is used to map the species distribution. This procedure provides very large distribution ranges, since NPP is very high in the mountains (> 1000 g C yr-1) where the species are observed, but still quite significant in the lowlands (600-800 g C yr-1) where they are absent. We hypothesize that the NPP reflects the distribution of the potential niche of the species rather than the distribution of the realized niche. In other words, the present-day absence in the lowlands would not be due to unfavourable climatic conditions, but to reduced competitive advantage compared to rainforest tree species and/or to limited dispersal abilities. To verify this hypothesis, a simulation of the dynamic vegetation model was run with 91 African tree species from both lowlands and mountain areas. After only ~1000 years, the abundance of *Podocarpus* and *Afrocarpus* in the simulation is strongly reduced in the lowlands, while it remains high in the mountains. These distributions of the species in the dynamic model are now close to those produced by the niche-based model and to the observed distributions. The dynamic vegetation model suggests that *Podocarpus* and *Afrocarpus* have a broad potential distribution, while the realized distribution is much narrower. If so, the effect of climate change on these species may be less severe than expected, or at least largely conditioned by the response of the competitor species.

Alain HAMBUCKERS[1]*, Marc PAILLET*[2]*, Alexandra-Jane HENROT*[2]*, Franck TROLLIET*[2]*, Rachid CHEDDADI*[3]*, Xavier FETTWEIS*[4]*, Yassine El HASNAOUI*[5]*, Marie DURY*[2]*, Kristof PORTEMAN*[1]*, Louis FRANÇOIS*[2]

[1]Behavioural Biology Unit, UR-SPHERES, University of Liège, Belgium , E-mail: alain.hambuckers_at_uliege.be, [2]Unit for Modelling of Climate and Biogeochemical Cycles, UR-SPHERES, University of Liège, Belgium, [3]Institut des Sciences de l'Evolution, Université Montpellier, CNRS-UM-IRD, France, [4]Laboratory of Climatology, UR-SPHERES, University of Liège, Belgium, [5]Marine Geology , SIUMV, Morocco

Refining the outputs of a dynamic vegetation model (CARAIB): the importance of plant traits to improve prediction accuracy at tree species level.

Dynamic vegetation models (DVMs) are process-based models combining the inputs and the outputs of sub-models, possibly in feedback loops, to simulate the plant functions. The sub-models compute conditions outside and inside the plant and physiological reactions from the environmental data (climate, light intensity, air CO_2 concentration, soil properties). DVMs are tools of choice to predict the future and the past of the vegetation taking into account climatic variations. The emergence of new questions in the context of climate change, particularly on threatened species or on commercial species, compels to apply DVMs to species while the information to parameterize and validate them is largely lacking. Of particular importance are the morpho-physiological traits. These were intensively studied within the hypothesis that they could be used to predict plant performances. This hypothesis finally revealed not very suitable, but it brought to light that important traits controlling photosynthesis and water relationships could strongly vary within each species in response to environmental conditions.
We studied the Atlas cedar (*Cedrus atlantica* (Endl.) Manetti ex Carrière), in Morocco (northern Africa). It is a threatened tree species of important economic value. We also studied the English oak (*Quercus robur* L.) and the sessile oak (*Quercus petraea* (Matt.) Liebl.) in eastern Belgium. In a series of localities, we determined several traits (specific leaf area, leaf C/N, sapwood C/N, as well as for the cedar, leaf longevity) and we assessed biomass and net primary productivity as validation data, thanks to forest inventories, dendrochronology analyses and allometric equations combined with leaf area index

estimations. We compared the model simulations of the CARAIB DVM when varying the set of traits (direct site estimates or default values) to the field estimates of biomass and net primary productivity. We found that trait default values provide sufficient information for the DVM to compute mean output values but low ability to reproduce between site variations. On the contrary, the in situ traits improve drastically this ability, which indicates that the plant performances are steady the results of acclimation to the evolving local environmental conditions.

Susana LEÓN YÁNEZ, *Andrea VILLOTA, Alex DÉFAZ, Carolina BOADA*
Paleobotanical Laboratory, Herbarium QCE, Pontific Catholic University of Ecuador

Three millennia of environmental change and vegetation dynamics at the Occidental Ecuadorian Andean Cordillera: Mojanda, Pichincha and Chimborazo sites

We analyzed the pollen and charcoal content of three sediment cores taken at high elevation wetlands in Mojanda, Pichincha and Chimborazo to explore how vegetation responded to climatic variation over the last 3000 yrs. Mojanda core was obtained from Huarmicocha lake at 3748 m a.s.l. spanning the last 3400 cal yr BP. Pichincha core was obtained from a small peat bog in the western flank of Guagua Pichincha volcano at 3900 m a.s.l. and covers the last 730 cal yr BP and, Chimborazo core was extracted from a peat bog at 4200 m a.s.l. at the wet side of Chimborazo volcano encompassing the last 2800 cal yr BP. The three sites have been dominated by paramo vegetation since the beginning of each record but there is also a permanent signal of the forests down slope. At Mojanda site, paramo with Poaceae, Cyperaceae and Plantaginaceae as the dominant taxa, was very important from 3400 to 2200 yrs BP, but between ca 2200 and ca 1300 cal yr BP, montane rainforest and subparamo taxa increased in abundance, suggesting increasingly warmer climatic conditions; a very wet period seems to have occurred 1200 yrs BP, upper mountain rainforest (dominated by *Weinmmania*, *Hedyosmum* and *Polylepis*) had a higher presence around 700 yrs BP and seems to be recovering importance towards the present. At Pichincha site, paramo vegetation has a high representation during the whole analyzed period with Cyperaceae, Poaceae and Plantaginaceae as the dominant taxa, the period from 500 to 50 yrs BP appears as wetter than at present; and upper mountain rainforest has higher values during the last 70 years with *Hedyosmun*, Myrsine Rubiaceae and Melastomataceae as the most important taxa. At Chimborazo site, paramo also was the dominant vegetation with Poaceae, Plantaginaceae and Gentianaceae as the dominant taxa, the period from 2800 to ca 1700 yrs BP seems wetter and colder with paramo and subparamo vegetation of high importance; from 1700 to 500 yrs BP taxa from upper and lower mountain rainforests increased their importance coinciding with the Medieval Climatic Anomaly (~1,200 to 900 years cal BP), upper mountain rainforest was composed mainly by *Clethra, Alnus, Hedyosmun* and Solanaceae); at Chimborazo site the last 400 years showed big fluctuations suggesting an increase in human intervention. Moreover, this finding may indicate that fire and other human activities as agriculture had favored paramo expansion and stopped the upslope movement of the upper forest line. Charcoal particles found at the analyzed sediments shows that fires were constantly present at the three locations, at Mojanda from ca 1300 to 500 cal yr BP, a period of an evident higher influx of charcoal particles is coincidental with nearby ancient human occupation, at Pichincha fires increased from 350 to 80 yrs BP. At Chimborazo charcoal particles were present for the last 1700 years but increased 700 yrs BP and for the last 200 years. In general an increase in fires seem to be related to local human activities.

Zehao SHEN
Peking University. Peking. China.

Vegetation Change in the Three Parallel Rivers in China.

In the dry valleys of the Three Parallel Rivers region, a world hotspot of biodiversity in northwest Yunnan Province of China, we investigated vegetation using six sampling transects along altitudinal gradients on the eastern and the western aspects of Nu-Irrawaddy River, Langcang-Mekong River, and Jinsha River. We compared the elevational distribution of plant species richness and species turnover rates along the six transects, and explained the patterns using climate, geography and vegetation variables. The dry-warm vegetation zone was dominated by shrubs and herbs and located below the altitude of 3,000 m a.s.l. At higher elevations, shrub and herbs were replaced with a forest zone. The plant species richness increased with elevation, mean annual precipitation and latitude, especially for herb and shrub species, and was also related to river, vegetation zones, and longitude. The species richness of shrubs also increased significantly across the region from west to east. Species richness of herbs and shrubs in the Nu-Irrawaddy River were higher than those in the Lancang-Mekong River and the Jinsha River, whereas the difference of species richness among three rivers was not significant for trees. Herb species richness in the forest zone was less than that in the shrub and herb zones. Species turnover rate of different zones presented inconsistent altitudinal gradient patterns, but all peak values appeared in the ecotones between shrub communities, in the lower altitudes of the transect, and forest communities, in the higher altitudes. The forest-shrub ecotone is located at an altitude range of 1,900–2,100 m a.s.l. in the Nu-Irrawaddy River valley, at 2,300–2,400 m a.s.l. in the Lancang- Mekong River valley, and at 2,700–2,900 m a.s.l. in the Jinsha River valley. The mean species turnover rates between shrub & herb section and forest section within each transect were less than that of the same vegetation section between different transects within the same basin, and also less than the mean turnover rates for same vegetation section in all six transects. Spatial isolation, climate difference and vegetation type together could explain ~67.5% of the variation in species turnover rate among the 12 vegetation sections of the six altitudinal transects, independently contributing by 35.5%, 32% and 0.5%, respectively. These results show the primary role of climate in determining the species richness between vegetation types, whereas geographical isolation between the rivers as a dominant factor in the assembly (e.g. species composition) of plant communities.

