Food and Agriculture Organization of the United Nations

CLIM-FO Climate Change & Forestry

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CONTENTS

I. FOCUS ON COP 22

UN Climate Change Conference (COP22)

7-18 November 2016
Marrakech, Morocco

The twenty-second session of the Conference of the Parties (COP 22) and the twelfth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP 12) were held in Bab Ighli, Marrakech, Morocco from 7-18 November 2016. On 5 October 2016, the threshold for entry into force of the Paris Agreement was achieved. The Paris Agreement entered into force on 4 November 2016. As a result, the first session of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA 1) took place in Marrakech in conjunction with COP 22 and CMP 12.

COP 22 was perceived to have two tasks, each with a different audience. To the outside world, delegates had to demonstrate that the UNFCCC could contribute to the momentum generated post-Paris by the actions of non-state actors, as well as other international processes, including the Kigali Amendment to the Montreal Protocol that phases out the powerful greenhouse gas hydrofluorocarbons (HFCs), and the International Civil Aviation Organization's new offsetting mechanism for carbon emissions from the international aviation sector. Internally, delegates had considerable technical work at hand, to build a foundation for the accelerated completion of the modalities, procedures and guidelines that will make the Paris Agreement implementable.

A brief analysis on the extent to which COP 22 achieved these two tasks can be found here.

The decisions adopted by COP22/CMP12/CMA1 are listed here.

The Marrakech Partnership for Global Climate Action was launched at the High-Level Event on Accelerating Climate Action. The Partnership supports voluntary collaboration between Parties and non-Party stakeholders, including civil society, the private sector, financial institutions, cities and other subnational authorities, local communities and indigenous peoples, as well as coalitions and voluntary initiatives, as set out in the Paris decision.

The Marrakech Action Proclamation for our Climate and Sustainable Development was introduced during the closing session of the COP and signalled a shift towards a new era of implementation and action on climate and sustainable development. Among other pledges, the Developed Country Parties reaffirmed their USD $100 billion mobilization goal. There was also a call for further climate action and support, well in advance of 2020, taking into account the specific needs and special circumstances of developing countries, the least developed countries and those particularly vulnerable to the adverse impacts of climate change.

Forest Action Day

8 November 2016
Marrakech, Morocco

Hosted by the Food and Agriculture Organization of the United Nations (FAO) and UN Development Programme (UNDP), Forest Action Day took place on 8 November 2016 during UNFCCC COP 22 in Marrkech, Morocco. More than a dozen initiatives from Africa to Indonesia to South America were presented to demonstrate how climate mitigation and adaptation actions related to forests and agriculture are firmly anchored in the Nationally Determined Contributions of over 120 Parties to the Climate Convention. Deforestation and forest degradation currently contribute up to 12 percent of carbon emissions – more than the entire transport sector combined. Yet, by halting deforestation and reducing and reversing forest degradation, forests could contribute significantly to the climate solution in the coming decades. More than a dozen announcements were made at the session, including:

Moratorium on Indonesian Peatland Clearing: The Government of Indonesia announced it is implementing a moratorium on clearing super-high-carbon intact peatland.

African Leadership on Sustainable Development: The public-private partnership Tropical Forest Alliance 2020 (TFA 2020) showcased progress of partnership through the African Palm Oil Initiative, a signature initiative of TFA 2020 which engages 9 African Countries. In addition, the Central African Forest Initiative, which includes 6 central African high-forest-cover countries, has taken a major step since COP21 toward the implementation of sustainable development frameworks in the region through the signing of a $200 million Letter of Intent to support REDD+ and responsible and inclusive development investments.

Brazilian Transformation: The multi-stakeholder Produce, Conserve, Include (PCI) strategy in Mato Grosso, Brazil, seeks to simultaneously reduce deforestation in the Amazon by 90% by 2030, increase agricultural production and promote socioeconomic inclusion of smallholders and traditional populations.

Breakthrough Technology for Transparency: A new partnership between FAO and Google has created Collect Earth, an open-source tool that provides access to large collections of free, high-resolution satellite imagery and cloud computing.

II. IN THE PRESS

7 September 2016

Thrive or fail: Examining forest resilience in the face of fires

In 1988, fires consumed more than a million acres of Yellowstone National Park and its surrounding lands. But for the past three decades, Yellowstone's forests -- resilient ecosystems composed of species adapted to periodic severe fire -- have embarked on their recovery. However, this year, several new fires -- including the Maple, Buffalo and Berry fires -- are burning through those young pine forests.

7 September 2016

Seeing the forest for the trees: World's largest reforestation program overlooks wildlife

After years of environmental destruction, China has spent billions of dollars on the world's largest reforestation program, converting a combined area nearly the size of New York and Pennsylvania back to forest. The government-backed effort, known as the Grain-for-Green Program, has transformed 28 million hectares (69.2 million acres) of cropland and barren scrubland back to forest in an effort to prevent erosion and alleviate rural poverty. While researchers around the world have studied the program, little attention has been paid to understanding how the program has affected biodiversity until now.

New research led by Princeton University and published in the journal Nature Communications finds that China's Grain-for-Green Program overwhelmingly plants monoculture forests and therefore falls dramatically short of restoring the biodiversity of China's native forests, which contain many tree species. In its current form, the program fails to benefit, protect and promote biodiversity.

19 September 2016

An American tragedy: why are millions of trees dying across the country?

JB Friday hacked at a rain-sodden tree with a small axe, splitting open a part of the trunk. The wood was riven with dark stripes, signs of a mysterious disease that has ravaged the US's only rainforests – and just one of the plagues that are devastating American forests across the west. Friday, a forest ecologist at the University of Hawaii, started getting calls from concerned landowners in Puna, which is on the eastern tip of Hawaii's big island, in 2010. Their seemingly ubiquitous ohi'a trees were dying at an astonishing rate. The leaves would turn yellow, then brown, over just a few weeks – a startling change for an evergreen tree. "It was like popcorn – pop, pop, pop, pop, one tree after another," Friday said. "At first people were shocked, now they are resigned.

21 September 2016

Indonesia dismisses study showing forest fire haze killed more than 100,000 people

Indonesian, Malaysian and Singaporean authorities have dismissed research that suggested smoky haze from catastrophic forest fires in Indonesia last year caused 100,000 deaths. Some even contend the haze caused no serious health problems, but experts say those assertions contradict well-established science. Last year's fires in Sumatra and the Indonesian part of Borneo were the worst since 1997, burning about 261,000 hectares of forests and peatland and sending haze across the region for weeks. Many were deliberately set by companies to clear land for palm oil and pulpwood plantations.

The study in the journal Environmental Research Letters by Harvard and Columbia researchers estimated the amount of health-threatening fine particles, often referred to as PM2.5, released by the fires that burned from July to October and tracked their spread across south-east Asia using satellite observations.

26 September 2016

How Small Forests Can Help Save the Planet

Eve Lonnquist's family has owned a forest in the mountains of northwest Oregon since her grandmother bought the land in 1919. Her 95-year-old father still lives on the 157-acre property..... These family forests, environmental groups argue, represent a large, untapped resource for combating the effects of climate change.

26 September 2016

Soil modelling to help curb climate change

Soil is a major carbon pool, whose impact on climate change is still not fully understood. According to a recent study, however, soil carbon stocks and could be modelled more accurately by factoring in the impacts of both soil nutrient status and soil composition. Determining the volume of carbon dioxide efflux from soil is important to enabling better choices in forest management with respect to curbing climate change. Knowledge of the extent and regional variation of soil carbon stocks is vital. Current soil carbon stock predictions are unreliable and it is difficult to estimate the volume of carbon dioxide efflux that is emitted from soil as a result of climate change.

12 October 2016

Climate change has doubled Western U.S. forest fires

A new study says that human-induced climate change has doubled the area affected by forest fires in the U.S. West over the last 30 years. According to the study, since 1984 heightened temperatures and resulting aridity have caused fires to spread across an additional 16,000 square miles than they otherwise would have - an area larger than the states of Massachusetts and Connecticut combined. The authors warn that further warming will increase fire exponentially in coming decades. The study appears in the journal Proceedings of the National Academy of Sciences.

28 October 2016

Forests and finance trends — role of forests in meeting the Paris climate targets

While the Paris agreement solidified the role forests play in the fight against climate change, a recent report indicates that forest carbon trading is not working in developing countries and that voluntary carbon markets remained stagnant amid flagging demand in 2015. The findings comes from the latest State of Forest Carbon Finance report, released on Wednesday, which looked at the amount of money flowing into forest projects and government programs designed to reduce carbon dioxide emissions, in 2015. Forest carbon finance refers to the funding of initiatives designed to reduce deforestation, plant new trees and promote carbon-conscious land management — all of which results in a reduction of CO_2 emissions.

31 October 2016

Adapting to climate change – a major challenge for forests

Climate change is happening so quickly that a question mark hangs over whether forests can adapt accordingly without human interference and can continue to perform their various functions such as timber production, protection against natural hazards and providing a recreational space for the public. In Switzerland, temperatures have already risen by around 1.9°C since the beginning of industrialization. Even keeping global warming down to the 1.5-2°C target set by the Paris Agreement on climate change will yield a further increase of 1-2°C.

