CLIM-FO Climate Change & Forestry

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FAO, Forestry Department, Forest and Climate Change Team
Food and Agriculture Organization of the United Nations

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I. IN THE PRESS

September 2014 - IISD

Blue Carbon Initiative Helps Assess Coastal Ecosystems Carbon Stocks

The Blue Carbon Initiative, co-led by Conservation International (CI), the International Union for Conservation of Nature (IUCN) and the Intergovernmental Oceanic Commission (IOC) of the UN Educational, Scientific and Cultural Organization (UNESCO), has produced a manual, titled 'Coastal Blue Carbon: Methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrass meadows.'

12 September 2014 - Global Landscapes Forum

FAO short films covering the whole landscape

Vietnam is increasing its forest area by one percent every year. In Finland, one of the leading countries of sustainable forest management, destruction of forests is expressly prohibited by law. More than 90 percent of the sellers of forest produce are women. Russia's far east is the ground of one tenth of the world's forests that are threatened by illegal logging.

11 September 2014 - SNV

Eco-shrimp production and mangrove restoration in Ca Mau, Vietnam: a short documentary

Mangrove forests play a vital role in preserving the ecosystem from coastal protection to carbon capture. However, in the past 50 years, half of Vietnam's mangrove forests have been lost due to aquaculture expansion in particular, shrimp production. SNV and the International Union for Conservation of Nature (IUCN) have been working together on a programme integrating mangrove protection and organic shrimp farming, called Mangroves and Markets (MAM). To celebrate the successes of this project IUCN and SNV have made a documentary feature.

11 September 2014 - The Guardian

UN Climate Summit must show climate change action is in everyone's interests

UN Secretary General, Ban Ki Moon, will host the Climate Summit in New York on 23 September, bringing together more than 100 heads of state, along with chief executives, city mayors, and civil society and labour leaders, to spur renewed efforts on climate change. The summit aims to underscore not just the urgency of low-carbon, resilient development, but also that acting on climate can advance the direct interests of nations, businesses and communities.

10 September 2014 - World Agroforestry Centre

Which agroforest for which farm under changing climates?

Climate change is often thought to mean rising temperatures, drought and stronger typhoons. However, it is not limited to only extreme events. The impacts of climate change also reach the agricultural sector, affecting, to name but a few, the yields, incomes and security of supply of nutritious food of the many millions of smallholding farmers.

7 September 2014 - REDD Monitor

REDD in the news: 1-7 September

REDD-Monitor's weekly round up of the news on REDD, organised by date with short extracts.

4 September 2014 - IISD

UNEP and IUCN Partner for Forest Restoration

The UN Environment Programme (UNEP) and the International Union for Conservation of Nature (IUCN) have announced a partnership intended to support the 2011 'Bonn Challenge on Forests, Climate Change and Biodiversity,' which aims to restore at least 150 million hectares of degraded forest landscapes by 2020

2 September 2014 - IISD

UN Climate Summit Big Data Challenge Winners Announced

A monitoring system providing real-time forest information and a tool promoting climate-smart agriculture among farmers in Colombia are the winners of the UN Global Pulse's Big Data Climate Challenge. Seven additional 'Projects to Watch' come from a wide range of countries, including India, China, South Africa, the UK and the US. Aimed at highlighting data-driven evidence to drive climate action, the Challenge is an initiative of the UN Secretary-General. The winners of the Challenge will be invited to share their research at the Climate Summit, to be held on 23 September 2014, in New York, US

September 2014 - Forests Climate Change

Before carbon is counted, policy indicators offer way to measure REDD+ progress

Countries can measure their progress in REDD+ by assessing their policy environment, even if supportive governance structures are not in place and they aren't ready to measure their carbon emission reductions, a recent study shows.

The idea of REDD+ (Reducing Emissions from Deforestation and forest Degradation) is to encourage developing countries to keep their forests standing by placing a financial value on the carbon in trees, with payments from wealthier countries made based on measurable results.

II. MULTILATERAL PROCESSES IN CLIMATE CHANGE

Past events

The Climate Summit, 23 September, UN Headquarters: the forest-related outcomes

The Climate Summit, organized by the Secretary-General of the United Nations, took place at the UN Headquarters in New York on 23 September. Over 120 heads of state and government attended. The objectives of the summit --to raise ambition, mobilize resources and generate action toward a new climate deal in 2015 -- were reflected in announcements of new partnerships, ambitious actions and financial support in forestry, agriculture, energy, transportation, cities and other sectors. Forests were highlighted at the Summit as a crucial area for climate action. The UN Secretary General, Ban Ki-moon, stated that: "Forests are not only a critical part of the climate solution – the actions agreed today will reduce poverty, enhance food security, improve the rule of law, secure the rights of indigenous people and benefit communities around the world". Forest-related commitments made at the summit were significant in their ambition, the breadth of the stakeholders involved, the effort to address agricultural drivers of deforestation, and new financial support pledged. The NY Declaration on Forests, a non-legally binding political declaration, was a main outcome of the summit. The declaration includes the most ambitious global goals related to forests set to date. The declaration aims to halve the rate of loss of natural forests globally by 2020 and strive to end the loss of natural forests by 2030. It also seeks to restore 150 million hectares (ha) of degraded forests and landscapes by 2020 and another 200 million ha by 2030. Achievement of these goals would result in an estimated 4.5 to 8.8 billion tonnes of CO_2 pollution annually, equivalent to removing from the road every car in the world.

Over 155 governments, corporate and indigenous leaders, non-governmental organizations and civil society organizations signed the forest declaration, indicating their commitment to work in concert and partnership to achieve these shared goals. The strong engagement of the private sector, in particular companies dealing with commodities such as palm oil, soy, beef and pulp and paper, the production of which are key drivers of deforestation, was another significant feature of the summit. More than 20 global food companies (including Unilever, Cargill, Neslié, Kelloggs, Golden Agri-Resources and Asia Pulp and Paper) committed themselves to deforestation-free supply chains. As for forest restoration, pledges were made to restore over 33 million ha of degraded landscapes and forestlands, including 22 million by Ethiopia, 8 million by the Democratic Republic of Congo, 2.5 million by Uganda and 1.2 million by Guatemala. These pledges, along with those already made in response to the Bonn Challenge, raise the existing level of commitment for forest and landscape restoration to over 55 million ha. Commitments for action were backed by pledges of financial support. The Governments of Germany, Norway and the United Kingdom announced a collective commitment to fund up to 20 new large-scale REDD+ programmes over the next few years to provide results-based payments for emissions reductions. Norway pledged $3 billion up to 2020, including $100 million to support indigenous peoples, $300 million to Peru and $150 million to Liberia for efforts to reduce deforestation. Time will tell how successful the Climate Summit was in raising the level of political support for an ambitious climate agreement in 2015. In any event, the new partnerships and higher level of commitment on forests pledged at the Climate Summit will certainly lend useful support to efforts to reduce deforestation and increase restoration. Although not specifically addressed by the New York Declaration, the hope is that actions to fulfil the pledges will also support additional efforts to achieve sustainable forest management, to increase resilience and adaptation in the forest sector and ultimately to increase forests' contribution to sustainable development, including food security and poverty alleviation. **More**

Upcoming events

Bonn Climate Change Conference, 20-25 October 2014, Bonn, Germany

The Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) will hold the sixth part of its second session from 20-25 October 2014 in Bonn, Germany. Further information on the session will be made available in due course. **More**

III. EVENTS & MEETINGS

2nd International Conference on Evaluating Climate Change and Development

4-6 November, 2014, Washington D.C, United States of America

Scheduled for November 4-6, 2014 in Washington D.C., this 2nd International Conference will tackle the difficulties linked to the evaluation of climate change and development, described by many as a major 21st century evaluation challenge. Participants for the conference are expected to be drawn equally from the global South and North to take stock of existing tools and methods but also reflect on and share experiences on emerging approaches in order to improve the practice of climate change evaluation. Efforts will also be made towards identify new and innovative ways to create an enabling environment for the demand and use of climate change and development evaluation in order to improve policy making. **More**

2014 Global Landscapes Forum

6-7 December, 2014, Lima Peru

The second Global Landscapes Forum will be held in Lima on the weekend in the middle of the 20th Conference of the Parties (COP20) to the UNFCCC. With this timing and location, this major event can draw on the presence in the city of world leaders, development experts and leading thinkers to create an influential space to position landscapes at the center of the emerging climate and development agreements. Countries are forging a successor to the Kyoto Protocol under the United Nations Framework Convention on Climate Change (UNFCCC) and, in parallel, designing a set of Sustainable Development Goals to replace the Millennium Development Goals. Connecting these two processes and multifunctional landscapes is vital if we are to overcome the complex challenges common to everyone on the planet. The two-day event will take place at the Westin Lima Hotel and Convention Center, a 20-minute drive from the COP20 venue and in the only venue in Lima outside the COP with the capacity to support an event of this size and diversity. **More**

Economics of Climate Change Mitigation Options in the Forestry Sector

6-27 February 2015, online conference

Forestry policy makers, forest economists, scientists and researchers from all over the world can now register for a unique FAO-run online conference entitled Economics of Climate Change Mitigation Options in the Forestry Sector. A hundred free places are available for each session of the conference, which will take place during 6 -27 February 2015. The conference will focus on the costs and benefits of ways in which the forestry sector can mitigate climate change, and examine how different countries and regions mitigate climate change through forest management interventions and improved use of wood. Discussions will also showcase lessons learned from mitigation efforts and their impacts on the value chain of forest products. Visit the Conference web page to register, or submit a case study abstract. **More**

IV. RESEARCH ARTICLES

Legal Harvesting, Sustainable Sourcing and Cascaded Use of Wood for Bioenergy: Their Coverage through Existing Certification Frameworks for Sustainable Forest Management

Sikkema, R., Junginger, M., van Dam, J., Stegeman, G., Durrant, D., Faaij, A.