Keynote: David A. NEILL *and Mercedes ASANZA*
Universidad Estatal Amazónica, Puyo, Pastaza, Ecuador
davidneill53_at_gmail.com

Plants with nowhere to go in a warming world: Endemic species from the sandstone summits of the Cordillera del Cóndor in Ecuador and Peru

Plants, as well as animals, can migrate in response to climate change if they possess adequate seed dispersal mechanisms and can reach areas of appropriate climate envelopes during and following climate change. Numerous post-Pleistocene pollen records from North America and Europe attest to the northward migrations of plant species over several thousand years. Similar post-Pleistocene records in the tropical Andes document upslope migration of plants during the same time period. At present, several research groups in the tropical Andes are documenting changes in the elevational distribution of plants in response to a warming climate. However, some plant species that occupy the summits of tropical mountains may not have that option since there are no suitable habitats at higher elevations to which they could migrate. Such is the case of endemic plants on the "*Tepuis*" – the sandstone table mountains of the Guiana Shield in southern Venezuela and adjacent countries, and also the "*Andean tepuis*" of the Cordillera del Cóndor and other mountain ranges east of the main cordillera of the Andes in Ecuador and Peru. The highest summits of the Andean *tepuis*, at 2400-2900 m elevation, harbor numerous locally endemic, slow-growing plant species that are adapted to the nutrient-poor, strongly acidic soils derived from the sandstone bedrock. These edaphic conditions do not exist anywhere else at higher elevations in the tropical Andes, and the *tepui* endemics cannot compete on the richer soils derived from volcanic and metamorphic rocks on the nearby slopes of the eastern cordillera. A significant portion of the biological diversity of the tropical Andes may therefore be faced with extinction in future decades – the plants with nowhere to go in a warming world.

***Keynote: Mark BUSH*[1], *Bryan VALENCIA*[2], *Courtney SHADIK*[1]**
[1]Institute for Global Ecology, Department of Biological Sciences, Florida Institute of Technology.
[2]Depatment of Geosciences, KIAM National University of the Amazon, Ecuador.
mbush_at_fit.edu

Microrefugia, migration, and conservation

Microrefugia are small-scale, local, settings that allow populations to persist through adverse climatic conditions, while other members of the population die out. Microrefugia can be viewed as populations or as settings. We argue that the future value to conservation of microrefugia is primarily as settings.

In the past, microrefugia allowed survivors of climatic adversity to jump start subsequent population expansions, from a range of geographic locations far from the main population. These local starting points, reduced migration distances, and allow species to maintain near equilibrium with climate change.. Evidence for the existence of microrefugia is in part based on modern observation and in part an inference that provides a logical explanation of otherwise improbable migration rates. Trees generally migrate at c. 0.1 - 1 km per year. The apparent expansion and contraction of populations in both temperate and tropical settings under past climate change requires rates that are 10-100 x faster than this unless we invoke the presence of microrefugia.

Identifying individual microrefugia is challenging, but in a few locations in Peru and Ecuador we could track the persistence of *Polylepis* species throughout the Holocene, we assigned these locations as microrefugia. Other settings saw *Polylepis* disappear during the mid-Holocene. We suggest that steep local topography was critical to *Polylepis* survival as it acted as a fire-break, so that during major droughts of the mid-Holocene while flatter landscapes burned, and lost their *Polylepis* woodlands, steeper sites retained their populations. We also demonstrated that climate within a microrefugium is not constant and so it is unlikely that any single setting will be suitable for all the species that are present at the onset. In other words microrefugia will not protect all species from local extinction.

Microrefugia should be viewed in the context of ever-changing landscapes in which species face filters of marginally acceptable conditions both in space and time. Microrefugia serve as stepping stones for some species, and population hubs for others. The longer the isolation of a population in a microrefugium, the lower its chance of survival. During the last ice age, rapid and frequent climate change, from hot to cold, and wet to dry, prompted populations to reconnect and limited the length of microrefugial isolation. The long, steady warming of the Holocene has already pushed microrefugial isolation to new limits. Under ongoing warming, we cannot foresee cooler conditions that will allow Andean microrefugia to reconnect. When coupled with human landuse fragmenting systems and projected warming, we anticipate that many if not all species that occur in cool, moist, modern microrefugia will go locally extinct. But because the microrefugium offers less extreme conditions than the surrounding environment, it will become a refugium for the next wave of species that need cooler and moister conditions than the matrix setting. Thus, conserving microrefugia is essential to maintaining mountain diversity, but we should think of them as promoting essential habitat diversity, rather than protecting any given species.

Anne-Marie LÉZINE
Laboratoire d'Océanographie et du Climat : Expérimentations et Approches Numériques (LOCEAN), UMR CNRS 7159 CNRS, Sorbonne Université, BP 100, 4 place Jussieu, 75005 Paris (France)
Anne-marie.lezine_at_locean-ipsl.upmc.fr

What we learn from the last glacial-interglacial transition to understand and predict the response of* Podocarpus *populations of Western Equatorial Africa to climate change?

Podocarpus populations of Western Equatorial Africa are today highly threatened due to intense anthropogenic pressure in one of the most populated region of Cameroon: The Cameroon mountains and the surrounding Grassfield plateaus. They are mainly located between 1800 and 2800 m asl in populations rarely exceeding several tens of trees except in the Oku mountains where an exceptional pure stand of *Podocarpus* occurs. Three pollen series have been obtained from sites with different topography and elevation range (Bambili: 2277m (Lezine et al., 2013; Izumi and Lezine, 2016; Lezine et al., 2018), Mbi: 2041m and Manoun: 1094m) which allow discussion of the turnover of species and the expansion rate of *Podocarpus* trees during the last deglacial-interglacial transition with the aim of evaluating the *Podocarpus* response (vulnerability or resilience) to climate change. Fossil pollen assemblages are discussed in the light of modern pollen deposition studies recovered along an elevational gradient from the top of the mountains to the lowland forests (Lebamba et al., 2009; Verlhac et al., 2018).
This research was supported by the National Research Agency (ANR), France through IFORA (ANR-06-BDIV-0014), C3A (ANR-09-PEXT-001), VULPES (ANR-15-MASC-0003) and the BR/132/A1/AFRIFORD project in Belgium. Thanks are due to the African Pollen Database (APD) for giving access to Lebamba et al. (2009) modern pollen data, and to the local authorities in Cameroon (National Herbarium, IRD office) for research facilities and authorizations.

Paulo E. De OLIVEIRA*[1,2]*, Jorge L. D. PINAYA*[3]*, Gregório C. T. CECCANTINI*[4]*, Maria del Carmen S. LOPEZ*[5]*, Augusto J. PEREIRA FILHO*[5]*, Pedro L.P. CORRÊA*[3]*.

[1]Institute of Geosciences, University of São Paulo, São Paulo, SP, Brazil, [2]Science Action, The Field Museum of Natural History, Chicago, Illinois, USA [3]Politechnical School, University of São Paulo, São Paulo, SP, Brazil, [4]Institute of Biosciences, University of São Paulo. São Paulo, SP, Brazil, [5]Institute of Astronomy and Geophysics and Atmospheric Sciences, University of São Paulo, SP, Brazil
paulo.deoliveira_at_usp.br

Past and future of the Brazilian Highland forests: understanding montane microrefugia and their relation to climatic change

The origin of modern plant distributions in high altitudes of southern and southeastern Brazil, in areas with strong floristic affinities to distant rainforests at isolated mountain tops in the northeast region and northern Amazon, remains unknown. To address this problem, we mapped the occurrence of arboreal and wood shrubby taxa such as *Araucaria, Podocarpus, Drimys, Hedyosmum, Ilex, Myrsine, Symplocos, Weinmannia*, Myrtaceae, Ericaceae and Arecaceae in 31 palynological records spanning from the Last Glacial

Maximum and encompassing a latitudinal range of 30^{O}S to 0^{O}S. We then mapped the extant distribution with several herbaria geolocated data and, validated with niche-based species distribution modeling (MaxEnt) for each taxon. The data revealed two patterns of montane rainforest microrefugia distribution along two transects extending from south/southeast to northeastern Brazil and to the Amazon Basin, under a paleoclimatic scenario of abundant rainfall and lowered continental surface temperatures. We are now at the stage of obtaining ecological, physiological and anatomic data for *Podocarpus lambertii* at 1500-1800 m elev. at the Itatiaia mountain range for input to the CARAIB (*CARbon Assimilation In the Biosphere*) dynamic vegetation model to predict future changes in the altitudinal range of montane forests in Brazil under different scenarios of global warming. This approach is especially relevant considering that Brazil does not possess many high elevation mountains and pushing colder climates too high could cause lack of niches in some altitudes or restrict survival in most southern areas. Some relevant questions are: *i*) will the species reach these southern niches fast enough? *ii*) Will the species be able to reach these places by their own dispersion mechanisms, or will they locally be extinct? These questions and others demand more intensive and urgent research. This research is funded by The State of São Paulo Research Foundation (FAPESP), Proc. 2015/50683-2.