31 October 2016

Satellites help scientists see forests for the trees amid climate change

Scientists have found a way to use satellites to track photosynthesis in evergreens—a discovery that could improve our ability to assess the health of northern forests amid climate change. An international team of researchers used satellite sensor data to identify slight colour shifts in evergreen trees that show seasonal cycles of photosynthesis—the process in which plants use sunlight to convert carbon dioxide and water into glucose. Photosynthesis is easy to track in deciduous trees—when leaves bud or turn yellow and fall off. But until recently, it had been impossible to detect in evergreen conifers on a large scale.

2 November 2016

Indigenous rights are key to preserving forests, climate change study finds

The world's indigenous communities need to be given a bigger role in climate stabilisation, according to a new study that shows at least a quarter of forest carbon is stored on communal land, particularly in Brazil. The research by a group of academic institutions and environmental NGOs is the most comprehensive effort yet to quantify the contribution of traditional forest guardians to reduce emissions of greenhouse gases. Authors say the expansion of tribal land rights is the most cost-effective way to protect forests and sequester carbon – an issue that they hope will receive more prominence at the upcoming United Nations climate conference in Marrakech.

3 November 2016

Biggest threat to forests, beef lags in push to cut supply chain deforestation

More companies have promised to cut back deforestation in their supply chains for agricultural commodities since the Paris climate change deal last December, but progress in implementing those pledges is mixed, research groups said on Thursday. Under the New York Declaration on Forests, launched in September 2014, some 190 governments, companies, indigenous peoples' organisations, green groups and think tanks are aiming to help the private sector eliminate deforestation from the production of agricultural commodities by 2020. The first report to track such corporate sustainability promises said 108 companies had announced 212 new commitments since December 2015, boosting the total to 415 businesses. Levels vary between commodities: of around 630 companies assessed, 59 percent of those that source or produce palm oil had made commitments, and 53 percent in the wood and paper industry. But for soy, it was only 21 percent, and for cattle products as low as 12 percent. Those big four globally-traded commodities are responsible for 40 percent of deforestation.

9 November 2016

Forests absorb more carbon, buffer climate change

A slowdown in the rate of warming has triggered a "pause" in the atmosphere's uptake of carbon dioxide, shifting climate change into a lower gear. American and Australian -climate researchers say the world's forests have reacted to ballooning CO_2 levels, and a stalling in temperature growth over land, by sponging up more of the greenhouse gas. This triggered a pause in the growth rate of atmospheric CO_2 that lasted from 2002 until 2014. "Global ecosystems are slowing the rate at which CO_2 is -accumulating in the atmosphere, and thus slowing the rate of -climate change," said Trevor -Keenan, the lead author of the -report published in the journal Nature Communications.

10 November 2016

Collect Earth: Google and FAO launch new forest tool

Technology giant Google and the United Nations Food and Agriculture Organization on Tuesday unveiled a new digital tool that will allow countries to track land use change and calculate emissions reductions from avoiding deforestation more accurately. Called Collect Earth and presented at the United Nations climate change conference (COP 22) in Marrakesh, Morocco, the tool is the result of a partnership between Google and FAO inked last year, and will provide access to large collections of free, high-resolution satellite imagery and cloud computing services.

14 November 2016

Canadian and European boreal forests differ but neither is immune to climate change

Boreal forest covers an incredible 50 per cent of Canada's land mass and has evolved quite differently from the boreal forests of Northwestern Europe ..... The winters in the Canadian boreal forest are drier and 15 to 20C colder, with snow that is soft and shallow. In Northwestern Europe the winter is more mild and wet by comparison with deep snow that packs harder..... The difference in climate means the plant and animal species in both forests have evolved along two very different paths. There's no question that a shift in snow consistency and temperature will impact this immense ecosystem...

14 November 2016

Forest Value Must Be Defined To Implement Paris Agreement

A new approach to valuing the services provided by nature is the key to protecting the world's rainforests whilst reducing greenhouse gas emissions. Achieving this is one of the key steps towards transforming the Paris Agreement on climate change into visible action. To meet this goal the High Carbon Stock Approach (HCSA) must play a more prominent role in developing climate finance opportunities by making the value of forests clear, and linking them with both carbon targets and climate finance goals, proposed Aida Greenbury, Managing Director Sustainability, Asia Pulp & Paper Group and Co-Chair of the HCSA Steering Group during a HCS Steering Group event at COP22 in Morocco.

16 November 2016

Commercial Flight flies Cross-Country Using Renewable BioFuel

Washington state-based Alaska Airlines has made history flying the first commercial flight using the world's first renewable, alternative jet fuel made from forest residuals, the limbs and branches that remain after the harvesting of managed forests. The alternative jet fuel was produced through the efforts of the Washington State University-led Northwest Advanced Renewables Alliance (NARA). The demonstration flight departed Seattle-Tacoma International Airport earlier this morning for Reagan National Airport in Washington, D.C. The flight was fueled with a 20 percent blend of sustainable aviation biofuel, which is chemically indistinguishable from regular jet A fuel. The flight, the first commercial passenger flight of its kind, continues to advance viable alternatives to conventional fossil fuels for aviation.

16 November 2016

Peatlands protection seen key to preventing climate change 'tipping point'

The world's endangered peatlands need better protection or else climate change will spiral out of control, environmentalists said on Thursday at the launch of a global initiative to help prevent their destruction. Peatlands cover just 3 percent of the world's land surface, but contain twice as much carbon as the entire biomass of the world's forests. If they are drained or burned, that carbon is released as greenhouse gas into the atmosphere.

Fifteen percent of peatlands have already been drained, according to environmental data, and many more are under threat of being destroyed to make way for palm oil crops, pulp wood production and other uses. If this is allowed to happen, the resulting increase in emissions could raise temperatures enough to thaw permafrost - frozen soil, rock or sediment. This would in turn cause peatlands in Arctic and sub-Arctic regions to also release their carbon, according to the U.N. Environment Programme (UNEP) which is leading the initiative launched at international climate talks in Marrakesh.

III. EVENTS & MEETINGS

Recent events

24-27 October 2016
Global Environment Facility (GEF) Council Consultation Meeting with Civil Society Organization (CSOs), 51st GEF Council Meeting and 21st Meeting of the Least Developed Countries Fund and the Special Climate Change Fund (LDCF/SCCF) Council
The 51st meeting of the GEF Council was preceded on 24 October 2016, by a consultation with civil society organizations (CSOs). On 27 October 2016, the Council convened as the 21st meeting of the Least Developed Countries Fund (LDCF) and Special Climate Change Fund (SCCF).

7-18 November 2016
UN Climate Change Conference (COP22)
The twenty-second session of the Conference of the Parties (COP 22) and the twelfth session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP 12) were held in Bab Ighli, Marrakech, Morocco from 7-18 November 2016.

Upcoming events

28-30 November 2016: FAO, Rome, Italy
OLI to Develop Global Forest Indicators to Support Implementation of the 2030 Agenda and the International Arrangement on Forests (IAF) Strategic Plan
This organization-led initiative (OLI), hosted by the FAO, will provide a platform to propose a set of common, concise global indicators for input into negotiations on the UNFF Strategic Plan 2017-2030, to help monitor progress in achieving the forest-related SDGs and relevant goals and targets of other forest-related global processes. It will also provide input on a cycle and format for reporting, and provide guidance on the Global Forests Assessment 2020.

4-17 December 2016: *Cancún, Mexico*
CBD COP13, Cartagena Protocol on Biosafety COP/MOP8, and Nagoya Protocol on Access and Benefit-Sharing COP/MOP2
The 13th COP to the CBD, the 8th COP serving as the Meeting of the Parties (MOP) to the Cartagena Protocol on Biosafety and the 2nd COP serving as the MOP to the Nagoya Protocol on Access and Benefit-sharing will take place concurrently. The meetings will be preceded by a High Level Segment on 2-3 December.

13 December 2016 (10:00 EST/16:00 CET)
Jurisdictional Approaches to Zero Deforestation Commodities
This learning session organized by WWF Forest and Climate, will map the landscape of why, where, who, and how various actors are approaching the increasing convergence of these strategies to reduce deforestation and forest degradation related to commodity production. Register: http://bit.ly/2f3WBM7

16-20 January 2017: *UN Headquarters, New York*
UNFF Working Group and Special Session
The back-to-back meetings of the UN Forum on Forests (UNFF) Working Group and Special Session are expected to negotiate and endorse the Strategic Plan for 2017-2030 and the 4-year Programme of Work (4POW) for 2017-2020, based on recommendations submitted by the UNFF Ad Hoc Expert Group.

23-25 January 2017: FAO, Rome, Italy
Expert Meeting on Climate Change, Land Use and Food Security
This meeting will be co-hosted by the IPCC and the FAO. Further information will be made available at a later date.

IV. RESEARCH ARTICLES

Nonindustrial Private Forest Landowner Beliefs Toward Climate Change and Carbon Sequestration in the Southern United States

Khanal, Puskar N.; Grebner, Donald L.; Munn, Ian A.; Grado, Stephen C.; Grala, Robert K.; Henderson, James E.; Measells, Marcus K.