Forests 2014, 5, 2163-2211

The first objective of this paper was to provide an inventory of developments of certification schemes for sustainable biomass production, following recent EU legislation (both formalized and under development). One main pillar is the EU Timber Regulation for legal harvesting; a second one is the EU's 2010 recommendations for sustainable woody biomass sourcing for energy; the third one is the EU Waste Directive. The second objective was to benchmark the coverage of this (draft) legislation, when wood product certificates for sustainable forest management (SFM) are used as proof of the related legislative requirements. We studied North America, as it is a major biomass supplier to the EU-28. Together with existing forest legislation in the US and Canada, SFM certificates are actively used to cover the EU's (draft) legislation. However, North American forests are only partially certified with fibers coming from certified forests; these are referred to as forest management (FM) fibers. Other certified fibers should come from complementary risk assessments

downstream in the supply chain (risk based fibers). Our benchmark concludes that: (a) FM fiber certification by the Forest Stewardship Council (FSC) and the Program for the Endorsement of Forest Certification (PEFC) international standards show the highest level of coverage with EU's (draft) legislation; (b) There is insufficient coverage for risk based fibers by FSC Controlled Wood (FSC-CW), PEFC Due Diligence (PEFC-DD), or SFI-fiber sourcing (SFI-FS). Other weaknesses identified for elaboration are: (c) Alignment in definitions are needed, such as for primary forest, high carbon stock, and wood waste (cascading); (d) Imperfect mass balance (fiber check downstream) needs to be solved, as non-certified fiber flows are inadequately monitored; (e) Add-on of a GHG calculation tool is needed, as GHG life cycle reporting is not covered by any of the SFM frameworks.

'No RIGHTS-No REDD': some implications of a turn towards co-benefits

Howell, S

Forum for Development Studies; 2014. 41(2):253-272

REDD+ (Reducing Emissions from Deforestation and Forest Degradation in Developing Countries) is a new and very ambitious global programme which seeks to create a financial value for the carbon stored in forests, offering performance-based payment to reduce CO_2 emissions from forested lands. From an initial perception of REDDF+ as a relatively straightforward forestry project, it has turned into one that is increasingly focusing on the rights of the people who live in the forests. This is largely due to pressure from international and national environmental and human rights NGOs. A result of their activities is that several of the original co-benefits to REDD+, such as alleviating poverty, tenure reform, improving local livelihoods and forest governance, and protecting rights have become major concerns. The introduction of REDD+ in Indonesia is used as an example to highlight some challenges encountered in its implementation.

Remote sensing assessment of forest disturbance across complex mountainous terrain: the pattern and severity of impacts of tropical cyclone Yasi on Australian rainforests

Negron-Juarez, R. I.; Chambers, J. Q.; Hurtt, G. C.; Annane, B.; Cocke, S.; Powell, M.; Stott, M.; Goosem, S.; Metcalfe, D. J.; Saatchi, S. S.;
Remote Sensing; 2014. 6(6):5633-5649.

Topography affects the patterns of forest disturbance produced by tropical cyclones. It determines the degree of exposure of a surface and can alter wind characteristics. Whether multispectral remote sensing data can sense the effect of topography on disturbance is a question that deserves attention given the multi-scale spatial coverage of these data and the projected increase in intensity of the strongest cyclones. Here, multispectral satellite data, topographic maps and cyclone surface wind data were used to study the patterns of disturbance in an Australian rainforest with complex mountainous terrain produced by tropical cyclone Yasi (2011). The cyclone surface wind data (H*wind) was produced by the Hurricane Research Division of the National Oceanic and Atmospheric Administration (HRD/NOAA), and this was the first time that this data was produced for a cyclone outside of United States territory. A disturbance map was obtained by applying spectral mixture analyses on satellite data and presented a significant correlation with field-measured tree mortality. Our results showed that, consistent with cyclones in the southern hemisphere, multispectral data revealed that forest disturbance was higher on the left side of the cyclone track. The highest level of forest disturbance occurred in forests along the path of the cyclone track (+or-30 degrees). Levels of forest disturbance decreased with decreasing slope and with an aspect facing off the track of the cyclone or away from the dominant surface winds. An increase in disturbance with surface elevation was also observed. However, areas affected by the same wind intensity presented increased levels of disturbance with increasing elevation suggesting that complex terrain interactions act to speed up wind at higher elevations. Yasi produced an important offset to Australia's forest carbon sink in 2010. We concluded that multispectral data was sensitive to the main effects of complex topography on disturbance patterns. High resolution cyclone wind surface data are needed in order to quantify the effects of topographic accelerations on cyclone related forest disturbances.

A National, Detailed Map of Forest Aboveground Carbon Stocks in Mexico

Cartus, O.; Kellndorfer, J.; Walker, W.; Franco, C.; Bishop, J.; Santos, L.; Michel Fuentes, J. M
Remote Sensing; 2014. 6(6):5559-5588

A spatially explicit map of aboveground carbon stored in Mexico's forests was generated from empirical modeling on forest inventory and spaceborne optical and radar data. Between 2004 and 2007, the Mexican National Forestry Commission (CONAFOR) established a network of ~26,000 permanent inventory plots in the frame of their national inventory program, the Inventario Nacional Forestal y de Suelos (INFyS). INFyS data served as model response for spatially extending the field-based estimates of carbon stored in the aboveground live dry biomass to a wall-to-wall map, with 30 × 30 m2 pixel posting using canopy density estimates derived from Landsat, L-Band radar data from ALOS PALSAR, as well as elevation information derived from the Shuttle

Radar Topography Mission (SRTM) data set. Validation against an independent set of INFyS plots resulted in a coefficient of determination (R2) of 0.5 with a root mean square error (RMSE) of 14 t·C/ha in the case of flat terrain. The validation for different forest types showed a consistently low estimation bias (<3 t·C/ha) and R2s in the range of 0.5 except for mangroves (R2 = 0.2). Lower accuracies were achieved for forests located on steep slopes (>15°) with an R2 of 0.34. A comparison of the average carbon stocks computed from: (a) the map; and (b) statistical estimates from INFyS, at the scale of ~650 km2 large hexagons (R2 of 0.78, RMSE of 5 t·C/ha) and Mexican states (R2 of 0.98, RMSE of 1.4 t·C/ha), showed strong agreement.

Investigating afforestation and bioenergy CCS as climate change mitigation strategies

Humpenoder, F.; Popp, A.; Dietrich, J. P.; Klein, D.; Lotze-Campen, H.; Bonsch, M.; Bodirsky, B. L.; Weindl, I.; Stevanovic, M.; Muller, C

Environmental Research Letters; 2014. 9(6):064029

The land-use sector can contribute to climate change mitigation not only by reducing greenhouse gas (GHG) emissions, but also by increasing carbon uptake from the atmosphere and thereby creating negative CO2 emissions. In this paper, we investigate two land-based climate change mitigation strategies for carbon removal: (1) afforestation and (2) bioenergy in combination with carbon capture and storage technology (bioenergy CCS). In our approach, a global tax on GHG emissions aimed at ambitious climate change mitigation incentivizes land-based mitigation by penalizing positive and rewarding negative CO2 emissions from the land-use system. We analyze afforestation and bioenergy CCS as standalone and combined mitigation strategies. We find that afforestation is a cost-efficient strategy for carbon removal at relatively low carbon prices, while bioenergy CCS becomes competitive only at higher prices. According to our results, cumulative carbon removal due to afforestation and bioenergy CCS is similar at the end of 21st century (600–700 GtCO2), while land-demand for afforestation is much higher compared to bioenergy CCS. In the combined setting, we identify competition for land, but the impact on the mitigation potential (1000 GtCO2) is partially alleviated by productivity increases in the agricultural sector. Moreover, our results indicate that early-century afforestation presumably will not negatively impact carbon removal due to bioenergy CCS in the second half of the 21st century. A sensitivity analysis shows that land-based mitigation is very sensitive to different levels of GHG taxes. Besides that, the mitigation potential of bioenergy CCS highly depends on the development of future bioenergy yields and the availability of geological carbon storage, while for afforestation projects the length of the crediting period is crucial.