Rachel SALES *and Mark BUSH*
Institute for Global Ecology, Department of Biological Sciences, Florida Institute of Technology
Rsales2015_at_my.fit.edu

Using fire to identify Holocene vegetational refugia in the Peruvian Andes

The Andes is a renowned biodiversity hotspot and ongoing global climate change is forcing species to migrate upslope in the Andes, but migration cannot keep pace observed warming. During prior mid-Holocene warming a combination of droughts and shifting cloudbase caused lakes to dry out and, in dry areas, for humans to abandon whole landscapes. At high elevations, steep areas have been tagged as potential microrefugia during these episodes, but at mid-elevations microrefugia may owe more to orientation and cloud immersion than to topographic roughness. Lake Progreso, Peru, (2000 m elevation), is currently the oldest lake yielding a paleoecological record between 1500 m and 3000 m in the southern tropical Andes. I am conducting fossil pollen and charcoal analyses on this record to determine if these forests were refugia for plants during the mid-Holocene. Preliminary results suggest that Progreso has functioned as a climatic refugium for plants during the past 12,000 years. The fossil pollen record shows little change in forest taxa, such as *Alchornea*, *Hedyosmum*, and *Miconia*, during climatic anomalies. Grasses and herbs never rise above 10% abundance, and *Cecropia*, a tree genus indicative of disturbance, never rise above 5% abundance. Importantly, charcoal is almost completely absent from the record. Compared with the highland microrefugial settings, the species are different, the topography is different, and the overall niche shows little similarity, with one key exception: both lacked fire. Progreso, and possibly other mid-elevation sites that do not burn, could serve as a refugia for plants during future climate change. Subsequent studies should determine whether vegetational refugia also operate as refugia for their associated faunas.

Crystal N.H. MCMICHAEL[1] *and Mark B. BUSH*[2]
c.n.h.mcmichael_at_uva.nl

[1] Department of Ecosystem and Landscape Dynamics, Institute for Biodiversity & Ecosystem Dynamics (IBED), Faculty of Science, University of Amsterdam. [2]Institute for Global Ecology, Department of Biological Sciences, Florida Institute of Technology.

Spatiotemporal patterns of pre-Columbian people in Greater Amazonia

A current goal among many scientific disciplines is to incorporate data on past human land use and climate change into current global climate and vegetation models. Here, we used existing archaeological and paleoecological data to provide a spatiotemporal reconstruction of human history in Greater Amazonia over the Holocene. We used an ensemble distribution model based on a database of georeferenced ^{14}C-dated material and environmental factors to predict the changes in spatial distributions of past human occupation sites. We ran these models for the precultivation (13,000–6000 yr ago), early cultivation (6000–2500 yr ago), and late cultivation (2500–500 yr ago) periods. The ensemble models suggest that people mostly inhabited the peripheral areas of Greater Amazonia, including Andean regions, and the eastern sections of the main Amazon River and its larger tributaries during the precultivation period. Human populations began growing exponentially through the early cultivation period, and people spread and expanded into the interior forests and along river channels in western Amazonia. Populations continued growing through the late cultivation period in these same regions. Our results suggest that many forests, particularly in the Andean regions and the peripheral regions and riverine locations in Amazonia, may still be in recovery from disturbances that have occurred repeatedly through the Holocene. These results suggest that climatic microrefugia are likely to be found in areas there were not repeatedly occupied by people throughout the Holocene, but instead are likely to be found in areas that contain relatively low levels of past human disturbance.

Fausto ***SARMIENTO***
Neotropical Montology Collaboratory, Department of Geography, University of Georgia
fsarmien_at_uga.edu

From Microrefugia and Montology to Genomatics: Towards a Transdisciplinary Science of Mountain Studies.

Mountains aided civilization as archetype, framing meta-geographies about the vertical dimension on people's minds and their development pathways. Mountain metaphors remain guiding most sociocultural endeavors. This crash of paradigms in the post-modern and post-structural geographic fade, presents nature as a social construct, with socio-ecological production landscapes and systems (SEPLS), instead of the result of physical geomorphology alone. It is between these Cartesian or Spinozan dogmas that mountains continue as targets for geographical inquiry. Using inputs from critical biogeography theory, I argue for integrating analyses or Western ecological knowledge (WEK) and traditional and indigenous ecological knowledge (TEK) in favor of Montology. With the help of social science inputs to the climate change debate, I posit for alternative and (de)colonial modes of examining biocultural spatialities in the mountains, shedding light into conservation, protection, and curation of biocultural heritage and biodiversity. Complex environmental and cultural dilemmas reflect a post-colonial turn in the way we understand human-environmental couplings and landscape territorialization that make the treeline ecotone region particularly susceptible to misinterpretation. I propose a trilemma framework in the Andes to surmount positivistic and reductionistic approaches for geospatial inquiry, arguing that culture provides meaning and imbues mountain phenomena with landscape character and the essence of place through landscape archaeology, historicity, language, political ecology, aesthetics and poetics, in a true transdisciplinary fashion, allowing for new conservation paradigms for the protection of mountainscapes. This work is a contribution to the Belmont Forum funded project VULPES (Project ID: ANR-15-MASC-0003).

Paula CORDERO[1,3]*and Miriam REIBÁN*[2]
[1]Proyecto CEDIA Universidad Católica de Cuenca, Universidad del Azuay y Universidad de Cuenca
pcorderoc_at_ucacue.edu.ec

Evaluación de los efectos de las actividades socioeconómicas en el cambio del uso del suelo para su posterior análisis en la construcción de Escenarios de Cambio Climático en la zona de amortiguamiento del Parque Nacional Cajas

La interacción producida por el cambio del uso del suelo y el cambio climático han sido poco investigadas, en cuencas andinas existe muy poca literatura al respecto, se han tratado estos dos mecanismos por separado. Por lo tanto, el analizar los cambios demográficos y socieconómicos en concordancia con los cambios de cobertura nos dará una visión más holística del problema. Algunos autores como Buytaert et al. (2006), aseveran que los efectos del cambio climático pueden disparar los extremos hidrológicos (sequías e inundaciones) especialmente en cuencas de montaña, acarreando impactos negativos con respecto a la disponibilidad de agua para las demandas futuras (Kusangaya et al. 2014). La cuenca del río Tomebamba es fundamental para la ciudad de Cuenca por la dotación del 40% del agua que se consume, a más de provenir del PNC. Para estos análisis se partió de la información levantada por los censos nacionales de los años 1990, 2001 y 2010 adaptándoles a la cuenca del Tomebamba, en cuanto a unidad geográfica natural y no administrativa. También se realizaron talleres para el levantamiento de la información cualitativa y de percepciones con los pobladores. A más de ello se ha trabajado con imágenes satelitales para analizar el cambio de cobertura en esta misma serie histórica. En cuanto a los resultados preliminares obtenidos es sobresaliente la transformación en la parroquia de Sayausí, que por su ubicación de paso de una vía tan importante como la Cuenca Molleturo Naranjal ha cambiado notablemente su fuente de ingreso mostrando un crecimiento del sector terciario del 38,20% en 1990 hasta un 51,12% en el 2010 y la disminución en este sector primario de un 30,62% a un 19,69%. Respecto a la cobertura vegetal el mayor cambio de uso de suelo que se puede visualizar es de páramo a pasto con una disminución del 2% y una disminución de la vegetación arbustiva del 6%.

Estos cambios afectan a los ecosistemas naturales reguladores del ciclo hídrico y sumado a la variabilidad provocada por el cambio climático están provocando inundaciones y sequías. En los años 2009 y 2016 existió un intenso estiaje que avivó problemas en el abastecimiento de agua para los habitantes de la cuenca media y baja. En cambio, los años 2012 y 2014 fueron caracterizados por el desborde del río, causando inundaciones en la ciudad de Cuenca. En conclusión, los cambios en la dinámica socioeconómica del área de influencia del PNC es la que afecta a la cuenca baja del río Tomebamba y este estudio busca incidir en los tomadores de decisiones para el futuro**.**

---

*Qiuchi WAN [1], **Frédéric BOYER [2]**, Kangyou HUANG [1], Zhuo ZHENG [1], Rachid CHEDDADI [3], Pierre TABERLET [2]*

[1] School of Earth Science and Geological Engineering, Sun Yat-sen University, Guangzhou, Guangdong, China
[2] LECA, University of Grenoble Alpes, Grenoble, France
[3] ISEM, University of Montpellier, France

Genetic diversity of Fagus longipetiolata in subtropical China

Today, there are four species of beech in China (*Fagus longipetiolata, F. lucida, F. engleriana* and *F. hayatae*). Among the species studied in the VULPES project, *F. longipetiolata* is a deciduous mountain tree species that has the most extended range in subtropical China, however, its range is very fragmented with scarce individuals composing each population. The aim of our study is to evaluate the modern genetic diversity of F. longipetiolata over its entire range and evaluate the potential of its persistence in its modern refugia.
We sampled 20 populations of *F. longipetiolata* (87 individuals including one "outgroup" *F. lucida*) in subtropical China for DNA analysis covering most of the species range. We sequenced each sampled individual at low coverage. This low coverage sequencing allowed to assemble the whole sequence of the chloroplastic genome and the whole sequence of the nuclear ribosomal DNA cluster (nrDNA, containing the ITS marker) for *F. longipetiolata*. Based on these reference sequences we called Single Nucleotide Polymorphisms for all individuals providing information on the chloroplast and nuclear diversity within and among populations. We independently analyzed the chloroplasts and nrDNA genetic diversity. For both markers, three main genetic clusters could be detected. At the chloroplastic level, even if the signal seems to be locally structured (individuals from the same populations tend to be genetically close), no geographic structure can be detected at the species range level. For the nrDNA analysis, haplotypes seem to be randomly distributed within the species range. No clear link can be highlighted between the chloroplastic and nrDNA haplotypes distribution.This study highlights the low concordance in the chloroplast and nrDNA genetic diversity for *F. longipetiolata* within the species range across subtropical China. Several possible scenarios could explain the observed genetic distribution pattern. More analyses are necessary to reach a conclusion. We thus, plan to design microsats markers based on the DNA sequences that were already acquired to obtain more information on the nuclear genetic structure and apply it to a larger number of individuals. We also plan to acquire genetic data on the closely related species of *Fagus* as it could assess the possible genetic material exchanges that occurs (and occurred in the past) between species and better understand the modern observed genetic structure for *F. longipetiolata*.