Journal of Forestry, Vol 114, Number 5, September 2016, pp. 524-531(8) https://doi.org/10.5849/jof.15-033

Carbon storage utilizing forests is one of the most important strategies for implementing climate change mitigation. Considering the potential of carbon storage in forests owned by nonindustrial private forest (NIPF) landowners, it is imperative to understand their views regarding climate change and carbon sequestration. This study segments NIPF landowners in the southern United States on the basis of their beliefs toward climate change and carbon sequestration. A K-means cluster analysis was used to segment their climate change and carbon sequestration beliefs into three broad clusters: skeptic, supportive, and neutral landowners. The results indicated that a majority of southern landowners (47%) held neutral beliefs, whereas the proportions of supportive and skeptical clusters were 35 and 18%, respectively. These belief clusters differ with respect to landowner income and education as well as their landownership and management characteristics. In terms of the future impact of climate change, 40% of landowners in the supportive cluster expected timber yield to fluctuate more than 5% on average but only 12% in the skeptic cluster expected it, whereas 24% of landowners in neutral cluster anticipated the same impact. Results of this study provide insights on the current beliefs of NIPF landowners toward climate change and carbon sequestration as well as strategies for effectively communicating climate change and carbon sequestration information to them.

Variation in total and volatile carbon concentration among the major tree species of the boreal forest

Gao, Bilei; Taylor, Anthony R.; Chen, Han Y.H.; Wanga, Jian

Forest Ecology and Management, Vol 375, 1 September 2016, pp. 191–199 http://dx.doi.org/10.1016/j.foreco.2016.05.041

Understanding variation in carbon (C) concentration of live trees is essential for quantifying forest C stocks and validating forest C accounting models. Previous studies in boreal forests have assumed 50% C concentration or focused on species-specific C concentration estimation based on samples taken mostly from stemwood tissue of large trees. Yet, little is known about differences in C concentration between woody tissues or among trees of different sizes nor about the effects of life-history traits, such as shade tolerance and the role of volatile C on total C concentration in live trees. In this study, we examined variation in total and volatile C concentration in bark and stemwood tissues for trees of different sizes for six major North American boreal tree species. We found that bark had significantly higher total C and volatile C concentrations than stemwood and that both total C and volatile C concentration significantly varied among tree species. The average total C concentrations were 56.2% in the bark and 50.5% in the stemwood, and the average volatile C concentration were 5.8% and 3.0% for bark and stemwood, respectively. Furthermore, total C and volatile C concentration in stemwood and bark of almost all shade-intolerant species increased with tree size, whereas those of shade-tolerant species showed negative or neutral size-associated change. Our results show that volatile C concentration is a key driver of variation in total C concentration and highlights the importance of considering variation in C concentration when quantifying forest C stocks, which has important consequences for predicting future global C emissions scenarios.

Melaleuca forests in Australia have globally significant carbon stocks

Tran, Da B.; Dargusch, Paul

Forest Ecology and Management, Vol 375, 1 September 2016, pp 230–237 http://dx.doi.org/10.1016/j.foreco.2016.05.028

Melaleuca forest is one of the unique ecosystems in Australia which plays an important role to provide carbon storage helping mitigation to the global climate change, thus understanding how much carbon can be stored in the types of forests is necessary. In this study, data was collected and analyzed from four typical sorts of Melaleuca forests in Australia including: primary Melaleuca forests subject to continuous water inundation; primary Melaleuca forests not inundated by water; degraded Melaleuca forests subject to continuous water inundation; and regenerating Melaleuca forests subject to continuous water inundation. The carbon stocks of these typical Melaleuca forests were 381; 278; 210; and 241 t ha−1 of carbon, respectively. Averagely, carbon stocks were 169 (±26) t ha−1 of carbon in the above-ground biomass and 104 (±16) t ha−1 of carbon in soil and roots. The results provide important information for the future sustainable management of Melaleuca forests at both the national and regional scales, particularly in regards to forest carbon conservation and carbon farming initiatives. The results establish that Melaleuca forests in Australia hold globally significant stores of carbon which are likely to be much higher than previously estimated and used in national emissions reporting.

Examining the influences of tree-to-tree competition and climate on size-growth relationships in hydric, multi-aged Fraxinus nigra stands

Looney, Christopher E.; D'Amato, Anthony W.; Fraver, Shawn; Palik, Brian J.; Reinikainen, Michael R.
Forest Ecology and Management Vol 375, 1 September 2016, pp 238–248 http://dx.doi.org/10.1016/j.foreco.2016.05.050

Most research on tree-tree competition and size-growth relationship (SGR – a stand-level metric that infers the relative efficiency with which different sized trees utilize available resources) has focused on upland systems. It is unclear if inferences from these studies extend to wetland forests. Moreover, no study to date has thoroughly investigated the relationship between individual tree-tree competition and SGR. To fill these research gaps, we conducted a dendrochronological study examining the relationship of tree-tree competition, SGR, and climate in late-successional *Fraxinus nigra* (black ash) wetland forests in northern Minnesota, USA. We took advantage of a detailed, stem-mapped dataset of 1670 trees in five late-successional, multi-aged stands to explore the following research questions: (1) how do competitive interactions, particularly size symmetry, influence individual-tree growth; (2) do late-successional *F. nigra* stands display inverse asymmetric SGR; and (3) do short-term variations in drought influence SGR in *F. nigra* wetland forests? Using neighbourhood competition indices, which characterize the growth of individual trees based on the size, number, and distance of competitors, we examined the nature and strength of individual tree-tree interactions. Additionally, we used SGR to determine how tree size and individual tree contributions to stand productivity relate to changes in stand growth and competitive interactions during stand development. At the individual tree level, we found evidence of size-asymmetric competition, with larger trees disproportionately suppressing the growth of smaller trees. However, tree size was a stronger predictor of growth than competition at all sites. At the stand level, our multi-aged *F. nigra* sites showed consistent patterns of inverse size-asymmetric SGR (i.e., smaller individual trees growing at disproportionately higher rates relative to larger trees), which is generally consistent with previous observations of mature upland forests and supports the hypothesis that large trees decline in relative growth as stands age. While seemingly counter-intuitive, the simultaneous presence of size-asymmetric individual tree-level competition and stand-level inverse asymmetric SGR suggests declines in large tree production efficiency. Drought effects on SGR, as expressed by PDSI, while sometimes evident, appeared weak on both relatively mesic and extremely wet sites. Our findings, which are consistent with previous studies of both *F. nigra* wetlands and upland forests, demonstrate that the combined results of individual-tree competition models and stand-level SGR can provide deeper insights into growth and competition in *F. nigra* and other forest types.

Light use efficiency and carbon storage in nutrient and water experiments on major forest plantation species

Albaugh, Timothy J.; Albaugh, Janine M.; Fox, Thomas R.; Allen, H. Lee; Rubilar, Rafael A.; Trichet, Pierre; Loustau, Denis; Linder, Sune
Forest Ecology and Management Vol 376, 15 September 2016, pp 333–342 http://dx.doi.org/10.1016/j.foreco.2016.05.031

We used published data from nine sites where nutrient and water optimization studies had been installed in a 2 × 2 factorial design to determine maximum biomass production in response to a simple set of treatments. We tested for site and treatment effects on the relationships between stem, aboveground (stem, branches, foliage) and total (aboveground + roots) biomass production versus intercepted light (light use efficiency, LUE). We also estimated the additional carbon stored as a result of treatment. The sites were located in Australia (*Pinus radiata*), Brazil (*Eucalyptus grandis* × *urophylla*), France (*Pinus pinaster*), the United States in Georgia and North Carolina (*Pinus taeda*) and Hawaii (*Eucalyptus saligna*), Portugal (*Eucalyptus globulus*), South Africa (*E. grandis*), and Sweden (*Picea abies*). We hypothesized that site, treatment and their interaction would significantly affect LUE; however, we rejected our hypothesis because stem, aboveground and total LUE were not affected by site or treatment. The stem, aboveground and total LUE values were 1.21, 1.51, and 0.85 g MJ^{-1}, respectively. The total LUE value was lower than that for stem and aboveground LUE because a different population was used for the analysis (only five of the nine sites had total production data), and the total LUE relationship had a zero intercept whereas the stem and aboveground LUE relationships had a negative intercept. The average amount of additional carbon that would be stored by the irrigation, fertilization, and fertilization plus irrigation treatments was 3.9, 6.8 and 13.4 Mg CO_2 equivalents ha^{-1} yr^{-1}, respectively. These additional carbon storage estimates, based on these research studies with annual nutrient and water applications, were similar to results obtained in operational settings with less intensive nutrient applications.

Spatial interpolators for improving the mapping of carbon stock of the arboreal vegetation in Brazilian biomes of Atlantic forest and Savanna

Scolforo, Henrique Ferraco; Scolforo, Jose Roberto Soares; de Mello, Jose Marcio; de Mello, Carlos Rogerio; Morais, Vinicius Augusto

Forest Ecology and Management Vol 376, 15 September 2016, pp 24–35 http://dx.doi.org/10.1016/j.foreco.2016.05.047

The aim of this study was to map aboveground carbon stock of arboreal vegetation in the Savanna and Atlantic forest biomes in Minas Gerais State, Brazil, in order to assess the best spatial technique for mapping. The dataset was obtained from 148 forest fragments of these biomes. The best form of mapping was based on statistical criteria and mapping quality. The exponential semivariogram model was selected for conducting the study. The geographical model developed in this study for regression-kriging application was fitted having as input longitude and biome variables, and, globally, has presented good spatial behaviour of the carbon stock distributed along the Minas Gerais State. From mapping carbon stock by different techniques, it was found that regression-kriging mapping was the most efficient. In addition, as the semivariograms were fitted for each biome using kriging and co-kriging, it is possible to stand out the flexibility for using regression-kriging, including biome as a categorical variable in the geographical model. Another result was the high correlation found between different forms of mapping, which adds reliability for this study. Thus, it was concluded that the carbon stock distribution in the arboreal vegetation of these two biomes is spatially structured. Ordinary kriging and co-kriging have presented satisfactory results, however, regression-kriging has been more reliable for mapping and estimating carbon stock distribution, in the Minas Gerais State.