Downscaling global land cover projections from an integrated assessment model for use in regional analyses: results and evaluation for the US from 2005 to 2095

West, T. O.; Page, Y. le; Huang, M. Y.; Wolf, J.; Thomson, A. M

Environmental Research Letters; 2014. 9(6):064004

Projections of land cover change generated from integrated assessment models (IAM) and other economic-based models can be applied for analyses of environmental impacts at sub-regional and landscape scales. For those IAM and economic models that project land cover change at the continental or regional scale, these projections must be downscaled and spatially distributed prior to use in climate or ecosystem models. Downscaling efforts to date have been conducted at the national extent with relatively high spatial resolution (30 m) and at the global extent with relatively coarse spatial resolution (0.5 degrees). We revised existing methods to downscale global land cover change projections for the US to 0.05 degrees resolution using MODIS land cover data as the initial proxy for land class distribution. Land cover change realizations generated here represent a reference scenario and two emissions mitigation pathways (MPs) generated by the global change assessment model (GCAM). Future gridded land cover realizations are constructed for each MODIS plant functional type (PFT) from 2005 to 2095, commensurate with the community land model PFT land classes, and archived for public use. The GCAM land cover realizations provide spatially explicit estimates of potential shifts in croplands, grasslands, shrublands, and forest lands. Downscaling of the MPs indicate a net replacement of grassland by cropland in the western US and by forest in the eastern US. An evaluation of the downscaling method indicates that it is able to reproduce recent changes in cropland and grassland distributions in respective areas in the US, suggesting it could provide relevant insights into the potential impacts of socio-economic and environmental drivers on future changes in land cover.

A tale of two springs: using recent climate anomalies to characterize the sensitivity of temperate forest phenology to climate change

Friedl, M. A.; Gray, J. M.; Melaas, E. K.; Richardson, A. D.; Hufkens, K.; Keenan, T. F.; Bailey, A.; O'Keefe, J

Environmental Research Letters; 2014. 9(5):054006

By the end of this century, mean annual temperatures in the Northeastern United States are expected to warm by 3-5 degrees C, which will have significant impacts on the structure and function of temperate forests in this

region. To improve understanding of these impacts, we exploited two recent climate anomalies to explore how the springtime phenology of Northeastern temperate deciduous forests will respond to future climate warming. Specifically, springtime temperatures in 2010 and 2012 were the warmest on record in the Northeastern United States, with temperatures that were roughly equivalent to the lower end of warming scenarios that are projected for this region decades from now. Climate conditions in these two years therefore provide a unique empirical basis, that complements model-based studies, for improving understanding of how northeastern temperate forest phenology will change in the future. To perform our investigation, we analyzed near surface air temperatures from the United States Historical Climatology Network, time series of satellite-derived vegetation indices from NASA's Moderate Resolution Imaging Spectroradiometer, and in situ phenological observations. Our study region encompassed the northern third of the eastern temperate forest ecoregion, extending from Pennsylvania to Canada. Springtime temperatures in 2010 and 2012 were nearly 3 degrees C warmer than long-term average temperatures from 1971-2000 over the region, leading to median anomalies of more than 100 growing degree days. In response, satellite and ground observations show that leaf emergence occurred up to two weeks earlier than normal, but with significant sensitivity to the specific timing of thermal forcing. These results are important for two reasons. First, they provide an empirical demonstration of the sensitivity of springtime phenology in northeastern temperate forests to future climate change that supports and complements model-based predictions. Second, our results show that subtle differences in the character of thermal forcing can substantially alter the timing of leaf emergence and canopy development. By explicitly comparing and contrasting the timing of thermal forcing and leaf phenology in 2010 and 2012, we show that even though temperatures were warmer in 2012 than in 2010, the nature and timing of thermal forcing in 2010 lead to leaf emergence that was almost a week earlier than 2012.

Carbon emissions from tropical forest degradation caused by logging

Pearson, T. R. H.; Brown, S.; Casarim, F. M.
Environmental Research Letters; 2014

The focus of landuse related efforts in developing countries to reduce carbon emissions has been on slowing deforestation, yet international agreements are to reduce emissions from both deforestation and forest degradation (REDD). The second ‘D’ is poorly understood and accounted for a number of technical and policy reasons. Here we introduce a complete accounting method for estimating emission factors from selective timber harvesting, a substantial form of forest degradation in many tropical developing countries. The method accounts separately for emissions from the extracted log, from incidental damage to the surrounding forest, and from logging infrastructure, and emissions are expressed as units of carbon per cubic meter of timber extracted to allow for simple application to timber harvesting statistics. We applied the method in six tropical countries (Belize, Bolivia, Brazil, Guyana, Indonesia, and Republic of Congo), resulting in total emission factors of 0:99–2:33 Mg C m□3. In all cases, emissions were dominated by damage to surrounding vegetation and the infrastructure rather than the logs themselves, and total emissions represented about 3–15% of the biomass carbon stocks of the associated unlogged forests. We then combined the emission factors with country level logging statistics for nine key timber producing countries represented by our study areas to gain an understanding of the order of magnitude of emissions from degradation compared to those recently reported for deforestation in the same countries. For the nine countries included, emissions from logging were on average equivalent to about 12% of those from deforestation. For those nine countries with relatively low emissions from deforestation, emissions from logging were equivalent to half or more of those from deforestation, whereas for those countries with the highest emissions from deforestation, emissions from logging were equivalent to <10% of those from deforestation. Understanding how to account emissions and the magnitude of each emissions source resulting from tropical timber harvesting practices helps identify where there are opportunities to reduce emissions from the second ‘D’ in REDD.

Potential greenhouse gas benefits of transatlantic wood pellet trade

Dwivedi, P.; Khanna, M.; Bailis, R.; Ghilardi, A
Environmental Research Letters; 2014. 9(2):024007

Power utility companies in the United Kingdom are using imported wood pellets from the southern region of the United States for electricity generation to meet the legally binding mandate of sourcing 15% of the nation's total energy consumption from renewable sources by 2020. This study ascertains relative savings in greenhouse gas (GHG) emissions for a unit of electricity generated using imported wood pellet in the United Kingdom under 930 different scenarios: three woody feedstocks (logging residues, pulpwood, and logging residues and pulpwood combined), two forest management choices (intensive and non-intensive), 31 plantation rotation ages (year 10 to year 40 in steps of 1 year), and five power plant capacities (20-100 MW in steps of 20 MW). Relative savings in GHG emissions with respect to a unit of electricity derived from fossil fuels in the United Kingdom range between 50% and 68% depending upon the capacity of power plant and rotation age. Relative savings in GHG emissions increase with higher power plant capacity. GHG emissions related to wood pellet production and transatlantic shipment of wood pellets typically contribute about 48% and 31% of total GHG

emissions, respectively. Overall, use of imported wood pellets for electricity generation could help in reducing the United Kingdom's GHG emissions. We suggest that future research be directed to evaluation of the impacts of additional forest management practices, changing climate, and soil carbon on the overall savings in GHG emissions related to transatlantic wood pellet trade.

Forest management approaches for coping with the uncertainty of climate change: trade-offs in service provisioning and adaptability

Wagner, S.; Nocentini, S.; Huth, F.; Hoogstra-Klein, M

Ecology and Society; 2014. 19(1):art32

The issue of rapid change in environmental conditions under which ecosystem processes and human interventions will take place in the future is relatively new to forestry, whereas the provision of ecosystem services, e.g., timber or fresh water, is at the very heart of the original concept of forest management. Forest managers have developed ambitious deterministic approaches to provide the services demanded, and thus the use of deterministic approaches for adapting to climate change seem to be a logical continuation. However, as uncertainty about the intensity of climate change is high, forest managers need to answer this uncertainty conceptually. One may envision an indeterministic approach to cope with this uncertainty; but how the services will be provided in such a concept remains unclear. This article aims to explore the fundamental aspects of both deterministic and indeterministic approaches used in forestry to cope with climate change, and thereby point out trade-offs in service provisioning and adaptability. A forest owner needs to be able to anticipate these trade-offs in order to make decisions towards sustainable forest management under climate change.