Keynote: Pierre TABERLET
Laboratoire d'Ecologie Alpine, CNRS UMR 5553,
Université Grenoble Alpes, Grenoble, France
pierre.taberlet_at_univ-grenoble-alpes.fr

Genetics and conservation biology in the context of Quaternary refugia

Global climate has fluctuated greatly during the past three million years, leading to great changes in the geographic distribution of most living organisms. Such range changes can have dramatic genetic consequences, particularly if the population size is low at some stage in microrefugia. We will first present the current knowledge about these range changes in boreal, temperate, and tropical zones. One of the key parameter is the importance of the range shift, and there are strong differences between tropical and temperate areas. Beside these considerations on changing distributions, we will introduce the basic concepts in conservation genetics, with a particular emphasis on the genetics of small populations that might lead to the inbreeding depression and extinction. Then, we will make the link between Quaternary range shifts, and genetics. More specifically, we will examine the possible genetic consequences of the different processes to colonize new areas, and to preserve (or not) the genetic diversity. During a range shift, two contrasted situation can occur: (i) the dispersal distance can be very high (several dozens of kilometers) leading to repeated founder effects and consequently a strong loss of diversity, or (ii) the dispersal distance can be very small, (a few hundred meters) that preserve the initial genetic diversity. Additionally, other extremely important parameters are the size of refugia during the period of lower population size and the number of such refugia. Finally, we will illustrate these different processes using published examples.

Keynote: Veerle VANACKER[1], *Armando MOLINA, Pablo BORJA, Gustavo TENORIO, Sebastian PAEZ, Marlon CALISPA, Gerard GOVERS, Diego MORA, Pierre DELMELLE, Marcos VILLACIS, Nathalia VALENCIA, Paul VINTIMILLA, Felipe CISNEROS.*

[1]Earth and Life Institute, University of Louvain, Belgium. PROMAS, Facultad de Ingenieria Civil, Universidad de Cuenca, Cuenca, Ecuador. Facultad de Ciencias Agropecuarias, Universidad de Cuenca, Cuenca, Ecuador. Department of Geo-sciences, KULeuven, Leuven, Belgium. ETAPA, Dirección de Gestion Ambiental, Cuenca, Ecuador. Departamento de Ingenieria Civil y Ambiental, Escuela Politecnica Nacional, Quito, Ecuador.
veerle.vanacker_at_uclouvain.be

Landscape dynamics in tropical Andean ecosystems in response to natural and anthropogenic disturbances

Tropical Andean landscapes are biogeographically very diverse: they have strong environmental gradients with rapid changes in geomorphology, geology and soils, climate and biota over short distances. Their headwater basins function as important regulators of water, sediment and nutrient supply to the Amazon basin. Anthropogenic activities have increasingly transformed the tropical Andean ecosystems into a patchwork of agricultural plots, urban and rural centers, forest plantations, and remnants of native forests and grasslands.

In this talk, we will present two Andean landscapes at the edge, that are rapidly changing under the influence of land use and climate change. In each of them, we will highlight the dynamic interactions of biota and humans with earth surface processes. The first landscape is characteristic for the Inter-Andean valleys that were earlier used for agricultural production by pre-Incan Andean civilizations. Accelerated soil erosion by unsustainable farming practices led to soil fertility decline and potentially played a major role in rural out-migration. Following agricultural abandonment, recolonisation by local plants and tree planting led to landscape regreening, with measurable impacts on soil erosion and sediment transport, runoff generation and streamflow. The second, high Andean or paramo landscape, is situated above 3200 m a.s.l., and highly sensitive to climate warming. This alpine tundra ecosystem is less affected by land use change. The mosaic of tussock grasses, cushion plants and native forests provides a good opportunity to study the influence of biota on soil-landscape development. Beyond the hillslope-scale topographic control on soil development, we observed significant differences in soil weathering extent between vegetation communities hinting to eco-evolutionary plant-soil feedbacks. Although located only 45 km apart, the two contrasting landscapes illustrate how the interactions and feedbacks between earth surface processes, biota and humans reshape tropical Andean landscapes**.**

Gentile Francesco FICETOLA[1,2]*, Rachid CHEDDADI[3], Frederic BOYER[1], Eric COISSAC[1], Pierre TABERLET[1]*

[1] Univ. Grenoble Alpes, CNRS, Laboratoire d'Écologie Alpine (LECA), F-38000 Grenoble, France
[2] Department of Environmental Science and Policy, Università degli Studi di Milano. Via Celoria 26, 20133 Milano, Italy
[3] ISEM, Université de Montpellier, CNRS, Montpellier, France

francesco.ficetola@gmail.com

Genetic diversity, microrefugia, and the conservation of the Atlas Cedar in Morocco

The Atlas cedar, *Cedrus atlantica*, is currently restricted to a relatively small range in North-Western Africa, mostly in Algeria and Morocco. Palaeoecological and model simulation studies in Morocco suggest that cedar forests had much broader distribution in the past, and they have undergone a rapid decrease over the last decades. Currently, Atlas cedars survive in restricted and isolated micro-refugia in the Rif and Atlas Mountains. We used genome-skimming to reconstruct chloroplasts and assess genetic diversity of cedar populations covering the whole species range. Genome-skimming data were also used to develop 20 variable microsatellite loci, in order to assess genetic diversity at nuclear loci. Genetic diversity at chloroplasts did not show significant geographic pattern, confirming that Atlas cedars had a much broader distribution in the past, and suggesting that until cedars were one single, panmictic population. Spatial structure was also weak at nuclear microsatellites (average Fst = 0.09), in agreement with the hypothesis that cedars were panmictic until recently. Nevertheless we detected significant differences between the Rif and Atlas populations and, within the Atlas, between High Atlas and Middle Atlas. Populations retained high values of genetic diversity, with expected heterozygosity generally >0.7. The geographic pattern of expected heterozygosity was weak. Conversely, we detected significant spatial variation of allelic richness, with higher genetic diversity in the Rif and in the High Atlas populations. These results suggest that Atlas cedar decline has not impacted yet its genetic diversity. Model simulations show that the range of the cedar forests decreased by about 75% over the last 50 years in the Rif mountains where the allelic richness is the highest. Thus, early management actions limiting population shrinkage can be effective in conserving intraspecific diversity of cedars and therefore preserving the species from local extinction.

B. Bynum BOLEY
Warnell School of Forestry and Natural Resources. University of Georgia, Athens, Georgia. USA.
bynum.boley_at_warnell.uga.edu

Can Sustainable Tourism Help Indigenous Food Cultivation? The Potential for a Symbiotic Sustainable Relationship

A topic of increasing concern among the Food and Agriculture Organization of the United Nations (FAO) and others involved in international agriculture is the increased homogenization of world agriculture crops resulting in many indigenous crops to be listed as endangered (Bazile et al., 2012; FAO, 2012; Nierenber, 2013). These endangered indigenous crops span all continents and include crops such as quinoa in South America, amaranth in Africa, the Ermelo orange in Europe, the mungbean in Asia, and the Lifou Island Yam in Australia/Oceania (see Nierenber 2014 for a more complete list). Adding to the importance of protecting these indigenous crops is their proposed importance to helping mitigate the negative impacts of climate change. FAO Director-General José Graziano da Silva sees these neglected crops as vital to facing the world's future food security challenge because of these indigenous crops' ability to help humans adapt to changing climate conditions (FAO, 2012). With these challenges in mind, there is a need for more research focused on the incentives needed to encourage farmers to cultivate indigenous crops. One relationship that could help provide the market-based incentives necessary to increase cultivation of these endangered and neglected crops is the relationship between sustainable tourism and indigenous foods. This symbiotic relationship stems from a trend in tourism away from the Fordist model of mass tourism focused on standardization and homogenization to an increasing demand for authentic experiences embedded in all the unique geographical facets of communities (Boley, Nickerson, & Bosak, 2011; Sims, 2009). Within this paradigm shift is a focus on what Soper (2007) calls 'alternative hedonism.' According to Soper (2007), 'alternative hedonism' channels consumers' frustration with the 'inauthenitc' nature of modern life into travel behaviors that search for the authentic aspects of communities and consuming as much local as possible (Soper, 2007 cited in Sims, 2009). Much of this emphasis on local experiences centers around a region's gastronomy (Armesto López & Martin, 2006; Bazile et al., 2012; Everett & Aitchison, 2008; Sims, 2009). This has significant implications for indigenous food production because of the increased demand for indigenous products and the nature of how tourism shatters the supply chain by shrinking the distance (physical, social, and political) between the consumer and the producer. The proposed talk will walk through this potential

symbiotic relationship between sustainable tourism and indigenous food cultivation. This symbiotic relationship is centered around how these market-based incentives for local food specialties encourage more indigenous food cultivation which in turn increases the destination's competitiveness because its geographical uniqueness is better illuminated through the regional food specialties that cannot be found anywhere else in the world. Luckily, there are a hosts of other sustainable outcomes associated with indigenous crop cultivation. These tangential sustainable outcomes include economic, political, social, and psychological empowerment of farmers, increase food security, and maintained biodiversity. The talk will conclude with an open discussion with the audience on how this symbiotic model between tourism and indigenous crop cultivation could be applied in the Andes.