Strong gradients in nitrogen and carbon stocks at temperate forest edges

Remy, Elyn; Wuyts, Karen; Boeckx, Pascal; Ginzburg, Shimon; Gundersen, Per; Demey, Andreas; Van Den Bulcke, Jan; Van Acker, Joris; Verheyen, Kris

Forest Ecology and Management Vol 376, 15 September 2016, pp 45–58 http://dx.doi.org/10.1016/j.foreco.2016.05.040

Due to forest fragmentation, forest edges have become dominant features in landscapes around the world. Forest edges are exposed to a different microclimate in terms of air and soil temperature, light availability, soil moisture and wind speed than the forest interior. Furthermore, forest edges catch more atmospheric deposition, due to obstruction of the wind profile causing advection and turbulent exchange. Coniferous forest types are subjected to higher N deposition due to their higher Leaf Area Index (LAI), evergreen character and higher collecting efficiency of needles compared to leaves. In Europe, highest deposition values coincide with intensive livestock breeding areas, such as northern Belgium. It is still unclear how this elevated atmospheric deposition affects N and carbon (C) stocks at temperate forest edges. We assessed the N and C stocks of the aboveground (leaves/needles, wood) and belowground (forest floor, coarse and fine roots, mineral soil) forest pools along edge-to-interior transects in six forests, located in Belgium (two oak and two pine forests) and in Denmark (two spruce forests) on sandy haplic podzols. The total stocks increased towards the forest edge by 30% for N and 43% for C, averaged over all forests, within a confidence interval of 95% (which was in some cases rather wide). The aboveground wood stocks increased by 56% for N and C, the root stocks by 48% for N and C and the mineral soil stocks increased by circa 30% for N and C. Soil C sequestration (calculated via a static N balance based on N throughfall and leaching) increased at the forest edges, being on average 646 and 289 kg ha^{-1} $year^{-1}$ in the forest edge and interior, respectively. Forest type effects were less prominent than edge effects, with no amplified edge effect on N and C stocks in the coniferous forest types. Nevertheless, our results show the importance of incorporating forest edges when monitoring C storage on a landscape scale. The question arises, however, how much longer such forest edges will continue to accrue additional C when subjected to continuously high atmospheric N deposition.

Soil types influence predictions of soil carbon stock recovery in tropical secondary forests

Paz, Claudia Pandolfo; Goosem, Miriam; Bird, Michael; Preece, Noel; Goosem, Steve; Fensham, Rod; Laurance, Susan

Forest Ecology and Management Vol 376, 15 September 2016, pp 74–83 http://dx.doi.org/10.1016/j.foreco.2016.06.007

Tropical forests are major sinks of terrestrial carbon (C) both above- and below-ground. As a consequence their destruction and degradation is considered the second largest anthropogenic source of carbon dioxide to the atmosphere. Also contributing to the changing dynamics of the global carbon cycle is the widespread and significant expansion of secondary forest. Secondary forests that colonise abandoned agricultural lands can potentially recover above-ground C stocks to historical levels in a few decades. However, the dynamics of below-ground C stored as soil C stocks are unaccounted for in several tropical regions. Similarly, although parent materials are known to differ in chemical and physical properties, little is known about the relationships of soil C stocks with environmental predictors and whether they interact with soil types during natural forest regeneration. We investigated whether soil organic carbon (SOC) stocks change with secondary forest age in two contrasting soil types (derived from either basalt or granite). Soil and vegetation parameters were analysed to determine the best predictors of SOC stock changes in secondary forests. SOC stocks from 24 secondary forests (up to 69 years since pasture abandonment)

were compared with those from active pastures and mature forests. We found that clay-rich soils (originating from basalt parent material) store higher amounts of SOC, although these stocks remain unchanged as secondary forests matured. In contrast, SOC stocks in granite soils tend to be lower in young secondary forests and increase rapidly to levels comparable to mature forests. Moreover, our analysis indicated that soil pH and woody plant diversity are strong candidates as predictors of SOC stock variations, yet it appears this is within the context of soil type. Our results support the contention that models predicting SOC stocks during forest succession should not rely only on secondary forest age. Instead, predictions of SOC stocks can be improved with the inclusion of basic information on vegetation cover and soil type (especially soil texture).

Climate-sensitive integrated stand growth model (CS-ISGM) of Changbai larch (Larix olgensis) plantations

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Forest growth modeling faces a new challenge of supporting forest management in the context of climate change. A traditional growth and yield model has the potential to be modified to function as a climate-sensitive model and thus could be applied to adaptive forest management. We developed a climate-sensitive integrated stand growth model (CS-ISGM) for larch plantations in Jinlin Province, northeast China. The parameters were estimated using systems of equations with errors-in-variables. Cross-validation using national forest inventory plot data showed that this model had better performance than the conventional ISGM model. The mean temperature of the driest quarter and precipitation of the wettest month were the most important climate predictors for the stand basal area and dominant height growth. The growth, productivity and mortality of the larch plantations were simulated using CS-ISGM with future climate scenarios (RCP2.5, RCP4.6, and RCP8.0) from 2040 to 2080. The results showed that future climate changes could facilitate stand growth and accelerate mortality. Compared with the current climate, the periodical annual increment (PAI) values were 12.23%, 10.43%, and 0.11% higher; the stand productivity (SP) values were 5.48%, 4.22% and 1.50% higher; and the mortality trees were 16.62%, 13.00% and 4.17% higher under the RCP2.6, RCP4.5 and RCP8.5 scenarios, respectively. Middle-aged and near-mature forests would have higher growth than young and mature forests, but near-mature, mature and over-mature forests would have higher mortality than young and middle-aged forests. This model could be used to project larch stand growth under future climate change conditions and adaptation measures according to the simulation results from different climate scenarios.

Declining water yield from forested mountain watersheds in response to climate change and forest mesophication

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Climate change and forest disturbances are threatening the ability of forested mountain watersheds to provide the clean, reliable, and abundant fresh water necessary to support aquatic ecosystems and a growing human population. Here, we used 76 years of water yield, climate, and field plot vegetation measurements in six unmanaged, reference watersheds in the southern Appalachian Mountains of North Carolina, USA to determine whether water yield has changed over time, and to examine and attribute the causal mechanisms of change. We found that annual water yield increased in some watersheds from 1938 to the mid-1970s by as much as 55%, but this was followed by decreases up to 22% by 2013. Changes in forest evapotranspiration were consistent with, but opposite in direction to the changes in water yield, with decreases in evapotranspiration up to 31% by the mid-1970s followed by increases up to 29% until 2013. Vegetation survey data showed commensurate reductions in forest basal area until the mid-1970s and increases since that time accompanied by a shift in dominance from xerophytic oak and hickory species to several mesophytic species (i.e., mesophication) that use relatively more water. These changes in forest structure and species composition may have decreased water yield by as much as 18% in a given year since the mid-1970s after accounting for climate. Our results suggest that changes in climate and forest structure and species composition in unmanaged forests brought about by disturbance and natural community dynamics over time can result in large changes in water supply.

Land-use change outweighs projected effects of changing rainfall on tree cover in sub-Saharan Africa

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Global change will likely affect savanna and forest structure and distributions, with implications for diversity within both biomes. Few studies have examined the impacts of both expected precipitation and land use changes on vegetation structure in the future, despite their likely severity. Here, we modeled tree cover in sub-Saharan Africa, as a proxy for vegetation structure and land cover change, using climatic, edaphic, and anthropic data (R2 = 0.97).

Projected tree cover for the year 2070, simulated using scenarios that include climate and land use projections, generally decreased, both in forest and savanna, although the directionality of changes varied locally. The main driver of tree cover changes was land use change; the effects of precipitation change were minor by comparison. Interestingly, carbon emissions mitigation via increasing biofuels production resulted in decreases in tree cover, more severe than scenarios with more intense precipitation change, especially within savannas. Evaluation of tree cover change against protected area extent at the WWF Ecoregion scale suggested areas of high biodiversity and ecosystem services concern. Those forests most vulnerable to large decreases in tree cover were also highly protected, potentially buffering the effects of global change. Meanwhile, savannas, especially where they immediately bordered forests (e.g. West and Central Africa), were characterized by a dearth of protected areas, making them highly vulnerable. Savanna must become an explicit policy priority in the face of climate and land use change if conservation and livelihoods are to remain viable into the next century.