The legitimacy of incentive-based conservation and a critical account of social safeguards

Krause, T.; Nielsen, T. D.;

Environmental Science & Policy; 2014. 41:44-51

Incentive-based conservation has become a significant part of how tropical forests are being governed. Reducing emissions from deforestation and forest degradation (REDD+) is a mechanism to mitigate climate change that many countries have started to implement. REDD+, however, is criticized for its potential negative impacts on local populations and Indigenous people. To prevent and mitigate the negative impacts, safeguards are increasingly being used to prevent and shift the focus toward 'non-carbon' elements of forest conservation. We discuss the legitimacy of these types of projects from a stakeholder perspective. Using a normative framework, we assess the Ecuadorian Socio Bosque conservation program, concentrating more specifically on the level of input and output legitimacy. Results show that Socio Bosque in its current form has shortcomings in both input and output legitimacy. We argue that an encompassing conception of legitimacy, including input and output criteria, particularly from a local stakeholder perspective, is essential for the future success of incentive-based conservation and particularly for REDD+ projects.

Reforming the EU approach to LULUCF and the climate policy framework

Ellison, D.; Lundblad, M.; Petersson, H

Environmental Science & Policy; 2014. 40:1-15

We focus on recent progress in reforming the role of forests and other land use in the EU climate policy framework. EU inclusion of LULUCF (Land Use, Land-Use Change and Forestry) in the climate policy framework still lags international developments, remaining at odds even with the United Nations Framework Convention on Climate Change's (UNFCCC) Kyoto framework. Though the EU has made some important changes that eclipse even the UNFCCC framework - in particular regarding the inclusion of cropland and grazing land management in mandatory EU-level carbon accounting practices - in other respects the EU has far to go. As part of a strategy for fulfilling emission reduction commitments within the EU burden-sharing agreement, Member states are not permitted to trade either in domestically nor foreign produced forest-based carbon credits. On the other hand, *both* the EU and the UNFCCC/Kyoto LULUCF frameworks remain distant from an idealized model that could facilitate increased climate change mitigation and a more efficient and balanced use of forest-based resources. Limiting the incorporation of forests in the climate policy framework has significant consequences for the cost and rapidity of emission reductions. Forest potential thus remains under-mobilized for climate change mitigation. In this context, we draw particular attention to the fact that forest-based carbon sequestration's potential contribution to *negative emissions* represents an important missed opportunity. In the context of ongoing discussions over the EU and UNFCCC's Post-Kyoto frameworks, we propose an all-encompassing LULUCF carbon accounting model incorporating *all* previously omitted carbon pools and activities, thus weighing LULUCF removals and emissions on a par with emissions from other sectors (industry, the energy sector, end-users). The successful integration of LULUCF into the EU climate policy and carbon-trading frameworks could dovetail neatly with emerging international climate change mitigation efforts.

Foliar CO_2 in a holm oak forest subjected to 15 years of climate change simulation

Ogaya, R.; Llusia, J.; Barbeta, A.; Asensio, D.; Liu, D.; Alessio, G. A.; Penuelas, J
Plant Science; 2014. 226:101-107

A long-term experimental drought to simulate future expected climatic conditions for Mediterranean forests, a 15% decrease in soil moisture for the following decades, was conducted in a holm oak forest since 1999. Net photosynthetic rate, stomatal conductance and leaf water potential were measured from 1999 to 2013 in *Quercus ilex* and *Phillyrea latifolia*, two co-dominant species of this forest. These measurements were performed in four plots, two of them received the drought treatment and the two other plots were control plots. The three studied variables decreased with increases in VPD and decreases in soil moisture in both species, but the decrease of leaf water potential during summer drought was larger in *P. latifolia*, whereas *Q. ilex* reached higher net photosynthetic rates and stomatal conductance values during rainy periods than *P. latifolia*. The drought treatment decreased ca. 8% the net photosynthetic rates during the overall studied period in both *Q. ilex* and *P. latifolia*, whereas there were just non-significant trends toward a decrease in leaf water potential and stomatal conductance induced by drought treatment. Future drier climate may lead to a decrease in the carbon balance of Mediterranean species, and some shrub species well resistant to drought co

Estimating above-ground biomass of trees: comparing Bayesian calibration with regression technique

Zell, J.; Bosch, B.; Kandler, G

European Journal of Forest Research; 2014. 133(4):649-660

The commitment to report greenhouse gas emissions requires an estimation of biomass stocks and their changes in forests. When this was first done, representative biomass functions for most common tree species were very often not available. In Germany, an estimation method based on solid volume was developed (expansion procedure). It is easy to apply because the required information is available for nearly all relevant tree species. However, the distributions of neither parameters nor prediction intervals are available. In this study, two different methods to estimate above-ground biomass for *Norway spruce* (*Picea abies*), *European beech* (*Fagus sylvatica*), and *Scots pine* (*Pinus sylvestris*) are compared. First, an approach based on information from the literature was used to predict above-ground biomass. It is basically the same method used in greenhouse gas reporting in Germany and was applied with prior and posterior parameters. Second, equations for direct estimation of biomass with standard regression techniques were developed. A sample of above-ground biomass of trees was measured in campaigns conducted previously to the third National Forest Inventory in Germany (2012). The data permitted the application of Bayesian calibration (BC) to estimate posterior distribution of the parameters for the expansion procedure. Moreover, BC enables the calculation of prediction intervals which are necessary for error estimations required for reporting. The two methods are compared with regard to predictive accuracy via cross-validation, under varying sample sizes. Our findings show that BC of the expansion procedure performs better, especially when sample size is small. We therefore encourage the use of existing knowledge together with small samples of observed biomass (e.g., for rare tree species) to gain predictive accuracy in biomass estimation.

Estimation of biomass and carbon stock of woody plants in different land-uses

Sundarapandian, S. M.; Amritha, S.; Gowsalya, L.; Kayathri, P.; Thamizharasi, M.; Dar, J. A.; Srinivas, K.; Gandhi, D. S
Forest Research: Open Access; 2014. 3(1):115.

A substantial increase in the number of forest plantations has been observed in the last two decades owing to a greater awareness on climate change and global initiative of REDD and REDD+ (Reducing Emissions from Deforestation and forest Degradation) programs. In light of this, biomass and total carbon stocks of woody plants were estimated in five study sites–four plantations and a natural forest at Puthupet, Tamil Nadu, India. The aboveground biomass in the study sites were 32.7, 38.1, 121.1, 143.2and 227.2 (Mg/ha) in Anacardium occidentale, Casuarina equisetifolia, Mangifera indica, Cocos nucifera and natural forest respectively. In the natural forest, Pterospermum canescens contributed to the greatest aboveground biomass (55.54 Mg/ha), whereas the least was from Diospyros ferrea (1.07 Mg/ha). The maximum carbon stock was reported from the natural forest site (131.8 Mg/ha) while the minimum was from Anacardium occidentale plantation (19.5 Mg/ha). A significant positive relationship was observed between basal area with biomass and total carbon. The low values of biomass and carbon stocks in plantations maybe due to less stand age structure. Our results suggest that besides the natural forests, plantations also have great potential for carbon sequestration in the coastal areas and suggest developing more plantations and retaining it for a longer period of time will be helpful in reducing the atmospheric carbon dioxide concentrations

Soil organic carbon stock assessment in two temperate forest types of western Himalaya of Jammu and Kashmir, India.

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Forest Research: Open Access; 2014. 3(1):114

Soil organic carbon (SOC) in the temperate forests of the Himalayas is important to estimate their contribution to regional, national and global carbon stocks. This information however is poor and fragmented in regards to the western Himalayas of India. No published information is available on SOC stock in this region. Carbon stocks were assessed at different soil depths (0-10, 10-20 and 20-30 cm) in *Pinus wallichiana* (PW) and *Abies pindrow* (AP) forest types in the western Kashmir Himalayas of India. SOC stocks in these temperate forests were relatively low ranging from 50.37 to 55.38 Mg C ha^{-1} in the top 30 cm of soils. Significantly greater SOC stock was observed in PW forest type compared to AP forest type. Tree density, shrub density, shrub biomass, herb biomass, and forest floor litter were greater in the PW forest type as compared to AP forest type, which could be the reason for greater accumulation of organic carbon in soil. The present study revealed that tree species composition and its associated underground vegetation alter SOC accumulation in the moist temperate forest ecosystems. In addition, environmental parameters such as soil moisture and soil biological activity change soil carbon sequestration potential in moist temperate forest ecosystems.