Antonio BORRERO-VEGA
Electro Generadora del Austro ELECAUSTRO S.A., Universidad de Cuenca, Ecuador

Stakeholders committed to the conservation of the Machángara river in the Ecuadorian Andes, a twenty year successful case study in the city of Cuenca.

The water basin of Machángara River located at the northwest of the city of Cuenca, Ecuador, inserted in the Macizo del Cajas, is an essential contribution to the life and ecological balance of the city and its surroundings, it constitutes an area of enormous biodiversity. A successful experience of commitment of eight public and private entities, has led for more than 20 years to constitute a management model that is studied within the AICCA project of adaptation to the impacts of climate change in the Ecuadorian Andes. The involvement of the stakeholders related to drinking wáter treatment, irrigation, conservation of the environment, regulation on the use of water, water reserve, agricultural and livestock production, hydroelectric generation, scientific research and education, has led to the creation of a Conservation Committee of the Machángara River Basin, which oversees all the mentioned aspects, and has established an Integral Environmental Management Plan that is executed with the commitment of all.

Sarah Jane WILSON*, Jeanine RHEMTULLA, and Oliver COOMES*
Department of Geography, McGill University
sjwil_at_umich.edu

Small montane cloud forest fragments are important for conserving tree diversity in the Ecuadorian Andes

Montane tropical cloud forests, with their high biodiversity, endemism, and rapid rates of clearing, are a top global conservation priority. But conserving and restoring cloud forest requires both a knowledge of species distributions at local and landscape scales, and how people use and interact with these forests. Empirical work has focused mainly on species distributions along elevation gradients, with less focused on understanding spatial variation among forests at the same elevation. In this paper we compared tree communities across multiple intact Andean cloud forests at similar elevations. We also surveyed households to understand their forest use practices and forest change patterns and drivers in the region. Forests were located in five ridge-top reserves at the upper end of the 'mid-elevation diversity bulge' (1900–2250 masl) in the *Intag* Valley, a heavily deforested region in the Ecuadorian Andes. We also surveyed local households (120) and key informants in communities (16) in a part of the region with active forest restoration projects about their reasons for restoring forest and history of forest use. We found that tree communities were distinct in reserves located as close as 10 to 35 km apart, and that spatially closer forests were not more similar to one another. Although larger (1500 to 6880 ha), more intact forests contained significantly more tree species (108–120 species/0.1 ha) than smaller (30 to 780 ha) ones (56–87 species/0.1 ha), each reserve had unique combinations of more common species, and

contained high proportions of species not found in the others. Results show that protecting multiple cloud forest patches is essential to conserve landscape-level tree diversity, and that even small forest reserves contribute significantly to biodiversity conservation. Findings contribute to the decades-old SLOSS (single large versus several small) debate, and suggest that montane forests require specific conservation strategies based on their unique topography and species distributions. Local people expressed that forests in this region are essential for providing water and other key benefits for farming, but that these benefits only became apparent after forests were cleared around their communities. A local NGO played a key role in making this link. Findings can be applied to create strategies and management plans to conserve and restore cloud forests in the Andes and tropical montane cloud forests elsewhere.

Nancy HILGERT, *Virgilio BENAVIDES and George VARELA*
BENHIL C. LTDA.
nancyperegrinus_at_gmail.com

Importance of maintaining the forested hills surrounding the city of Guayaquil for the diversity of the urban avifauna

In the city of Guayaquil, founded on the mangroves of the endangered Tumbesian dry forest ecoregion, in Southern Ecuador, there are approximately 300 bird species, including 115 species adapted to live and nest in urban environments surrounded by plants, metal and concrete structures; they also feed on almost contaminated delicacies, and withstand extreme noise. They take advantage of any space and claim it as their territory, which makes it difficult to dislodge them if the habitat offered is slightly satisfactory for their subsistence, or there are new habitats for certain birds that could recently consider urbanites and for others that are simply migrating.
The diversity of avifauna is also due to the existence of green areas, estuaries, riverbanks, mangroves, gardens, flowerbeds, tree-lined avenues, linear parks and, in general, all kind of plants in the cityscape, providing with a variety of ecosystems dressed with a nature that little by little is stabilizing ecologically. This offers to the great avian diversity of the urban sector new habitats to live. Moreover, the city is surrounded by diverse ecosystems and is framed by Important Areas for Birds Conservation (IBAs) that include protected state and private areas, and unprotected areas. Mostly the hills above 100 masl are protected by the Municipality of Guayaquil, and get the Protective Vegetation and Forests category (BVP) from de Ministry of Environment, and are the following: BVP Bosqueira (100 sp.); BVP Paraíso (150 sp); BVP Palo Santo (50 sp); BVP Cerro Blanco (230 sp); BVP Prosperina (160 sp), and with many national protected areas such as Isla Santay National Recreation Area (128 sp); Samanes National Recreation Area (130 sp); National Recreation Area Parque Lago (160 sp); Manglares El Salado Fauna Production Reserve (120); the marshes and mangroves of Guayaquil (150 sp); Manglares Churute ecological Reserve, with many of these hills reaching 300 to 700 masl. So the importance of maintaining their forests is vital for the diversity of the urban avifauna and wildlife of Guayaquil. We can find that 9 of them are threatened with extinction, including the Guayaquil Macaw (*Ara ambiguus guayaquilensis*), symbol bird species for the City, the Ecuadorian red-lored parrot (*Amazona lilacina*), the Grey- backed Hawk (*Pseudastur occidentalis*), also we can find endemic and cuasi-endemic birdspecies (46) the Pacific parrotlet, the Yellow-tailed oriole, three species of tanagers, Ecuadorian Ground Dove, Gray-cheek Parakeet, Ecuadorian Piculet, Scarlet-backed Woodpecker, Blackish-headed Spine Tail, the Baron´s Hermit, Ecuadorian Trogon, Jet Antbird, Superciliated Wren, Oranged-crowned Euphonia and Peruvian Meadowlark. In the mangrove environment is easy to observe the Great Egret, Snowy Egret, Little Blue heron, Tricolored Heron, Roseate Spoonbill, White Ibis, Green Kingfisher and Ringed Kingfisher. The Municipal Public Company of Tourism, Civic Promotion and International Relations of Guayaquil is promoting the conservation of the city's biodiversity through tourism and environmental education by creating the program "Guayaquil is your destination to: enjoy its nature", "Guayaquil is your destination to urban birdwatching in the Estero Salado mangrove side and Linear parks route".

Inhye KONG *and Fausto SARMIENTO*
Neotropical Montology Collaboratory, Department of Geography, University of Georgia

inhye.kong_at_uga.edu

Identifying social values for landscape conservation: a case of El Cajas National Park

Previously, most landscape conservation studies have focused on species or biodiversity-oriented practices. However, landscape has played a significant role in a society for shaping and sustaining shared social values which hold significant meaning in a community. In addition, non-residents visiting the landscape also shape social values which reproduce locally shared values or discover new values in new perspectives, resulting in shaping destination images. Despite the significant roles, however, social values have been overlooked in conservation practices primarily due to the lacking information to interpret collective and intangible meanings shared in the public. In this study, we aim to explore social values at El Cajas National Park utilizing user-generated contents shared in online platforms (Google Reviews and TripAdvisor) to provide insights for conservation policy considering socio-ecological systems (SES). We selected Local Guides in Google Reviews as the representatives of local individuals and non-Ecuadorian reviewers in TripAdvisor as foreign visitors. Contents from two different groups were compared and contrasted to examine social values shaped in different background of origins. As a result, we figured that both local individuals and foreign visitors exhibited strong appreciation for nature and natural features in aesthetic awe. Compared to foreign visitors, however, local individuals expressed more diverse intangible values, such as national pride or social-relational values, which were not identified in foreign visitor groups. The findings in this study are expected to support conservation policy as well as touristic destination management of El Cajas National Park.