A framework for prioritizing conservation translocations to mimic natural ecological processes under climate change: A case study with African antelopes

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Ongoing climate change is leading to significant range shifts in many taxa. Although climate-induced spatiotemporal dynamics have subtle implications for prioritization of translocation release areas, the terminology underlying current guidelines for conservation translocation remains focused on a dichotomy between 'reintroductions' within the indigenous range and 'assisted colonisations' anywhere else. We here propose a dispersal barrier-based framework for categorizing release areas according to their compatibility with natural ecological processes under climate change. Setting as a criterion that consistently suitable conditions are forecast over the timeframe considered, we define six translocation types corresponding to six translocation release zones: 'reinforcement' within the 'stable current range'; 'assisted dispersal sensu stricto' within the 'expected novel range'; 'compensatory dispersal' within the 'idealized novel range' (i.e. projected only if simulating absence of anthropogenic dispersal barriers); 'accelerated dispersal' within the 'expected connected envelope' (i.e. the spatiotemporally connected bioclimatic envelope beyond dispersal range); 'accelerated compensatory dispersal' within the 'idealized connected envelope' (i.e. unreachable connected envelope only if simulating absence of anthropogenic dispersal barriers); and 'artificial dispersal' within the 'unconnected envelope' (i.e. separated by natural physical barriers). Analysing projected range change in African antelopes by 2080, translocation across natural dispersal barriers was associated with elevated potential for interspecific competition with allopatric species and hence possible interference with ecosystem function. We argue that where translocation within the indigenous range is not an option, priority ranking of release sites would benefit from explicit consideration of dispersal barriers, favouring projected novel ranges above areas separated by distance and, especially, natural physical obstacles.

Current European policies are unlikely to jointly foster carbon sequestration and protect biodiversity

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The extension of forest area is a globally accepted tool to offset CO2 emissions from deforestation and the combustion of fossil fuels. The common assumption is that in addition to the perceived climate benefits increasing forest area will also support biodiversity, thus making afforestation a "win-win scenario". Based on the existing scientific evidences, we show that joined climate and biodiversity benefits are strongly context-dependent and that the outcome of afforestation is often highly questionable. In Europe, grasslands managed at low intensity contribute substantially to biodiversity conservation and carbon storage. However, many of these grasslands have been lost due to abandonment and subsequent spontaneous succession towards woody vegetation, or due to land use intensification. Moreover, grasslands are the ecosystems most often deliberately afforested in the context of EU carbon-centered policies that may thus counteract biodiversity conservation programmes. By reviewing the main EU policies targeting forests and grasslands, we found a striking ambivalence between policies and funding schemes addressing grassland conservation on the one hand (e.g. Habitats Directive, green payments within the Common Agricultural Policy) and those supporting afforestation on the other (e.g. rural development funds). We suggest three measures towards a better harmonization of the European Union policies that target forest and grassland ecosystems: (1) promoting the alignment of the decisions taken across different policy sectors; (2) focusing on the whole range of ecosystem services and biodiversity issues rather than on carbon management only; (3) valuing systems managed at low-intensity for their multifunctionality.

The El Niño - La Niña cycle and recent trends in supply and demand of net primary productivity in African drylands

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Climatic Change September 2016, Vol 138, Issue 1, pp 111–125 doi:10.1007/s10584-016-1730-1

Inter-annual climatic variability over a large portion of sub-Saharan Africa is under the influence of the El Niño-Southern Oscillation (ENSO). Extreme variability in climate is a threat to rural livelihoods in sub-Saharan Africa, yet the role of ENSO in the balance between supply and demand of net primary productivity (NPP) over this region is unclear. Here, we analyze the impact of ENSO on this balance in a spatially explicit framework using gridded population data from the WorldPop project, satellite-derived data on NPP supply, and statistical data from the United Nations. Our analyses demonstrate that between 2000 and 2013 fluctuations in the supply of NPP associated with moderate ENSO events average ± 2.8 g C m^{-2} $yr.^{-1}$ across sub-Saharan drylands. The greatest sensitivity is in arid Southern Africa where a + 1°C change in the Niño-3.4 sea surface temperature index is associated with a mean change in NPP supply of −6.6 g C m−2 $yr.^{-1}$. Concurrently, the population-driven trend in NPP demand averages 3.5 g C m^{-2} $yr.^{-1}$ over the entire region with densely populated urban areas exhibiting the highest mean demand for NPP. Our findings highlight the importance of accounting for the role ENSO plays in modulating the balance between supply and demand of NPP in sub-Saharan drylands. An important implication of these findings is that increase in NPP demand for socio-economic metabolism must be taken into account within the context of climate-modulated supply.

Sequestration of carbon from coarse woody debris in forest soils

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Worldwide, forests have absorbed around 30% of global anthropogenic emissions of carbon dioxide (CO_2) annually, thereby acting as important carbon (C) sinks. It is proposed that leaving large fragments of dead wood, coarse woody debris (CWD), in forest ecosystems may contribute to the forest C sink strength. CWD may take years to centuries to degrade completely, and non-respired C from CWD may enter the forest soil directly or in the form of dissolved organic C. Although aboveground decomposition of CWD has been studied frequently, little is known about the relative size, composition and fate of different C fluxes from CWD to soils under various substrate-specific and environmental conditions. Thus, the exact contribution of C from CWD to C sequestration within forest soils is poorly understood and quantified, although understanding CWD degradation and stabilization processes is essential for effective forest C sink management. This review aims at providing insight into these processes on the interface of forest ecology and soil science, and identifies knowledge gaps that are critical to our understanding of the effects of CWD on the forest soil C sink. It may be seen as a "call-to-action" crossing disciplinary boundaries, which proposes the use of compound-specific analytical studies and manipulation studies to elucidate C fluxes from CWD. Carbon fluxes from decaying CWD can vary considerably due to interspecific and intraspecific differences in composition and different environmental conditions. These variations in C fluxes need to be studied in detail and related to recent advances in soil C sequestration research. Outcomes of this review show that the presence of CWD may enhance the abundance and diversity of the microbial community and constitute additional fluxes of C into the mineral soil by augmented leaching of dissolved organic carbon (DOC). Leached DOC and residues from organic matter (OM) from later decay stages have been shown to be relatively enriched in complex and microbial-derived compounds, which may also be true for CWD-derived OM. Emerging knowledge on soil C stabilization indicates that such complex compounds may be sorbed preferentially to the mineral soil. Moreover, increased abundance and diversity of decomposer organisms may increase the amount of substrate C being diverted into microbial biomass, which may contribute to stable C pools in the forest soil.

Developing management strategies for tree improvement programs under climate change: Insights gained from long-term field trials with lodgepole pine

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The growing concern of the impact of climate change in forestry has prompted tree improvement programs and regulatory agencies to integrate climate change adaptation in the production and use of tree seed. In support of such adaptation strategies, we conducted a case study for lodgepole pine (*Pinus contorta* Dougl.) in Alberta, Canada. We compared the tree height for populations and families planted across 37 progeny and provenance trials when transferred among six physiogeographically and climatically distinct breeding regions. Based on these results we infer how lodgepole populations and families are adapted to current climate conditions and how they might respond to future changes in climate. Interestingly, in almost all regions we found that local populations grew better than introduced sources, suggesting that in the current climate the use of local populations is still an appropriate reforestation strategy with some exceptions. Notably, in cool and wet higher elevation environments

(between 1050 and 1650 m), local populations were outgrown by populations originating from warmer lower elevation regions. Moreover, these higher elevation populations were always outgrown when transferred to other regions. A number of transfers among regions were identified that ensure productivity gains under recent climate conditions, and simultaneously represent a short term adaptation measure for warming of about +0.5 °C. Further, we provide a database for selection of families within breeding populations to enhance their resilience to climate change.

Conversion from forests to pastures in the Colombian Amazon leads to contrasting soil carbon dynamics depending on land management practices

Navarrete, Diego; Sitch, Stephen; Aragão, Luiz E. O. C.; Pedroni, Lucio
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Strategies to mitigate climate change by reducing deforestation and forest degradation (e.g. REDD+) require country- or region-specific information on temporal changes in forest carbon (C) pools to develop accurate emission factors. The soil C pool is one of the most important C reservoirs, but is rarely included in national forest reference emission levels due to a lack of data. Here, we present the soil organic C (SOC) dynamics along 20 years of forest-to-pasture conversion in two subregions with different management practices during pasture establishment in the Colombian Amazon: high-grazing intensity (HG) and low-grazing intensity (LG) subregions. We determined the pattern of SOC change resulting from the conversion from forest (C3 plants) to pasture (C4 plants) by analysing total SOC stocks and the natural abundance of the stable isotopes 13C along two 20-year chronosequences identified in each subregion. We also analysed soil N stocks and the natural abundance of 15N during pasture establishment. In general, total SOC stocks at 30 cm depth in the forest were similar for both subregions, with an average of 47.1 ± 1.8 Mg C ha^{-1} in HG and 48.7 ± 3.1 Mg C ha^{-1} in LG. However, 20 years after forest-to-pasture conversion SOC in HG decreased by 20%, whereas in LG SOC increased by 41%. This net SOC decrease in HG was due to a larger reduction in C3-derived input and to a comparatively smaller increase in C4-derived C input. In LG both C3- and C4-derived C input increased along the chronosequence. N stocks were generally similar in both subregions and soil N stock changes during pasture establishment were correlated with SOC changes. These results emphasize the importance of management practices involving low-grazing intensity in cattle activities to preserve SOC stocks and to reduce C emissions after land-cover change from forest to pasture in the Colombian Amazon.