Carbon storage in HWP. Accounting for Spanish particleboard and fiberboard

Canals, G. G.; Valero, E.; Picos, J.; Voces, R

Forest Systems; 2014. 23(2):225-235

Aim of study: The study quantifies carbon stock in particleboard and fibreboard, for the period 1990-2006. It is the first accounting made for the Spanish wood industry using industrial accurate data and it could be comparable to other European studies. Area of study: Spain. Material and methods: A comparison of the three different approaches (Stock Change Approach, Production Approach, Atmospheric Flow Approach) of the 2006 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas (GHG). Due to the complexity derived from the amount of input variables and the recurrence of the formulas, the Montecarlo simulation method was chosen to compare results. Main results: Between 1990-2006 the carbon stock of the Spanish panel industry has been growing steadily, reaching around 1,000 Gg C in all three approaches studied. During the period 1990-2002, the Stock Change Approach is the one which provides a higher carbon stock accounting. However, since 2002 the Production Approach is the one which presents higher values of carbon stock. Research highlights: The main result of the study shows the important role of carbon stock which play the Spanish wood based panel industry during the period analysed. The results highlight the economic and environmental importance of carbon stock stored in such wood products, as well as its remarkable increase during the study period. They also highlight the importance of good practices such as cascade use of wood resources as well as the need for properly coordination between climate change and forest policies.

Vulnerability and adaptation to climate change of selected community-based forest management areas in Oas, Albay, Philippines

Tapia, M. A.; Pulhin, J. M.; Peras, R. J. J

Asia Life Sciences - The Asian International Journal of Life Sciences; 2014. 23(2):567-592.

Community-based forest management (CBFM) communities have been put at the forefront of forest management following a paradigm shift in forestry, which favors a more participatory approach to bring development to the grassroots. Whilst such intervention is intended to achieve total human development, realities on the ground saw a disparity in the realization of this goal and the 'bundle of responsibilities' bestowed on the upland communities. Achieving human development is further challenged by climate change which poses threats to forest and the delivery of its services, where the livelihoods of upland communities depend. Set at this backdrop, this study assessed the vulnerability and adaptation to climate change of selected CBFM communities in Oas, Albay, Philippines, applying the Adaptation Policy Framework. Data were collected using participatory rural appraisal techniques, household survey, key informant interviews and secondary data collection. Results revealed the high vulnerability of the selected communities to extreme weather events, such as typhoons and El Nino, which translates as well to high vulnerability to climate change. This can be traced to their fragile environments caused by degraded forest ecosystems, high degree of dependence on farming in the absence of alternative livelihoods, and low adaptive capacity due to inadequate basic services. 'Bandaid' or 'bearing the losses' approach to adaptation further aggravated the situation. Though CBFM can be considered a 'no regret' adaptation to climate change, it failed to deliver its promise of ecological sustainability and improved livelihoods in the two communities due to administration and financial issues. Notwithstanding current limitations of CBFM, however, it still remains a promising approach not only in accomplishing its original objectives, but also in reducing vulnerability to climate change. Updating CBFM to respond to future climate and with improvements in its facilitation and implementation aspects, it could prove to be an indispensable strategy for climate change adaptation.

Efficient integration of a deadwood inventory into an existing forest inventory carried out as two-phase sampling for stratification

Ritter, T.; Saborowski, J
Forestry (Oxford); 2014. 87(4):571-581

Deadwood is an important component of many ecosystems and plays a major role for biodiversity, soil protection and carbon sequestration. Despite its high ecological value, deadwood is not included in the main focus of traditional forest inventories. The sampling designs of these inventories are therefore not optimal for deadwood sampling. However, in recent years, interest in non-timber aspects of forest structure and demand for multipurpose forest inventories has increased. Drawing on the example of a German state forest district inventory, we suggest an efficient integration of point transect and line intersect sampling of deadwood into an existing forest inventory, carried out as two-phase sampling for stratification. Compared with fixed area sampling, efficiency is tremendously increased using point transect sampling for standing deadwood and line intersect sampling for coarse woody debris.

Shifting with climate? Evidence for recent changes in tree species distribution at high latitudes

Boisvert-Marsh, L.; Perie, C.; Blois, S. de
Ecosphere; 2014. 5(7):art83

Warming has been particularly strong at high latitudes in recent decades and bioclimatic models predict northern shifts in optimal conditions for most species. Climate is a strong predictor of site occupancy for trees at broad spatial scales and interacts with other drivers of forest dynamics. Recent changes in distribution and occupancy patterns should therefore provide the best evidence of a tree species' potential to shift in the direction predicted by bioclimatic models. Studies examining recent distribution changes for plants, however, have mostly done so along altitudinal gradients or have used the latitudinal position of juvenile trees relative to adult ones to infer range dynamics. This study provides rare evidence of latitudinal shifts for 11 northern tree species by assessing recent changes in distribution using globally significant inventories from 1970 to 2002. It also compares observed trends with those inferred from the position of juveniles relative to trees in a single survey. Samplings cover 6456 forest plots in temperate and boreal forests up to treeline in eastern North America. The average overall latitudinal shift was 3.07+or-4.37 km northward although responses were species-specific. Shifts were detected more for juvenile than for adult trees and significant northward ones were detected more at northern range limits than at the median. All species demonstrated increased frequency of plot occupancy for saplings while occupancy generally decreased for adult trees. Five out of the 11 species examined (*Acer rubrum*, *Acer saccharum*, *Betula papyrifera*, *Fagus grandifolia*, and Populus tremuloides) showed significant distributional shifts consistent with northward migration. Saplings of *Abies balsamea*, Picea *glauca*, and *Picea mariana*, on the other hand, showed southward shifting trends. Natural and human disturbances undoubtedly interact with climate to determine forest dynamics; this study shows whether their combined effect can shift distribution in the direction predicted by bioclimatic models. Only continued monitoring will reveal whether these observations are just transient dynamics or indicative of shifting range in this century. Our study provides a benchmark against which to assess future observations of latitudinal shifts for trees.

Simulating the effect of anthropogenic vegetation land cover on heatwave temperatures over central France

Stefanon, M.; Schindler, S.; Drobinski, P.; Noblet-Ducoudre, N. de; D'Andrea, F
Climate Research; 2014. 60(2):133-146

Events similar to the 2003 heatwaves in France are likely to become more frequent, more intense and longer by the end of the 21st century. Policies for climate mitigation focus on carbon sequestration techniques while land cover change (LCC) may be a better short-term alternative at regional level. However, LCC impact studies conducted so far have often given contradictory results at mid-latitudes for summer temperature. Using a regional climate model, the impact of an afforestation scenario is evaluated for the years 2002 and 2003, and compared to an agricultural scenario. The favorable meteorological conditions in spring 2003 promote the development of agricultural vegetation compared to (1) conditions in 2002 and (2) tree phenology in the forested scenario. This dampens the extreme values of temperature from April to the end of June 2003 (up to 3 degrees C during the June heatwave). From early July to October, drought conditions cause crop failure, while forests are not affected by the lack of soil moisture owing to a deeper root system. Evapotranspiration is therefore smaller in the agricultural scenario, thus amplifying the July-August extreme temperatures. However this cooling capacity of trees in the afforestation scenario is limited during the August heatwave because the high temperatures reach a critical level above which the stomata close and transpiration is inhibited. Our experimental set-up highlights the role of climate-vegetation interactions during extreme events and demonstrates how choices of vegetation cover (e.g. trees versus crops) may substantially modify the summer temperatures in mid-latitude regions.

Erosion of bulk soil and soil organic carbon after land use change in northwest Vietnam

Haring, V.; Fischer, H.; Stahr, K

Catena; 2014. 122:111-119

Soil erosion by water and tillage are major drivers for soil degradation in the mountainous regions of NW Vietnam. Data on cumulative and recent erosion of bulk soil and soil organic carbon (SOC) are needed for carbon budgeting and to evaluate e.g. the impact of erosion on climate change, environmental services and subsequent socioeconomic consequences. Thus, the aims of the present study were (1) to quantify cumulative erosion and recent erosion rates of bulk soil (2) to quantify cumulative eroded SOC and (3) to estimate the proportions of water and tillage induced soil erosion after land use change from primary forest to continuous maize cultivation for up to 21 years. Soil erosion rates were determined by 137Cs and ranged from 12 to 89 t ha− 1 a− 1. A large part of the variation of cumulative bulk soil (R2 = 0.79) and SOC loss (R2 = 0.67) between the sites was simply but effectively explained by the ratio of site specific cumulative RUSLE LS factors to clay contents. The newly developed CIDE approach, which attributes SOC changes on steep slopes to either carbon input, decomposition or erosion, delivered 20% higher (up to 0.7 kg m− 2) and more reliable estimates on cumulative SOC erosion than a traditional approach, because CIDE considered the effects of soil profile truncation, decomposition and humification, which all affected SOC simultaneously to soil erosion. Tillage induced soil flux accounted for 38 ± 3 kg m− 1 per tillage pass, which was lower than found in similar studies. Soil erosion by water was higher than tillage induced erosion in middle and foot slope positions, accounting for 86 to 89% of total soil erosion. To prevent further soil degradation, erosion protection measures should be implemented.

Predicting the responsiveness of soil biodiversity to deforestation: a cross-biome study

Crowther, T. W.; Maynard, D. S.; Leff, J. W.; Oldfield, E. E.; Mcculley, R. L.; Fierer, N.; Bradford, M. A.;
Global Change Biology; 2014. 20(9):2983-2994.