Ximena PALOMEQUE
School of Agronomic Engineering, University of Cuenca
Ximena.palomeque_at_ucuenca.edu.ec

Natural or assisted succession as approach of forest recovery on abandoned lands with different land use history in the Andes of Southern Ecuador

Forest recovery on disturbed areas is of special significance in the Ecuadorian Andes, where deforestation is a serious problem. Natural diachronic succession was evaluated on three large plots or sites, differing in their land use and vegetation composition, one is dominated by grass species on an abandoned pasture (Pasture site), the other two are post-fire vegetation dominated by bracken (Bracken site) and various shrubs (Shrub site). Additionally, we assessed the effectiveness of manual removal of competitive herbaceous species to accelerate forest recovery. Monitoring was done in 2003, 2005 and 2007 on 48 subplots of 116 m2 each recording species richness and woody-species density. Results showed that the Pasture site demonstrated a competitive effect of exotic grasses on woody species recruitment with much lower species recruitment and density, suggesting serious inhibition of natural forest regeneration and an unclear successional trajectory. The Bracken and Shrub sites became significantly similar floristically and there is evidence for a marked facilitation of woody plant recruitment correlated with light availability on the ground. Both sites showed characteristics of classic succession, with Shrub showing a higher species richness and density while late-successional species are poorly represented on the Bracken site. However, NMDS ordination using species density showed that the two trajectories may not be converging towards a common “final state”. Manual weeding was ineffective for accelerating forest recovery. These results suggest that the main limiting factor for the recruitment of woody species on the Pasture site is strong grass competition and must be addressed before seed availability, while seed availability seems to be the constraining factor for Bracken and Shrub site development, thus direct seeding or planting may be effective in accelerating forest recovery.

Eduardo ERAZO ACOSTA
Research Group "Curriculum and University" University of Nariño, Colombia.
rueduardo2000_at_hotmail.com

Indigenous women of the department of Cauca, in struggle of their territories against great mining and developmental extraction in southwestern Colombia

Global environmental deterioration, analysis from Latin America and the work of indigenous women, indigenous movement Colombia-Ecuador, marked epistemes In the framework of climate change, the devastation of the so-called Allapammama, from the original communities of the Andean region, is urgent and necessary to talk about real figures, scientific research results that account for environmental deterioration and calls like the Landau Committee, or the dissertations in favor of the climate change, as forms of urgent care against the effects on the territory and resilience due to climate change. >From the science there are several calls like the Global researcher climate change, but from the same original communities there are processes of epistemic contribution that urgent to a new care of nature. The analysis of ecology, environmental care and climate change in Latin America is used In the framework of the post-conflict call in Colombia, peace is presented at the international level as the only reality, without doubt giving rise to a myriad of mega-mining and extractive pro-development factors, affecting even more the conditions of the historically excluded, the original communities located in strategic places, because of the richness in páramos, water, biodiversity continue to be attacked systematically, with threats, forced displacement, assassinations, for questioning the mega-development model that favors the damage to the Allpamamma and above all increases the factors of violence and exclusion in the country, not so for the mass media that serve in unison with national and international oligopolic interests. Women within the indigenous movement play a fundamental role, as they are committed leaders and above all depositaries of the ancestral knowledge of the defense of the Allpamamma, their leadership is part of the same episteme of the indigenous communities, on how to understand the mother earth, is taken into account in the organization of life plans and community organization, starting from the recognition of orality, as a factor of transmission of defense of ancestral knowledge, added to the development of the axes of life and community plans: economic, political, educational and environmental, as factors associated with the care of the survival of life and community ontologies.

Ana MARISCAL[1,2]*, Carmen MARISCAL*[1]*, Carlos ANDRADE*[1]*, Patricio LOPEZ*[1]*, Margot COHEN*[3,4]*, Chloé BROCHARD*[5]*, Elisabeth DIETZE*[1,6]

[1]Fundación Cambugan, Atacames N26 48 and Humberto Albornoz, Quito Ecuador. [2]Universidad Andina Simón Bolívar, Sede Ecuador, Toledo N22-80 (Plaza Brasilia), Quito, Ecuador. [3]Fulbright Ecuador, Diego de Almagro N25-41, Quito, Ecuador. [4]Universidad San Francisco de Quito, Diego de Robles (Campus Cumbayá), Quito, Ecuador. [5]Sciences Po Toulouse, Puits Creusés CS 88 526-31685 Toulouse Cedex 6 France. [6]Alfred-Wegener-Institute Helmholtz-Centre for Polar and Marine Research, Polar Terrestrial Environmental Systems Group, Telegrafenberg, A43-215, 14473 and GFZ German Research Centre for Geosciences, Section Organic Geochemistry, Telegrafenberg, 14473 Potsdam, Germany.
fundacion_cambugan_at_yahoo.com

Nature-Culture Restoration Network - A Pilot Project in Ecuador

Ecuador harbors some of the richest forest biodiversity throughout the world, but at the same time, exhibits a high deforestation rate, especially in mountain regions. The ongoing forest loss, along with irregular rain and drought periods, have resulted in extinction of native species. These processes most heavily affect rural communities, in which inhabitants depend on the native ecosystems for their livelihood. The establishment of a creative, long term conservation initiative is urgently needed in order to ensure the preservation of these disappearing forested mountainscapes, while maintaining local cultural values and contributing to local economies in farming communities. This is the guiding principle of the Cambugan Foundation, working specifically with the *Cambugan-Paso Alto* protected forests, Pichincha Province, Ecuador. Since its initiation in 2000, the foundation has been working with local community

members and organizations to protect and preserve forest biodiversity. Starting in 2017, the foundation also began establishing cooperative agreements with communities living around the protected forest buffer zone, and started a multinational project to learn about the state of conservation of local ecosystems. The Nature-Culture Restoration Network aims to contribute in the recovery and restoration of local nature and culture in Ecuador by initiating new collaborations, exchanging information and experiences, and generating participatory, community-centered research. The project consists of interviews with local communities and participatory meetings to learn about the local land use history, social organizations and cultures. The use of interviews and participatory techniques are essential to analyzing the spatial distribution within and between communities in order to identify potential human and wildlife conflicts. These techniques will also be used to determine perceptions and experiences of local land use changes, and to develop viable solutions for local ecosystems and communities. This summary presents an overview of the Nature-Culture Restoration Network, including the goals, methodology, and initial phases of the project. As the pilot project progresses, the network can be used to identify new socio-ecological research topics to direct further research at universities and research centers on a multinational level, considering long-term conservation perspectives and land use changes in the Ecuadorian Andes. The network will also contribute to the development of local research centers, training programs, and the formation of local environmental committees. The pilot project aims to improve local nature-culture recovery and restoration processes based on the collaboration between local communities, governmental and non-governmental organizations, educational institutions, and research centers, while emphasizing the participation of researchers, students, and volunteers who are interested in contributing to this growing body of community-centered research.

Dunlian QIU
Institute of Mountain Hazards and Environment, Chinese Academy of Sciences
qiudunlian_at_imde.ac.cn

Journal of Mountain Science: an important platform for publishing mountain research achievements

The Journal of Mountain Science (JMS) founded in 2004, is an international scientific outlet published in English. JMS is sponsored by Institute of Mountain Hazards and Environment, Chinese Academy of Sciences, and published by Springer. JMS is one of the five SCI-indexed journals listed specially on reporting mountain research. In the oral presentation, I'll briefly introduce the five SCI-indexed journals on mountain science and introduce the history of JMS and its future development strategy.

Keynote: Selene BÁEZ
National Polytechnic School, Quito. Ecuador
Selenebae_at_gmail.com

Effects of current global environmental change on Neotropical montane forests

Currently, global environmental change is threatening Neotropical montane forests biodiversity and ecosystem function due to climate change, deforestation, and human population growth. Despite of its paramount global importance, montane tropical forests have been the focus of surprisingly few empirical studies, especially if compared to other Neotropical regions, including Amazonia. For example, the Tropical Andean is one the most species-rich global biodiversity hotspot, as it hosts 15% of the world's plant species in only 1% of the world's land surface (>45,000 species). This region holds about 10% of the known species of vascular plants, and >3,300 species of vertebrates of which about half are endemic; moreover it has a critical conservation value due to high rates of evolutionary biological diversification. In consequence, my talk will summarize the available knowledge, mainly coming from studies conducted over long-term and large-spatial scales, about how Neotropical montane forests are responding to different environmental stressors related to global environmental change. I will focus on forest responses

in terms of species diversity, and carbon fixation rates as they are the tightly related to the provision of a variety of ecosystem services of great importance to human populations.

POSTERS

15h30 - 16h30: Poster session
Auditorium Claudio Cordero environs

Andrés ARMIJOS-MONTAÑO *and Darwin PUCHA-COFREP*
Laboratorio de Anatomía de Maderas Tropicales, Carrera de Ingeniería Forestal, Universidad Nacional de Loja, 110111 Loja-Ecuador.
asarmijos32_at_gmail.com

Wood anatomical evaluation of 50 tree species from southern Ecuador

The identification of tropical woods through their anatomical characteristics has become more important in recent years as a key for the control and forest management. The goal of this research is to identify tree species through their wood anatomy with statistical analysis like unsupervised classification, clusters, dendrograms, and heatmaps. For this study 50 tree species from the southern region of Ecuador were analyzed following main 50 microscopic characteristics of the IAWA normative in the Laboratorio de Anatomía de Maderas Tropicales at the Universidad Nacional de Loja. In this analysis we found that the family and genus do not directly influence the anatomical properties of the wood. Only in specific cases tree species within the same family share common characteristics, such as *Anadenanthera colubrina* and *Inga marginata* (Fabaceae), *Cedrela odorata*, *Swietenia macrophylla*, and *Guarea kunthiana* (Meliaceae). However, with the unsupervised classification we found that tree species from diferent families and sites share common characteristics and they look very similar in their anatomical sections (E.g. *Pouteria lucuma* and *Alnus acuminata*, *Clethra fimbriata* and *Gynoxys nitida*, *Erytrina velutina* and *Ochroma pyramidale*, etc.). For all these reasons, it is necessary to carry out a deeper study with relationships between anatomical properties, taxonomic classification, site, and climatic conditions to achieve greater precision in the identification of tropical woods.