Shape selection in Landsat time series: a tool for monitoring forest dynamics

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We present a new methodology for fitting nonparametric shape-restricted regression splines to time series of Landsat imagery for the purpose of modeling, mapping, and monitoring annual forest disturbance dynamics over nearly three decades. For each pixel and spectral band or index of choice in temporal Landsat data, our method delivers a smoothed rendition of the trajectory constrained to behave in an ecologically sensible manner, reflecting one of seven possible 'shapes'. It also provides parameters summarizing the patterns of each change including year of onset, duration, magnitude, and pre- and postchange rates of growth or recovery. Through a case study featuring fire, harvest, and bark beetle outbreak, we illustrate how resultant fitted values and parameters can be fed into empirical models to map disturbance causal agent and tree canopy cover changes coincident with disturbance events through time. We provide our code in the r package ShapeSelectForest on the Comprehensive R Archival Network and describe our computational approaches for running the method over large geographic areas. We also discuss how this methodology is currently being used for forest disturbance and attribute mapping across the conterminous United States.

Soil carbon stock changes due to edge effects in central Amazon forest fragments

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Amazon forest stocks large quantities of carbon both in plant biomass and in soil. Deforestation has accelerated the process of forest fragmentation in the Brazilian Amazon, resulting in changes in carbon stocks in both biomass and soil. Logging, including that under legal forest management, can create edge-like conditions inside the forest. We investigated the relationship between changes in carbon stocks in the soil and the distance to the nearest edge in forest remnants after about 30 years of isolation. We assessed the effect of edges using geographically weighted regression (GWR), which considers the non-stationary character of soil carbon stocks and assigns relative weights to the observations according to the distance between them. Data from 265 georeferenced plots distributed over 28 ha of forest fragments in the Manaus region were included in these analyses. Soil-carbon stocks were estimated for areas before (1984–1986) and after (2012–2013) isolation of the fragments. The GWR model indicated an

apparent relationship between change in carbon stocks and distance from the edge (R2 = 0.79). The largest changes occurred in plots located closest to the edges. In 202 plots ⩽100 m from an edge, soil-carbon stock increased significantly (p = 0.01) by a mean of 1.34 Mg ha^{-1} over the ~30-year period. Such changes in soil carbon stocks appear to be associated with higher rates of tree mortality caused by microclimatic changes in these areas. Increased necromass inputs combined with changes in composition and structure of vegetation may result in increased rates of decomposition of organic matter, transferring carbon to the soil compartment and increasing soil carbon stocks. Considering both "hard" edges adjacent to deforestation and "soft" edges in logging areas, the soil-carbon increase we measured implies an absorption of 6 × 106 MgC in Brazilian Amazonia. In hard edges maintained for ~30 years, the soil-carbon increase offsets 8.3% of the carbon losses from "biomass collapse" in the first 100 m from a clearing. Soil carbon did not change significantly in 63 forest-interior plots, suggesting that global climate change has not yet had a detectible effect on this forest carbon compartment.

Effects of climate on the radial growth of white ash infested with emerald ash borer

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Emerald ash borer (EAB) (*Agrilus planipennis* Fairmaire), is a non-native beetle responsible for widespread mortality of several North American ash species (*Fraxinus sp.*). The objective of this study was to examine the effects of climate on the radial growth of white ash (*Fraxinus americana*) infested with emerald ash borer. Sites with infested white ash from different land-use categories (i.e., natural forests vs. high-use recreational areas) were selected along a latitudinal gradient in the eastern Lower Peninsula of Michigan. Infested trees were selectively sampled based on predetermined crown condition (vigour) classes and categorized into two levels of EAB infestation severity (i.e. low vs. high). Sampling of 3 control regions in the northern Lower Peninsula, and western Upper Peninsula were based on measuring trees that were visually healthy (no major crown mortality or visible signs and symptoms of EAB). Dendroclimatic analyzes indicated that radial growth of white ash in the three northern control regions were the only groups to have a negative response to winter snowfall, indicating a latitudinal sensitivity. Dendroclimatic analyzes also indicated that white ash in Michigan across the control regions and EAB impacted latitudinal regions, land-use categories, and EAB infestation levels, was shown to have a strong negative relationship with precipitation and available moisture in the summer of the previous year. A negative response in the current year's radial growth due to the climate moisture index at the end of the growing season for trees with higher severity EAB infestation levels was also observed. The negative relationship with summer precipitation and moisture index suggested that crown canopies may be damaged by strong winds associated with storm events characteristic of Michigan summers. Increased risk of branch failure due to EAB infestation may further increase ash susceptibility to wind damage. Since moisture levels have also been shown to be important for EAB larval development, it is possible that the negative responses of radial growth to precipitation at the end of the growing season may benefit EAB larval development, thereby reducing radial growth of white ash.

Response of floodplain pedunculate oak (Quercus robur L.) tree-ring width and vessel anatomy to climatic trends and extreme hydroclimatic events

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Increasing temperatures and recent changes in runoff regimes observed in Central Europe might alter the growth and relative water uptake of floodplain trees. To predict responses of floodplain forests to climate change, it is necessary to determine the climatic controls over tree growth and vessel anatomy. We analysed the responses of tree-ring width and earlywood vessel anatomical parameters (average vessel lumen area, vessel density and total vessel lumen area) of pedunculate oak (*Quercus robur* L.) growing in a floodplain to hydroclimatic conditions represented by temperature, the drought index (scPDSI), river discharge, groundwater level, and occurrence of floods and drought events. Site chronologies were assembled for floodplain and reference sites and, subsequently, correlated with time series of hydroclimatic conditions. Our results show that radial growth of floodplain trees is particularly positively influenced by temperature during the growing season and during previous year's summer. By contrast, the growth of reference trees is highly drought-limited. Earlywood average vessel lumen area chronologies from both floodplain and reference sites share a positive temperature signal from January to April. However, the effect of water availability (indicated by the drought index) on vessel size is mostly negative for floodplain trees (with a maximum response to the autumn of the year preceding tree-ring formation) and positive or non-significant for reference trees. Vessel density chronologies contain the inverse environmental information as tree-ring width, however, with amplified negative correlations with current year temperatures at floodplain sites. Total vessel area is associated mostly with temperature in previous May and June. The drought index recorded exactly the same information in tree-rings as did river discharges and groundwater levels. The results of both correlation and trend analysis evidence that tree-ring width of floodplain *Q. robur* unambiguously increases with increasing temperature; on the other hand, droughts can become a serious problem affecting the productivity of

reference trees growing in more distal parts of the lowland. Vessel size of *Q. robur* growing outside the floodplain recently tends to increase with increasing temperatures, making xylem more effective at water transport but also more vulnerable to cavitation.

Assessing intra- and inter-regional climate effects on Douglas-fir biomass dynamics in Oregon and Washington, USA

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While ecological succession shapes contemporary forest structure and dynamics, other factors like forest structure (dense vs. sparse canopies) and climate may alter structural trajectories. To assess potential sources of variation in structural trajectories, we examined proportional biomass change for a regionally dominant tree species, Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), across vegetation zones representing broad gradients in precipitation and temperature with 3510 forest inventory plots in Oregon and Washington, USA. We found that *P. menziesii* biomass change decreased with *P. menziesii* biomass stocks and increased with *P. menziesii* density, remaining positive in older stands only in the wet and warm vegetation zone. Within two of the vegetation zones, biomass change was greatest in warm and wet environments. In dry vegetation zones, positive *P. menziesii* biomass change responses to initial canopy cover and canopy cover change (i.e., increases with cover loss and decreases with cover gain) indicated shifts in forest structure. Variation in *P. menziesii* biomass dynamics within and between vegetation zones imply multi-scale climatic controls on forest structural trajectories for *P. menziesii* and highlight the potential for continued atmospheric carbon sequestration in warm and wet forests of the Pacific Northwest for both young and old forests, given that future climatic conditions support similar forest dynamics.

Contributing factors for drought in United States forest ecosystems under projected future climates and their uncertainty

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Observations of increasing global forest die-off related to drought are leading to more questions about potential increases in drought occurrence, severity, and ecological consequence in the future. Dry soils and warm temperatures interact to affect trees during drought; so understanding shifting risks requires some understanding of changes in both temperature and precipitation. Unfortunately, strong precipitation uncertainties in climate models yield substantial uncertainty in projections of drought occurrence. We argue that disambiguation of drought effects into temperature and precipitation-mediated processes can alleviate some of the implied uncertainty. In particular, the disambiguation can clarify geographic diversity in forest sensitivity to multifarious drivers of drought and mortality, making more specific use of geographically diverse climate projections. Such a framework may provide forest managers with an easier heuristic in discerning geographically diverse adaptation options. Warming temperatures in the future mean three things with respect to drought in forests: (1) droughts, typically already unusually hot periods, will become hotter, (2) the drying capacity of the air, measured as the vapour pressure deficit (VPD) will become greater, and (3) a smaller fraction of precipitation will fall as snow. More hot-temperature extremes will be more stressful in a direct way to living tissue, and greater VPD will increase pressure gradients within trees, exacerbating the risk of hydraulic failure. Reduced storage in snowpacks reduces summer water availability in some places. Warmer temperatures do not directly cause drier soils, however. In a hydrologic sense, warmer temperatures do little to cause “drought” as defined by water balances. Instead, much of the future additional longwave energy flux is expected to cause warming rather than evaporating water. Precipitation variations, in contrast, affect water balances and moisture availability directly; so uncertainties in future precipitation generate uncertainty in drought occurrence and severity projections. Although specific projections in annual and seasonal precipitation are uncertain, changes in inter-storm spacing and precipitation type (snow vs. rain) have greater certainty and may have utility in improving spatial projections of drought as perceived by vegetation, a value not currently captured by simple temperature-driven evaporation projections. This review ties different types of future climate shifts to expected consequences for drought and potential influences on physiology, and then explains sources of uncertainty for consideration in future mortality projections. One intention is to provide guidance on partitioning of uncertainty in projections of forest stresses.