The consequences of deforestation for aboveground biodiversity have been a scientific and political concern for decades. In contrast, despite being a dominant component of biodiversity that is essential to the functioning of ecosystems, the responses of belowground biodiversity to forest removal have received less attention. Single-site studies suggest that soil microbes can be highly responsive to forest removal, but responses are highly variable, with negligible effects in some regions. Using high throughput sequencing, we characterize the effects of deforestation on microbial communities across multiple biomes and explore what determines the vulnerability of microbial communities to this vegetative change. We reveal consistent directional trends in the microbial community response, yet the magnitude of this vegetation effect varied between sites, and was explained strongly by soil texture. In sandy sites, the difference in vegetation type caused shifts in a suite of edaphic characteristics, driving substantial differences in microbial community composition. In contrast, fine-textured soil buffered microbes against these effects and there were minimal differences between communities in forest and grassland soil. These microbial community changes were associated with distinct changes in the microbial catabolic profile, placing community changes in an ecosystem functioning context. The universal nature of these patterns allows us to predict where deforestation will have the strongest effects on soil biodiversity, and how these effects could be mitigated.

Afforestation effects on SOC in former cropland: oak and spruce chronosequences resampled after 13 years

Barcena, T. G.; Gundersen, P.; Vesterdal, L
Global Change Biology; 2014. 20(9):2938-2952

Chronosequences are commonly used to assess soil organic carbon (SOC) sequestration after land-use change, but SOC dynamics predicted by this space-for-time substitution approach have rarely been validated by resampling. We conducted a combined chronosequence/resampling study in a former cropland area (Vestskoven) afforested with oak (*Quercus robur*) and Norway spruce (*Picea abies*) over the past 40 years. The aims of this study were (i) to compare present and previous chronosequence trends in forest floor and top mineral soil (0-25 cm) C stocks; (ii) to compare chronosequence estimates with current rates of C stock change based on resampling at the stand level; (iii) to estimate SOC changes in the subsoil (25-50 cm); and (iv) to assess the influence of two tree species on SOC dynamics. The two chronosequence trajectories for forest floor C stocks revealed consistently higher rates of C sequestration in spruce than oak. The chronosequence trajectory was validated by resampling and current rates of forest floor C sequestration decreased with stand age. Chronosequence trends in topsoil SOC in 2011 did not differ significantly from those reported in 1998, however, there was a shift from a negative rate (1998: -0.3 Mg C ha^{-1} yr^{-1}) to no change in 2011. In contrast SOC stocks in the subsoil increased with stand age, however, not significantly (P=0.1), suggesting different C dynamics in and below the former plough layer. Current rates of C change estimated by repeated sampling decreased with stand age in forest floors but increased in the topsoil. The contrasting temporal change in

forest floor and mineral soil C sequestration rates indicate a shift in C source-sink strength after approximately 40 years. We conclude that afforestation of former cropland within the temperate region may induce soil C loss during the first decades followed by a recovery phase of yet unknown duration.

Thermal acclimation of leaf respiration of tropical trees and lianas: response to experimental canopy warming, and consequences for tropical forest carbon balance

Slot, M.; Rey-Sanchez, C.; Gerber, S.; Lichstein, J. W.; Winter, K.; Kitajima, K
Global Change Biology; 2014. 20(9):2915-2926.

Climate warming is expected to increase respiration rates of tropical forest trees and lianas, which may negatively affect the carbon balance of tropical forests. Thermal acclimation could mitigate the expected respiration increase, but the thermal acclimation potential of tropical forests remains largely unknown. In a tropical forest in Panama, we experimentally increased nighttime temperatures of upper canopy leaves of three tree and two liana species by on average 3 °C for 1 week, and quantified temperature responses of leaf dark respiration. Respiration at 25 °C (R25) decreased with increasing leaf temperature, but acclimation did not result in perfect homeostasis of respiration across temperatures. In contrast, Q10 of treatment and control leaves exhibited similarly high values (range 2.5–3.0) without evidence of acclimation. The decrease in R25 was not caused by respiratory substrate depletion, as warming did not reduce leaf carbohydrate concentration. To evaluate the wider implications of our experimental results, we simulated the carbon cycle of tropical latitudes (24°S–24°N) from 2000 to 2100 using a dynamic global vegetation model (LM3VN) modified to account for acclimation. Acclimation reduced the degree to which respiration increases with climate warming in the model relative to a no-acclimation scenario, leading to 21% greater increase in net primary productivity and 18% greater increase in biomass carbon storage over the 21st century. We conclude that leaf respiration of tropical forest plants can acclimate to nighttime warming, thereby reducing the magnitude of the positive feedback between climate change and the carbon cycle.

The influence of sampling design on tree-ring-based quantification of forest growth

Nehrbass-Ahles, C.; Babst, F.; Klesse, S.; Notzli, M.; Bouriaud, O.; Neukom, R.; Dobbertin, M.; Frank, D
Global Change Biology; 2014. 20(9):2867-2885

Tree-rings offer one of the few possibilities to empirically quantify and reconstruct forest growth dynamics over years to millennia. Contemporaneously with the growing scientific community employing tree-ring parameters, recent research has suggested that commonly applied sampling designs (i.e. how and which trees are selected for dendrochronological sampling) may introduce considerable biases in quantifications of forest responses to environmental change. To date, a systematic assessment of the consequences of sampling design on dendroecological and-climatological conclusions has not yet been performed. Here, we investigate potential biases by sampling a large population of trees and replicating diverse sampling designs. This is achieved by retroactively subsetting the population and specifically testing for biases emerging for climate reconstruction, growth response to climate variability, long-term growth trends, and quantification of forest productivity. We find that commonly applied sampling designs can impart systematic biases of varying magnitude to any type of tree-ring-based investigations, independent of the total number of samples considered. Quantifications of forest growth and productivity are particularly susceptible to biases, whereas growth responses to short-term climate variability are less affected by the choice of sampling design. The world's most frequently applied sampling design, focusing on dominant trees only, can bias absolute growth rates by up to 459% and trends in excess of 200%. Our findings challenge paradigms, where a subset of samples is typically considered to be representative for the entire population. The only two sampling strategies meeting the requirements for all types of investigations are the (i) sampling of all individuals within a fixed area; and (ii) fully randomized selection of trees. This result advertises the consistent implementation of a widely applicable sampling design to simultaneously reduce uncertainties in tree-ring-based quantifications of forest growth and increase the comparability of datasets beyond individual studies, investigators, laboratories, and geographical boundaries.

An improved approach for remotely sensing water stress impacts on forest C uptake

Sims, D. A.; Brzostek, E. R.; Rahman, A. F.; Dragoni, D.; Phillips, R. P
Global Change Biology; 2014. 20(9):2856-2866

Given that forests represent the primary terrestrial sink for atmospheric CO2, projections of future carbon (C) storage hinge on forest responses to climate variation. Models of gross primary production (GPP) responses to water stress are commonly based on remotely sensed changes in canopy 'greenness' (e.g., normalized difference vegetation index; NDVI). However, many forests have low spectral sensitivity to water stress (SSWS) – defined here as drought-induced decline in GPP without a change in greenness. Current satellite-derived estimates of GPP use a vapor pressure deficit (VPD) scalar to account for the low SWSS of forests, but fail to capture their responses to water stress. Our objectives were to characterize differences in SSWS among forested and nonforested ecosystems, and to develop an improved framework for predicting the impacts of

water stress on GPP in forests with low SSWS. First, we paired two independent drought indices with NDVI data for the conterminous US from 2000 to 2011, and examined the relationship between water stress and NDVI. We found that forests had lower SSWS than nonforests regardless of drought index or duration. We then compared satellite-derived estimates of GPP with eddy-covariance observations of GPP in two deciduous broadleaf forests with low SSWS: the Missouri Ozark (MO) and Morgan Monroe State Forest (MMSF) AmeriFlux sites. Model estimates of GPP that used VPD scalars were poorly correlated with observations of GPP at MO (r2 = 0.09) and MMSF (r2 = 0.38). When we included the NDVI responses to water stress of adjacent ecosystems with high SSWS into a model based solely on temperature and greenness, we substantially improved predictions of GPP at MO (r2 = 0.83) and for a severe drought year at the MMSF (r2 = 0.82). Collectively, our results suggest that large-scale estimates of GPP that capture variation in SSWS among ecosystems could improve predictions of C uptake by forests under drought.