Virgilio BENAVIDES ANDRADE *and Nancy HILGERT VALDERRAMA*
Escuela de postgrado en Ciencias Ambientales. Universidad Nacional de Piura.
virgilbenavides_at_gmail.com

Ancestral techniques application for degraded ecosystems' restoration: a case analysis for a proposal for Restoration of a Sacred Land Farm, in Tumianuma, Loja, Ecuador

This research deals with the study of ancestral techniques for the recovery of mountain ecosystems that are deteriorated by different natural or anthropic circumstances. We propose to apply this ancestral knowledge in a place belonging to the land of the Palta people called "*Finca Sagrada*", which is currently owned by biodynamic farmers and mystic scholars of different ancient philosophies. *Finca Sagrada* is located in the Vilcabamba Valley, Loja - Ecuador; a world renowned site for its nature and the longevity of its inhabitants, as well as a meeting place for mystics and shamans from different parts of the world. *Finca Sagrada* or the "Home of the original thoughts" has also the same physical, mystical and spiritual qualities reflected therein since ancestral time.
We did a series of interviews with seasoned mystic scholars and people of cognate fields, these people come from different parts of the world and gave their testimony on the relationship between well-known existing energies of the elements of nature, as well as the beings of local ancestral places, or that is to say the "Mother Nature" – natural environment and its relationship with the human beings.
Part of the study is related with the *Mamos Koguis* ethnicity from the Tayrona people of the Sierra Nevada de Santa Marta in Colombia, where they recount their powerful history, wisdom and philosophy as they preach for the protection and care of nature. They also express the enormous need in the use of

sacred stones or sacred quartz in their ceremonies as fundamental tools for the reappearance of water and for their works in recovering rivers, forests and ancestral villages. It is concluded that in the proposed "planting" of these sacred stones or crystals in *Finca Sagrada* by *Mamos Koguis* for obtaining water using ancient techniques and recovering its ecosystem, the proposal will have academic rigor between the useful ancient wisdom and unorthodox techniques to help modern Western knowledge to develop a sustainable environmental restoration.

Miriam CHALÁN *and DARWIN PUCHA COFREP*
Laboratorio de Dendrocronología, Carrera de Ingeniería Forestal, Universidad Nacional de Loja, 110111 Loja-Ecuador.
mlchalanl_at_unl.edu.ec

Influence of precipitation on the annual growth of Acacia macracantha Humb. & Bonpl. ex Willd in two dry forest of the province of Loja

The main goal of this research was to evaluate the influence of precipitation on the annual growth of *Acacia macracantha* (Faique) in natural forests located in the Loja and Espíndola cantons of Loja province to help in the generation of new information on the dynamics of forest ecosystems and their response to climatic variations. For this study, complete wooden discs of 24 trees were obtained. The samples were polished with sandpaper from grain 40 to 4000 in the Dendrochronology laboratory at the Universidad Nacional de Loja. The tree- rings of each sample were identified and measured with the Lintab Pro 6 measuring system and TsapWin Pro software. Precipitation data were obtained from INAMHI's 1965-2018 meteorological records. Four nearby weather stations were selected for each site to get the climate data. The data analysis was carried out with the open source statistical programming platform R, with the dplR" package (Dendrochronology Program Library in R) and "detrendR". With preliminary results, it was found that trees of *Acacia macracantha* at Malacatos (Loja) had an average age of 51 years and at Espíndola of 41 years. The highest growth of A. macracantha in Malacatos was observed in 1983 and 2017 and in Espindola between 1983-1984 and 1990.

Haley DeLOACH *and Fausto SARMIENTO*
Neotropical Montology Collaboratory, Department of Geography, University of Georgia Athens, Georgia USA
Haleyd_at_uga.edu

Preserving Biocultural Natures: How can the Penan hunter-gatherers fit into Malaysia's conservation management plan?

Gunung Mulu (Mount Mulu) National Park in Sarawak, Malaysia is the most internationally studied and protected tropical karst area in the world for its outstanding biodiversity and geological history, but the Penan hunter-gatherers inhabiting the region have a narrative of insight into the landscape and managing its resources that differs from the popular neoliberal conservation agenda in place. Since the Park's establishment in 1958, and augmented by its UNESCO World Heritage Site inscription in 2000, park management installed policies restricting forest resource extraction, which presently limits Penans' customary resource management practices which have maintained the integrity of this internationally valued landscape for hundreds of years. While the displacement of indigenous communities and ecological knowledge is not unprecedented among the environmental justice nor scientific communities, little urgency exists in exploring the merit of the reciprocity between cultural diversity and biodiversity in a present-day global society wracked by planetary change and uncertainty. However, efforts have been made on an international level to recognize and support communities, which have cultural practices and resource management methods that have evidently shaped and maintained landscapes over a long period of time. The tropical karst mountains of Sarawak, Malaysia have yet to be recognized or protected for its value as a biocultural landscape stewarded by indigenous groups, and my research aims to shed light on Penan values, beliefs, and customary resource management as contributing to valid and sustainable

practices of mountain conservation. The poster will introduce and briefly review the Penan biocultural landscape and their sustainable practices (called molong), influenced by Penan values, beliefs, and customary resource management methods, which offer insight into the benefits of indigenous stewardship on wildlife conservation. The purpose of this presentation is to share the initial phase of my Master's research project and its objectives and methods to determine if Gunung Mulu National Park's inscription as a biocultural landscape would motivate the prioritization of Penan values in conservation management plans. Upon completion of fieldwork at Gunung Mulu National Park in May 2019, I anticipate results confirming that the Park's recognition as a biocultural landscape would be advantageous to both the local Penan communities and the mountain forest ecosystem of the area.

Mario DONOSO-CORREA[1] *and Fausto SARMIENTO*[2]
[1]VLIR-Migration project. University of Cuenca, Ecuador. [2]Neotropical Montology Collaboratory, Geography Department, University of Georgia, USA.
donoso.mario_at_gmail.com

Geospatial memory and joblessness interpolated: international migration oxymora in the city of Biblián, southern Ecuador

This study observed the economic and educational conditions of Biblián and carried out a geographical analysis regarding the variables of lack of education and joblessness to evaluate if these two factors can be used to predict the trend of international emigration. Poverty affects the small and mid-size cities of this southern mountainscape in Ecuador thereby creating a mosaic of different socio-economic areas inside urban settlements affected by the lack of educational availability and joblessness. This create an imperative to emigrate from depressed areas to more affluent countries--especially the United States. Conversely, wealthy retirees have immigrated into the region motivated by the environmental quality and the conservation prospects of the territory. The tension generated by the lack of economic opportunities in mountain towns versus the increased affluence of locals by remittances from abroad as well as the increased presence of expatriates make Azuay and Cañar provinces the focus in understanding the local socio-economic dynamics amidst global tendencies such as migratory flows from developing to developed worlds. We studied the economic and educational situation with data from the 2015 census of the Monitoring Mechanism for Migratory Impact (MIMM) conducted in the city of Biblián, province of Cañar, Ecuador, which consists of a spatial-statistical database, also called the Geographic Information System (GIS). Based on this information, we carried out a Geographically Weighted Regression (GWR) using two independent variables, the levels of education and unpaid work in relation to a dependent variable, namely, international emigration. Our research question was, Are low levels of education and lack of paid jobs the predictors of external migration? If so, could educational attainment and joblessness be the main variables that can predict tendencies of international emigration? For better visualization and analysis, spatial interpolations were subsequently made. The main results of this study show areas in the city of Biblián where there is exhibited a greater influence of low levels of education and unpaid work on emigration as well as urban areas where this association is less prominent. For example, in the GWR, between levels of education and international emigration, the local one produced coefficients of determination (R^2) with variations between 0.07% and 60.07% with local standard errors (SE) which fluctuated between 0.60% and 10.02%; the GWR made between unpaid work and emigration abroad produced local R^2 with variations between 4.31% and 5.34% and the local SE which fluctuated between 2.97% and 2.99%; Finally, the GWR of both independent variables against international emigration generated local R^2 between 4.02% and 5.34% with local SE between 7.85% and 33.32%.

Lourdes Alexandra ***GUAMÁN-GUAMÁN*** *and Darwin PUCHA-COFREP*
Laboratorio de Dendrocronología, Carrera de Ingeniería Forestal, Universidad Nacional de Loja, 110111 Loja-Ecuador.
laguamang_at_unl.edu.ec

Biological rotation age in* Cordia alliodora *(Ruiz yPav.) Oken throught dendrochronological methods in a plantation from Zamora-Chinchipe province in southern Ecuador.