Observed and anticipated impacts of drought on forest insects and diseases in the United States

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Future anthropogenic-induced changes to the earth's climate will likely include increases in temperature and changes in precipitation that will increase the frequency and severity of droughts. Insects and fungal diseases are important disturbances in forests, yet understanding of the role of drought in outbreaks of these agents is limited. Current knowledge concerning the effects of drought on herbivorous insect and pathogen outbreaks in U.S. forests is reviewed, and compared between the relatively mesic and structurally diverse forests of the eastern U.S. and the more xeric forests of the western U.S. Theory and limited evidence suggests a non-linear relationship between drought intensity and outbreaks of aggressive bark beetle species (i.e., those capable of causing extensive levels of tree mortality), where moderate droughts reduce bark beetle population performance and subsequent tree mortality, whereas intense droughts, which frequently occur in the western U.S., increase bark beetle performance and tree mortality. There is little evidence for a role of drought in outbreaks of the southern pine beetle (*Dendroctonus frontalis*), the only bark beetle species that causes large amounts of tree mortality in the eastern U.S. Defoliators do not show consistent responses to drought. The response of sapfeeders to drought appears non-linear, with the greatest performance and impacts at intermediate drought intensity or when drought is alleviated by wetter periods. Interactions between tree pathogens and drought are poorly understood, but available evidence suggests reduced pathogen performance and host impacts in response to drought for primary pathogens and pathogens whose lifecycle depends directly on moisture (humidity). In these cases, rates of reproduction, spread, and infection tend to be greater when conditions are moist. In contrast, secondary fungal pathogens (i.e., those that depend on stressed hosts for colonization) are anticipated to respond to drought with greater performance and host impacts. In the western U.S., drought increases stress on trees severely infected by mistletoes thereby predisposing mistletoe-infected trees to attack by insects, particularly bark beetles and wood borers. Research needed to advance understanding of drought impacts on forest insects and diseases, and the role of forest management in mitigation of infestations during drought are discussed.

Carbon storage in a restored mangrove forest in Can Gio Mangrove Forest Park, Mekong Delta, Vietnam

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Mangrove forests are considered to be the most important carbon (C) sink in the tropics. Evaluation of ecosystem C storage in restored mangrove forests will provide important information for management and conservation practices, climate change mitigation strategies and reduction of emissions from deforestation and forest degradation (REDD+) schemes. Despite this, a gap remains in the understanding of ecosystem C storage in Can Gio Mangrove Forest Park (CGM), the largest restored mangrove forest area in the Mekong Delta, Vietnam. In the present study, ecosystem C storage was quantified in CGM in growing mangrove forests, a typhoon disturbed forest, and a mudflat by measuring the biomass of trees, roots, downed woody debris, sediment organic C, and overall depth. The mean above-ground C storage was 102 ± 24.7, 298.1 ± 14.1 and 243.6 ± 40.4 MgC ha^{-1} for fringe, transition, and interior forests, respectively. The high above- and below-ground C stocks resulted in high ecosystem C storage, ranging from 765 to 1026 MgC ha^{-1}, with an overall mean of 910.7 ± 32.3 MgC ha^{-1}. The ecosystem C storage of the typhoon disturbed forest and mudflat was less than that of mangrove forests, with values of 573.5 MgC ha^{-1} and 619.8 ± 24.3 MgC ha^{-1}, respectively. At the regional scale, CGM can store up to 41.5 Tg C, which is equivalent to 152.3 Tg of CO2e. The results of the present study suggest that mangrove restoration and conservation are effective tools for enhancing C storage and offsetting C emissions at both regional and national scales.

Influence of disturbances and climate on high-mountain Norway spruce forests in the Low Tatra Mts., Slovakia

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Survival and growth of trees in high-mountain regions is limited by harsh environmental conditions, and is therefore sensitive to climate change. The main aims of this study were to develop the regional boundary line for high-mountain spruce forests of the Low Tatra Mts., to reconstruct and compare the disturbance regime of investigated localities, and to present the impact of recent climate change on release potential of Norway spruce. The study area included three localities with forest stands dominated by Norway spruce that were selected to represent the altitudinal zone 1200–1500 m a.s.l., excluding the tree line and extreme sites. In order to determine the most important climate characteristics driving tree growth, site chronologies were computed from the sample cores of

dominant and co-dominant trees, and correlations between chronologies and monthly climate variables from the previous May to the current September were computed for the period 1901–2008. Analysis of release potential and disturbance histories was performed using the boundary line method. Uniform macro-climate and site conditions in the selected region enabled to construct the regional boundary line for Norway spruce in the Low Tatra. The comparison between boundary lines developed for Norway spruce in the Low Tatra and the other regions showed considerable differences. Therefore, in the high-mountain conditions, the transfer of boundary lines from other regions cannot be recommended. In investigated localities, we identified different disturbance regimes that resulted in variable stand structures and modified the growth responsiveness of Norway spruce to climate. A higher sensitivity to previous October temperature was observed in the most disturbed locality, whereas the growth of Norway spruce on the site with the lowest disturbance rates showed the highest correlation with current June–July temperature. After 1990, we registered enhanced release potential of Norway spruce accompanied by the increase of disturbance rates. Increased release potential was detected even for the trees older than 150 years.

Modeling dominant height growth of eucalyptus plantations with parameters conditioned to climatic variations

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Dominant height growth equations, which given at some base age is defined as site index, is usually used to assess site quality. A flexible and accurate way to represent the potential productive capacity of forest stands of Eucalyptus spp. was developed. The generalized algebraic difference method was used, in which 15 dynamic equations were tested for modeling dominant height growth. The models were fitted to a data set derived from permanent plots located in the states of Bahia (BA) and Espirito Santo (ES), Brazil, with clonal eucalyptus plantations. The database was analyzed separately for the clear-cut and coppice regimes. The selection of the best-fitting model for each management regime was based on statistical fitting, predictive validation, and graphical analysis. After selection of the best model, one of its parameters were expanded with the addition of climatic variables that allowed for the creation of scenarios. The polymorphic modified Von Bertalanffy-Richards model with a single asymptote performed the best for the two management regimes. For clear-cut management, conditioning the slope parameter by the mean monthly precipitation obtained the best performance. For coppice management, the asymptote parameter conditioned by the mean monthly precipitation and its distribution throughout the year provided the best performance. The inclusion of the climate modifiers added flexibility for the models, which was represented by the interannual variations of precipitation. Expansions of the parameters did not mischaracterize the behaviour of the modified Von Bertalanffy-Richards model for the management regimes studied. Climatic conditioning of the parameters of the slope and asymptote for the two management regimes led to accuracy gains in the estimates. Additionally, this enabled the generation of productivity scenarios based on the amount and distribution of the total precipitation for the areas under study.

Predicting the responses of forest distribution and aboveground biomass to climate change under RCP scenarios in southern China

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Global Change Biology Vol 2, Issue 11, November 2016 pp 3642–3661DOI: 10.1111/gcb.13307

In the past three decades, our global climate has been experiencing unprecedented warming. This warming has and will continue to significantly influence the structure and function of forest ecosystems. While studies have been conducted to explore the possible responses of forest landscapes to future climate change, the representative concentration pathways (RCPs) scenarios under the framework of the Coupled Model Intercomparison Project Phase 5 (CMIP5) have not been widely used in quantitative modeling research of forest landscapes. We used LANDIS-II, a forest dynamic landscape model, coupled with a forest ecosystem process model (PnET-II), to simulate spatial interactions and ecological succession processes under RCP scenarios, RCP2.6, RCP4.5 and RCP8.5, respectively. We also modeled a control scenario of extrapolating current climate conditions to examine changes in distribution and aboveground biomass (AGB) among five different forest types for the period of 2010–2100 in Taihe County in southern China, where subtropical coniferous plantations dominate. The results of the simulation show that climate change will significantly influence forest distribution and AGB. (i) Evergreen broad-leaved forests will expand into Chinese fir and Chinese weeping cypress forests. The area percentages of evergreen broad-leaved forests under RCP2.6, RCP4.5, RCP8.5 and the control scenarios account for 18.25%, 18.71%, 18.85% and 17.46% of total forest area, respectively. (ii) The total AGB under RCP4.5 will reach its highest level by the year 2100. Compared with the control scenarios, the total AGB under RCP2.6, RCP4.5 and RCP8.5 increases by 24.1%, 64.2% and 29.8%, respectively. (iii) The forest total AGB increases rapidly at first and then decreases slowly on the temporal

dimension. (iv) Even though the fluctuation patterns of total AGB will remain consistent under various future climatic scenarios, there will be certain responsive differences among various forest types.