Big eucalypts grow more slowly in a warm climate: evidence of an interaction between tree size and temperature

Prior, L. D.; Bowman, D. M. J. S

Global Change Biology; 2014. 20(9):2793-2799

Large trees are critical components of forest ecosystems, but are declining in many forests worldwide. We predicted that growth of large trees is more vulnerable than that of small trees to high temperatures, because respiration and tissue maintenance costs increase with temperature more rapidly than does photosynthesis and these costs may be disproportionately greater in large trees. Using 5 00 000 measurements of eucalypt growth across temperate Australia, we found that high temperatures do appear to impose a larger growth penalty on large trees than on small ones. Average stem diameter growth rates at 21 degrees C compared with 11 degrees C mean annual temperature were 57% lower for large trees (58 cm stem diameter), but only 29% lower for small trees (18 cm diameter). While our results are consistent with an impaired carbon budget for large trees at warmer sites, we cannot discount causes such as hydraulic stress. We conclude that slower growth rates will impede recovery from extreme events, exacerbating the effects of higher temperatures, increased drought stress and more frequent fire on the tall eucalypt forests of southern Australia.

Reforestation - climate change and water resource implications

Egginton, P.; Beall, F.; Buttle, J

Forestry Chronicle; 2014. 90(4):516-524

In a forested catchment, river discharge in any season can be either decreased or augmented by forest management practices such as appropriate species selection, density management, and length of rotation. The efficacy of any such strategy in either new plantations or existing forests can be maximized by considering the distribution of the key hydrological functions in the catchment. With the growing awareness of climate change and its impacts, the adequacy of our water supply is becoming an issue of increasing societal importance. At the same time there is greater discussion about using our forests for carbon sequestration and biofuels. Policy-makers should be careful when introducing new programs that incentivize widespread reforestation. The implications of such planting programs on annual and seasonal river flows (under both current and future climatic conditions) need to be considered. Informed choices need to be made as to the objectives for which we manage our forests. In turn, this means that there is an urgent need for water managers and forest managers to work more closely together than in the past to optimally plan and develop forest and water management strategies.

Climate-growth relationships for yellow-poplar across structural and site quality gradients in the southern Appalachian Mountains

Keyser, T. L.; Brown, P. M

Forest Ecology and Management; 2014. 329:158-165

Forecasted changes in climate across the southeastern US include an increase in temperature along with more variable precipitation patterns, including an increase in the severity and frequency of drought events. As such, the management of forests for increased resistance or resilience to the direct and indirect effects of climate change, including decreased tree- and stand-level productivity, is of interest to natural resource practitioners. Because the sensitivity of tree growth to climate can be moderated by competition, manipulating stand density through silvicultural activities may mitigate the negative effects climate change may have on tree growth and productivity. In this paper, we utilized dendrochronology data, along with long-term forest inventory data, from 134 plots established and subsequently thinned between 1960 and 1963 to analyze the effects of climate on annual tree growth for yellow-poplar (Liriodendron tulipifera L.) across a broad stand structural and site productivity gradient in the southern Appalachian Mountains.

Annual basal area increment (BAI) was most related to the Palmer Drought Severity Index (PDSI) during the months of May, June, and July (PDSIMJJ) relative to that of the annual or growing season when structural and site productivity variables were included in the analysis. Annual BAI of trees growing in stands of lower density responded to increases in PDSIMJJ at a faster rate than trees growing in stands of greater density. Conversely, those same trees experienced proportionally greater decreases in BAI at lower values of PDSIMJJ compared to trees in stands of greater density. Annual BAI was positivity related to site productivity, as quantified by site index, with BAI more sensitive to changes in PDSIMJJ on plots of progressively higher site index. Results suggest stand structure as well as measures of productivity should be considered when quantifying climate-growth relationships for forest tree species. Such information could not only aid in the identification of stands most susceptible to reduced growth, but also be used to develop site- or stand-specific silvicultural prescriptions focused on promoting resilience or resistance under a changing climate.

How much carbon is sequestered during the restoration of tropical forests? Estimates from tree species in the Brazilian Atlantic forest

Shimamoto, C. Y.; Botosso, P. C.; Marques, M. C. M

Forest Ecology and Management; 2014. 329:1-9

The estimation of carbon accumulation in restoration areas over time is an important step for the evaluation of the success of restoration programs and to indicate the best practices for forest management and conservation. In the present study, we evaluated the aboveground biomass (AGB) of 10 tree species (fast-growing and slow-growing tree species) that are representative of the Brazilian Atlantic forest to test if biomass accumulation varies with tree age and ecological group (fast- and slow-growing). We also used regression models to simulate how much carbon is sequestered over time in restoration areas of tropical wet forests. The results exhibited differences between the two groups in terms of biomass accumulation; the slow-growing species accumulated an almost two-fold higher amount of total biomass (379.4 kg) than the fast-growing species (208.56 kg). The estimated age of the individuals explained the biomass accumulation: the long-lived and slow-growing species accumulate less biomass over a longer time, and the short-lived fast-growing species accumulate more biomass over a shorter period. These differences suggest that the fast-growing tree species contribute more to the carbon stock during the early years (approximately 37 years) of the restoration and that the slow-growing species contribute more significantly during the later stages of succession. We estimated that second-growth forests (41-60 years old) accumulate more than two-fold carbon than immature forest (21-40 years old) and much more than ten-fold carbon than young forests (7-20 years old). These differences in carbon sequestration magnitudes suggest that services provided by restoration areas, can increase exponentially in the first 60 years, and this is particularly important for future conservation and management of areas undergoing restoration.

Estimating above-ground biomass of tropical rainforest of different degradation levels in Northern Borneo using airborne LiDAR

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Forest Ecology and Management; 2014. 328:335-341

Deforestation and degradation of forests have severely depleted carbon storage in tropical countries, whose forests have the most carbon-rich ecosystems in the world. Estimating above-ground biomass (AGB) with high accuracy is critical to quantifying carbon stocks in the tropics. We propose a model to estimate AGB in the tropical montane forests of northern Borneo with different disturbance histories using airborne LiDAR data. The level of forest degradation was determined from species composition and field-observed AGB. Of 50 sample plots established in forests with various levels of degradation, we categorized 20 as highly degraded (AGB: 52.18–229.11 Mg/ha), 16 as moderately degraded (AGB: 136.00–382.59 Mg/ha), and 14 as old-growth forest (AGB: 280.31–622.79 Mg/ha). Height metrics and laser penetration rate (LP) at specific heights from the ground were derived from vertical point profiles of LiDAR data. After testing the performance of single variables, we used stepwise multiple regressions to select variables to include in the model for AGB estimation. The best model with a single variable used the mean height from the laser returns (R2 = 0.78, RMSE = 65.54 Mg/ha). All LP variables were sensitive to AGB (R2 > 0.60). The final model from stepwise analysis included the mean height of the canopy height model and LP at 7 m height (adjusted R2 = 0.81, RMSE = 61.26 Mg/ha). The results confirm the suitability of LP variables for estimating AGB. We suggest that airborne LiDAR data can capture AGB variability at fine spatial scales, which correspond to deforestation and forest degradation caused by human activities and natural disturbances.

Reduction in browsing intensity may not compensate climate change effects on tree species composition in the Bavarian Forest National Park

Cailleret, M.; Heurich, M.; Bugmann, H

Forest Ecology and Management; 2014. 328:179-192

Climate change may directly induce shifts in stand-level dynamics by altering the regeneration, growth and mortality of tree species, and indirectly by modifying interspecific competition. While some experimental and simulation studies have shown that these effects can be compensated by lower browsing pressure, it is not clear how species composition and stand basal area may respond in the short and long term, and to which extent. We investigated the response of forests to isolated and combined changes of climatic conditions and ungulate browsing intensity in the Bavarian Forest National Park (BFNP), a strictly protected forest reserve. To this aim, we firstly characterized the browsing variability within the BFNP and among each tree species. Based on this, we implemented new equations in the forest gap model ForClim v3.0 and simulated the short- and long-term development of different forest types according to pertinent scenarios of browsing intensity. The model predicted a large dieback of the dominant *Picea abies* and *Abies alba* due to the increase in summer drought and winter temperatures; these species were progressively replaced by *Fagus sylvatica*. While climate change may have a positive impact on tree diversity in the short term (~100 years), long-term simulations (>1000 years) revealed reduced tree diversity and stand basal area compared to those predicted under current climate. While species composition was strongly dependent on browsing intensity under current climate through the changes in seedling selectivity by ungulates and in light regimes, the trajectory of vegetation development under climate change was not significantly altered by browsing. Even for highly palatable species such as *A. alba*, an eradication of ungulates could not compensate the decline of drought-intolerant species. We conclude that forest management tools to reduce ungulates population may be helpful to promote species diversity in *P. abies* dominated forest. However they may not be sufficient to compensate for the reduction in basal area and diversity that is induced by climate change.