The goal of this research is to estimate the biological rotation age for *Cordia alliodora* (Ruiz and Pav.) Oken through dendrochronological methods. The site of study is the plantation of *Cordia alliodora* (Laurel costeño) of the experimental plot el Padmi, located in the Los Encuentros, canton Yantzaza, province of Zamora Chinchipe. A total of 31 trees of a plantation with individuals between 15 and 62 cm of DAP were used for this study. The samples come from a collection of the Dendrochronology laboratory at the Universidad Nacional de Loja. The wood cores were careful sanded from grain number 100 to 4000. The identification and measurement of the annual growth rings was carried out with the help of the Lintab Pro 6 system and TSAP-Win Pro software. The data analysis was performed within the open source statistical programming platform R, with the dplR" package (Dendrochronology Program Library in R) and "detrendR". Within a preliminary analysis of 17 trees, we reach an Expressed Population Signal (EPS) of 0.87, which means that the number of trees is enough for this study. We found that trees from this plantation have an annual mean growth of 1cm per year and are 31 years old.

Jérémy ***MIGLIORE*** *[1,2]*, Anne-Marie LÉZINE[2], Olivier and J. HARDY[1]*
[1]Université Libre de Bruxelles (ULB), Evolutionary Biology and Ecology (EBE), CP 160/12, 50 avenue F.D. Roosevelt, 1050 Bruxelles (Belgium) [2]Laboratoire d'Océanographie et du Climat : Expérimentations et Approches Numériques (LOCEAN), UMR CNRS 7159 CNRS, Sorbonne Université, BP 100, 4 place Jussieu, 75005 Paris (France)
jeremy.migliore_at_ulb.ac.be

Tempo of diversification, colonization history and vulnerability of* Podocarpus *trees in Afromontane forests

Afromontane forests are characterized by a unique biodiversity that is found only at high altitude and extremely fragmented within a matrix mainly consisting of rain forests or savannas. Hotspots of biodiversity, these "sky islands" have attracted the interest of biogeographers to understand their role in speciation processes or at least their involvement in the persistence of species blocked by global warming since the last ice age. These Afromontane systems are therefore an exciting model for studying the processes and routes of colonization between mountains, and for analyzing the role of climate refugia and gene flow in preserving the genetic diversity of such currently isolated forests. As part of the project VULPES – VULnerability of Populations under Extreme Scenarios, we focus on the Afromontane *Podocarpus latifolius/milanjianus* (Podocarpaceae) conifers, patchily distributed from Cameroon to Angola in Central Africa and from Kenya in the northeast to the Cape region in South Africa. Our aim is thus to investigate both the paleoecological history and the phylogeography of these Podocarps as a model to gain insights into past vegetation patterns of Afromontane forests. Genomic data were developed using high throughput sequencing tools through both the capture of chloroplast genomes and nuclear DNA microsatellites genotyping on an extensive sampling, covering the distribution range of P. latifolius. The tempo of diversification of current lineages of *P. latifolius* is centered on the Pleistocene between 0.86 and 1.74 Myrs. The populations belong to distinct phylogroups restricted either in Central Africa or in East/South Africa. One phylogroup more latitudinally distributed and connecting Cameroon to East Africa questions about the role of North/South migration corridors in the current distribution range of Podocarps. At the population scale, microsatellite markers are used to better understand the role of extensive gene flow, in relation with past climatic oscillations. A focus will be made on the Cameroon Volcanic Line to contrast demographic scenario inferred from genetic data with paleoenvironmental data reviewed here from marine and continental paleoecological records.

Danilo MINGA[1], *Paula CORDERO[2], Mario DONOSO-CORREA[2-3],* Kabir MONTESINOS[3] *and Fausto O. SARMIENTO[4]*
[1]Herbario HA. Universidad del Azuay, [2] Universidad Católica de Cuenca. [3]Universidad de Cuenca. [4]Neotropical Montology Collaboratory, Geography Department, University of Georgia.

El microrefugio de Uchucay: un relicto de bosque interandino con una importante riqueza arbórea en la provincia del Azuay-Ecuador.

La Reserva Comunitaria de Uchucay, perteneciente al cantón Gualaceo de la provincia del Azuay, mantiene un importante relicto de bosque nativo interandino, que ha sido conservado por su relevancia en la generación y regulación del caudal hídrico, pero poco se conocía en cuanto a biodiversidad; por tal motivo, mediante transectos de 50 x 2 m, se estudió la riqueza y composición florística de especies leñosas con un diámetro igual o superior a 2,5 cm. En Uchucay se registraron 57 especies arbóreas, pertenecientes a 47 géneros y 32 familias, con una riqueza que oscila entre 12 y 18 especies por 100 m^2 y una alfa diversidad promedio de 2,5 en el índice de Shannon. La composición florística está caracterizada por la predominancia de especies como: *Weinmannia fagaroides*, *Columellia oblonga* y *Clusia flaviflora*; en tanto que la densidad muestra un promedio de 67 individuos por 100 m^2, con un área basal que alcanza los 0.77 m^2 por 100 m^2, (77 m^2 / ha). Estos resultados indican que son bosques maduros y con una elevada diversidad arbórea, que además constituye un microrefugio importante para especies de árboles amenazados como *Prumnopitys montana*; *Podocarpus oleifolius, Oreopanax avicenniifoliu*s, *Miconia hexámera* y *Gynoxys dielsiana*. La investigación incluyó un estudio sobre la percepción de los pobladores sobre el cambio ambiental y de qué manera se afectan con la pérdida de especies emblemáticas del bosque nativo, como el *Podocarpus* sp. El estudio es parte del proyecto VULPES (Project ID: ANR-15-MASC-0003) con el auspicio del Belmont Forum y refleja la colaboración interuniversitaria azuaya.

Manuela ORMAZA RODRIGUEZ *and Susana LEÓN-YÁNEZ*
Laboratorio de Botánica Andina y Paleoecología, Pontificia Universidad Católica del Ecuador, Quito.

Reconstruction of vegetation, climate and human impact during the Middle and Late Holocene in the páramo del Cajas, Ecuador

In this study, the paleoenvironment: history of vegetation, climate and human impact of Cajas National Park was reconstructed from ~6.545 to 514 years cal BP corresponding to the middle and late Holocene, respectively. The reconstruction was made from fossil records (pollen, spores and charcoal) present in a sediment core named CAJ, which was obtained from a small glacier lake at 3.935 m.a.s.l., located on the eastern flank of the western Cordillera. In CAJ, both in the first 18 and in the last 20 centimeters, no fossil records have been found due to sediment nature. For the rest of the sediment, climatic conditions ranging from warm-dry to cold - humid were registered. Two climatic events are highlighted: a) an increase in temperature at the transition from the middle to late Holocene; and b) an increase in temperature and dryness during the Medieval Climatic Optimum (MCO), both events evidenced by a decrease in páramo taxa abundance and an increase in the montane forest taxa. The vegetation of the study site from ~6.545-514 years cal BP has always been composed of páramo taxa, specifically Poaceae, Cyperaceae and *Plantago*. However, smaller amounts of pollen from other ecosystems are also found, as subpáramo taxa *Polylepis/Acaena* and Asteraceae and the upper montane forest trees, which undergo a change of abundance from *Podocarpus* to *Hedyosmum* during the middle to late Holocene transition. Low montane forest taxa are also present, including *Acalypha* as the most abundant taxon. Finally, the human impact and fires on the region were studied. The concentration and rate of accumulation of charcoal increased towards the late Holocene, more fires suggest a warmer climate and more human influence at the site. The greatest carbon accumulation occurred during the MCO (~1,200 to 900 years cal BP), a period that coincides with the presence of the "pueblo Cañari "(1,550 to 450 years cal BP) in Azuay. Amaranthaceae/Chenopodiaceae is also used as an indicator for human impact in the sediment and is first found ~ 4780 years cal BP. Overall, the CAJ sediment core offers an insight into the various fluctuations in the páramo taxa in the last ~7.000 years cal BP. The pollen record obtained from the CAJ sediment core elucidates the paleoenvironmental history of the climate, vegetation and human impact during the Middle and Late Holocene.

Silvana del Carmen PATIÑO-ROSARIO *and Darwin PUCHA- COFREP*
Laboratorio de Dendrocronología de la Universidad Nacional de Loja
scpr1994_at_gmail.com

Determination of the biological rotation age in* Cedrela montana *and* Cedrela odorata *from southern Ecuador.

The goal of this research is to know the biological rotation age of *Cedrela montana* Moritz ex Turcz., and *Cedrela odorata* L. through dendrochronological methods. The study area is located in the San Francisco Biological Reserve (Zamora Chinchipe province) and the natural forest in the El Tambo (Loja province). Increment core samples for this study were obtained from a 2017 wood collection in the Laboratory of Dendrochronology at the Universidad Nacional de Loja. The samples were polished with sandpaper of different grid from 100 to 4000, then, a visual identification of each ring was done with a stereo-microscopy, and finally measurement of annual tree-rings were done with the help of a system Lintab Pro 6, with the Software TSAP-Win Pro. The statistical analysis was done within the open source statistical programming platform R with the specialized package for dendrochronology "dplR" (Dendrochronology Program Library in R) and "detrendR". As preliminar results with partial samples, we found that trees have a mean age of 48 years, annual mean growth of 0.6 cm in diameter, and they reach their biological rotation age at the 69 years.