Large-scale impact of climate change vs. land-use change on future biome shifts in Latin America

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Global Change Biology Vol 22, Issue 11, November 2016 pp 3689–3701 DOI: 10.1111/gcb.13355

Climate change and land-use change are two major drivers of biome shifts causing habitat and biodiversity loss. What is missing is a continental-scale future projection of the estimated relative impacts of both drivers on biome shifts over the course of this century. Here, we provide such a projection for the biodiverse region of Latin America under four socio-economic development scenarios. We find that across all scenarios 5–6% of the total area will undergo biome shifts that can be attributed to climate change until 2099. The relative impact of climate change on biome shifts may overtake land-use change even under an optimistic climate scenario, if land-use expansion is halted by the mid-century. We suggest that constraining land-use change and preserving the remaining natural vegetation early during this century creates opportunities to mitigate climate-change impacts during the second half of this century. Our results may guide the evaluation of socio-economic scenarios in terms of their potential for biome conservation under global change.

Short-term climate change manipulation effects do not scale up to long-term legacies: effects of an absent snow cover on boreal forest plants

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Journal of Ecology Vol 104, Issue 6 November 2016 DOI: 10.1111/1365-2745.12636

Despite time-lags and nonlinearity in ecological processes, the majority of our knowledge about ecosystem responses to long-term changes in climate originates from relatively short-term experiments. We utilized the longest ongoing snow removal experiment in the world and an additional set of new plots at the same location in northern Sweden to simultaneously measure the effects of long-term (11 winters) and short-term (1 winter) absence of snow cover on boreal forest understorey plants, including the effects on root growth and phenology. Short-term absence of snow reduced vascular plant cover in the understorey by 42%, reduced fine root biomass by 16%, reduced shoot growth by up to 53% and induced tissue damage on two common dwarf shrubs. In the long-term manipulation, more substantial effects on understorey plant cover (92% reduced) and standing fine root biomass (39% reduced) were observed, whereas other response parameters, such as tissue damage, were observed less. Fine root growth was generally reduced, and its initiation delayed by c. 3 (short-term) to 6 weeks (long-term manipulation).

Projected changes in area of the Sundarban mangrove forest in Bangladesh due to SLR by 2100

Payo, A.; Mukhopadhyay, A.; Hazra, S. et al.

Climatic Change Vol 139, Issue 2, November 2016, pp 279–291 doi:10.1007/s10584-016-1769-z

The Sundarbans mangrove ecosystem, located in India and Bangladesh, is recognized as a global priority for biodiversity conservation and is an important provider of ecosystem services such as numerous goods and protection against storm surges. With global mean sea-level rise projected as up to 0.98 m or greater by 2100 relative to the baseline period (1985–2005), the Sundarbans – mean elevation presently approximately 2 m above mean sea-level – is under threat from inundation and subsequent wetland loss; however the magnitude of loss remains unclear. We used remote and field measurements, geographic information systems and simulation modelling to investigate the potential effects of three sea-level rise scenarios on the Sundarbans within coastal Bangladesh. We illustrate how the Sea Level Affecting Marshes Model (SLAMM) is able to reproduce the observed area losses for the period 2000–2010. Using this calibrated model and assuming that mean sea-level is a better proxy than the SLAMM assumed mean lower low water for Mangrove area delineation, the estimated mangrove area net losses (relative to year 2000) are 81–178 km^2, 111–376 km^2 and 583–1393 km^2 for relative sea-level rise scenarios to 2100 of 0.46 m, 0.75 m and 1.48 m, respectively and net subsidence of ±2.5 mm/year. These area losses are very small (<10 % of present day area) and significantly smaller than previous research has suggested. Our simulations also suggest that erosion rather than inundation may remain the dominant loss driver to 2100 under certain scenarios of sea-level rise and net subsidence. Only under the highest scenarios does inundation due to sea-level rise become the dominant loss process.

V. PUBLICATIONS, REPORTS AND OTHER MEDIA

Forests in the Climate Change Agenda: Unasylva 246

FAO 2016 / 88 pages

The articles cover a range of aspects relating to the role of forests in the climate change agenda. Together they provide a comprehensive overview, both for those already versed in the complexities of the issues and those who would like to gain a better grasp of them. Readers will be able to gain better insight into the background and status of ongoing climate negotiations, the functioning of mechanisms and initiatives such as reducing emissions from deforestation and forest degradation (REDD+), and where these stand in the international architecture. They will also discover several interesting and innovative success stories that point the way to some avenues for further exploration.

The State of Food and Agriculture 2016: Climate change, agriculture and food security

FAO 2016 / 173 pages

The Paris Agreement, adopted in December 2015, represents a new beginning in the global effort to stabilize the climate before it is too late. It recognizes the importance of food security in the international response to climate change, as reflected by many countries focusing prominently on the agriculture sector in their planned contributions to adaptation and mitigation. To help put those plans into action, this report identifies strategies, financing opportunities, and data and information needs. It also describes transformative policies and institutions that can overcome barriers to implementation.

FAO's work on climate change

FAO 2016 / 35 pages

This publication presents FAO's key messages on climate change and food security. It includes examples of FAO's support to countries so they are better able to adapt to the impacts of climate change in the agricultural sectors. It also brings together FAO's most up-to-date knowledge on climate change, including the tools and methodologies used to support countries' climate commitments and action plans.

A **series of infographic booklets** presenting key facts and figures on climate change and the agricultural sectors accompanies this publication.

The Agriculture Sectors in the Intended Nationally Determined Contributions: summary

FAO – 2016 / 11 pages

The Food and Agriculture Organization of the United Nations (FAO) has analyzed the INDCs and found that the agriculture sectors (crops, livestock, forestry, fisheries and aquaculture) feature prominently in meeting national mitigation contributions and adaptation objectives. This is a clear signal: the agriculture sectors are central to the response to climate change. This document is a summary of the FAO working paper, 'The agriculture sectors in the Intended Nationally Determined Contributions – an Analysis'. The working paper is available at http://www.fao.org/3/a-i5687e.pdf.

Guidelines on urban and peri-urban forestry

FAO 2016 / 170 pp

These guidelines are the result a consultative process that involved a large number of practitioners from both developed and developing countries. Two meetings were held in Glasgow and Delhi and a tentative outline was agreed upon. The guidelines are intended to provide a reference framework for decision makers and planners to adequately plan, design and manage the forest and trees in and around their cities. The document will include a general overview of the role of urban and peri-urban forests (UPF) towards a sustainable urban development, as well as specific chapters recommending policy and management actions to be taken to maximize UPF contribution in addressing both global and local challenges.

VI. JOBS

Green Climate Fund (GCF) Project Support Consultant

FAO-REU – Application deadline, 30 November 2016

Under the direct supervision of the Climate Change and Energy Coordinator for Europe and Central Asia (REUT) in close collaboration with other officers and consultants, the Green Climate Fund (GCF) Project Support Consultant will contribute to FAO's Green Climate Fund's work, specifically:

- Provide technical support and guidance to FAO's country offices with regard to the design and formulation of GCF and other related CC and environmental projects, which include e.g. contribute to the collection and analysis of relevant country data and information; support the identification of the relevant stakeholders that will be involved and beneficiaries who will be targeted; support the development of the project design with regard to establishment of expected project outcome and impact, objectives and project activities as well as support and guide the development of the results based framework, including the identification of indicators, outputs, means of verification and development of work plan and Gantt chart.
- The design and support country-led and regional project formulation on topics such climate change adaptation, climate-smart agriculture, disaster risk reduction, combatting land and forest degradation and sustainable forest managements need to be in line with the GCF's requirements and conditions, take into account countries' specific context and needs as well as demonstrate FAO's advantages to facilitate and technically support the implementation of these projects.
- Develop information materials, such as guidance document, bulletins, flyers, power point presentations, on the GCF projects for dissemination through REU region.
- Act as a liaison between the Regional Office for Europe and Central Asia (REU) and HQ's Climate, Energy and Tenure Division (NRC) with regard to coordination, collaboration and communication on GCF issues.
- Perform any other related duties and activities as required.

Chief of Party, Cambodia Prey Lang Extended Landscape Initiative

Winrock International – Application deadline, 15 December 2016

Winrock is seeking Chief of Party candidates for the upcoming USAID-funded Cambodia Prey Lang Extended Landscape Initiative. The initiative will improve biodiversity conservation and ecosystem health in Prey Lang extended landscape, increase sustainable economic opportunities and natural capital reinvestment and strengthen inclusive and effective landscape governance.

This position is contingent upon receipt of donor funding.

Forestry Program Officer

Winrock International – Application deadline, until suitable applicant is found

The Forestry Program Officer is an important technical role within the American Carbon Registry (ACR), providing support to the Director of Forestry, and other members of ACR staff on all aspects of registry management, including, but not limited to reviewing project listing applications, data reporting and verification documents; formulating responses to technical questions raised by project developers and verification bodies; supporting business development and outreach activities; and helping to coordinate the development and/or approval of new quantification methodologies.

CLIM-FO INFORMATION

The **objective** of CLIM-FO-L is to compile and distribute recent information about climate change and forestry. CLIM-FO-L is issued each month.

Past issues of CLIM-FO-L are available on the website of ***FAO Forest and Climate Change***:

http://www.fao.org/forestry/climatechange/en/

For technical help or questions contact **CLIM-FO-Owner@fao.org**

The Newsletter is prepared by:

Editor-in-chief: Simmone Rose

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