Carbon stocks and changes on Pacific Northwest national forests and the role of disturbance, management, and growth

Gray, A. N.; Whittier, T. R

Forest Ecology and Management; 2014. 328:167-178

The National Forest System (NFS) of the United States plays an important role in the carbon cycle because these lands make up a large proportion of the forested land in the country and commonly store more wood per unit area than other forest ownerships. In addition to sustaining natural resources, these lands are managed for multiple objectives that do not always align with maximizing carbon (C) sequestration. The objectives of this study were to determine C stocks and flux in measured pools on Pacific Northwest Region NFS lands and the major ecological drivers of C flux. We compiled tree, dead wood, and understory vegetation data from 11,435 systematically-placed inventory plots and estimated growth, mortality, decay, removals, and disturbance events based on two full measurements spanning 1993-2007. The area of NFS-administered lands increased by 0.3% during this period and the area in formally-designated protected status increased by 0.7%. There was 1293 Tg C (+or-11.2 Tg standard error) in non-soil C stocks at the first measurement, which increased by 45+or-2.2 Tg (3.4%), with 59% of the increase in the live tree pool and the remainder in the dead tree pools. C stocks followed broad regional patterns in productivity while C flux varied at local scales. Fires affected <1% of the forested area per year and were most prevalent in Wilderness areas. Fires reduced C stocks on burned plots by only 9%, and had a negligible effect on the region as a whole. Most tree harvest on NFS lands in the region consisted of partial harvest and had comparable impacts to fire during this period. C sequestration rates were higher (1.2+or-0.09 Mg/ha/yr) on the west side of the Cascade Mountains, and primarily stayed in the live tree pool, compared to lower rates (0.5+or-0.04 Mg/ha/yr) east of the Cascades where most of the increase was seen in the down wood pool. We discuss challenges to estimating forest ecosystem carbon stocks, which requires the application of a large number of equations and parameters for measured and unmeasured components, some with scant empirical support. Improved measurements and biomass models applied to networks of permanent plots would enable improved ground-based estimates of the drivers and components of regional changes in C.

Trees increase soil carbon and its stability in three agroforestry systems in central Alberta, Canada

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Agroforestry land-use systems have significant potential for increasing soil carbon (C) storage and mitigating increases in atmospheric greenhouse gas (GHG) concentrations. We studied the impact of three agroforestry systems (hedgerow, shelterbelt, and silvopasture) on soil organic C (SOC) and nitrogen (N) in the 0-10 cm mineral layer, by comparing SOC and N distributions in whole soils and three particle-size fractions (<53, 53-250, 250-2000 micro m) to assess the potential role of physical protection on soil C and N storage. We assessed thirty-five sites (12 hedgerows, 11 shelterbelts and 12 silvopastures), each comprised of 2 paired plots (forest and adjacent agricultural herbland), that were distributed along a 270 km long north-south soil/climate gradient in central Alberta, Canada. Across all sites, 48.4%, 28.5%, and 23.1% of SOC was found in the fine (<53

micro m), medium (53-250 micro m) and coarse fractions (250-2000 micro m), respectively. Mean SOC in the whole soil was 62.5, 47.7 and 81.3 g kg⁻¹ in hedgerow, shelterbelt and silvopasture systems, respectively. Soil C in the more stable fine fraction was 34.3, 28.8 and 29.3 g kg⁻¹ in the hedgerow, shelterbelt and silvopasture systems, respectively. Within each agroforestry system, the forested land-use consistently had greater total SOC and SOC in all size fractions than the agricultural component. Our results demonstrate the potential for trees to increase soil C sequestration in agroforestry systems within the agricultural landscape.

Future carbon cycle in mountain spruce forests of Central Europe: modelling framework and ecological inferences

Hlasny, T.; Barcza, Z.; Barka, I.; Merganicova, K.; Sedmak, R.; Kern, A.; Pajtik, J.; Balazs, B.; Fabrika, M.; Churkina, G

Forest Ecology and Management; 2014. 328:55-68

Although mountain Norway spruce forests may act as powerful carbon (C) sinks, the complexity of climate change effects on their C cycle remains unclear. In the current study, we combined the simulations produced by the process-based model Biome-BGC and the empirical model SIBYLA in order to predict the future C cycle in the spruce-dominated mountain forest stand in Central Europe. Annual data for tree height and diameter from 1997-2010 were used for models calibration. Observed climate data from 1939-2009 were transiently coupled with four climate change scenarios for the period 2010-2100. For the assessment of climate change effects, stable reference climate data were generated for 2010-2100. Because future forest mortality can follow different trajectories, Biome-BGC was run with three plausible mortality assumptions. Factorial Analysis of Variance based on Generalized Linear Models was used to dissect the total variability of produced estimates and to determine which factors explained most of the variability in the projected C pools and fluxes. Climate change was found to increase the total amount of C accumulated by ca. 3% in 2021-2050 and by 13% in 2071-2100 as compared with the reference climate. While the most likely increase was 12% for aboveground C and 6% for belowground by 2100, deadwood C remained relatively stable during the simulation period. By 2100, net ecosystem exchange was projected to increase by ca. 28%, indicating an increase in the ecosystem's capacity to accumulate C. Substantial proportions of the variability in all pools and fluxes were explained by mortality assumption and model selection but not by climate change scenario. Given the divergent outputs obtained in the current study and in other studies, we argue that C cycle simulations and inferences should not be based on any single model but rather on the integration of multiple models with complex simulation design. The performed variability decomposition stressed the importance of future forest mortality in forest C cycle modelling as well as the fact that climate change-driven scenarios of forest mortality have not been developed and used in C cycle simulations so far. Strong effect of mortality assumptions on the evaluated C cycle underscores the increasing importance of forest protection under climate change as well as the importance of silvicultural interventions to reduce stand susceptibility to damage. Low variability of the simulated values up to stand age 100 years implies that the proposed approach may provide useful support to management decisions mainly in stands where a rotation period up to 100 years is applied.

Altered stand structure and tree allometry reduce carbon storage in evergreen forest fragments in India's Western Ghats

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Tropical forests are among the largest terrestrial reservoirs of carbon, and play an important role in regulating global climate. However, as a result of historic and ongoing deforestation, carbon storage in this biome is increasingly dependent on forests that are fragmented and used by humans, with considerable uncertainty about how such disturbance alters carbon storage potential and cycling. Here, we evaluate differences in above-ground carbon stocks between fragmented and contiguous evergreen forests in the central Western Ghats, India. We also assess differences in the structure, tree allometry and functional composition of forest stands between contiguous and fragmented forests, and explore how these differences influence carbon storage in fragmented forests. Relatively large, well-protected forest fragments currently store 40% less carbon per hectare above ground than contiguous forests. These differences in carbon are related to (i) lower tree density and basal area in fragments, (ii) lower average stand height in fragments, and (iii) compositional shifts favoring species with lower wood densities. Reduced stand height in fragments was associated with intra-specific variation in tree allometry, with trees in fragments being relatively shorter at any given diameter than conspecifics in contiguous forests. Further, the relatively skewed distribution of carbon storage within a few large trees in current-day fragments is added cause for concern: carbon stocks in fragments are likely to decline further in the future, following the eventual death of large trees. Active management and restoration to mitigate ecologically driven changes in habitat structure and species composition might be as important as

improved management of resource use and protection from exploitation in order to sustain carbon storage ecosystem services provided by these tropical forest fragments.

Seeing the trees for the forest: drivers of individual growth responses to climate in *Pinus uncinata* mountain forests

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Journal of Ecology (Oxford); 2014. 102(5):1244-1257

Individual trees, not forests, respond to climate. Such an individual-scale approach has seldom been used to retrospectively track the radial growth responses of trees to climate in dendrochronology. The aim of this study was to adopt this individual view to retrospectively assess tree sensitivity to climate warming, and to evaluate and compare the potential drivers of tree growth responses to climate acting at species, site and individual scales. Following a dendroecological framework, we sampled a network of 29 *Pinus uncinata* forests in NE Spain and obtained tree-ring widths series from 642 trees. Individual features as northness, elevation, slope, basal area, sapwood area, tree height and tree age were used to evaluate the potential drivers of tree growth responses to climate. The analysed data set includes diverse ecological and biogeographical conditions. The tree growth responses to climate were assessed by relating growth indices to climatic variables using linear-mixed effects models. Maximum November temperatures during the year prior to tree-ring formation enhanced *P. uncinata* growth mainly in mid-elevation sites, whereas at higher elevations growth was more dependent on the positive effect of warmer minimum May temperatures during the year of tree-ring formation. Current June precipitation was the positive main climatic driver of growth in sites prone to water deficit such as the southernmost limit of the species distribution area or very steep sites. Elevation was the main factor controlling how much growth variability is explained by climate at the site and tree scales. Climate warming was more intense during the early 20th century, when the importance of elevation as an indirect modulator of growth declined as compared with the late 20th century. Synthesis. The individual-scale approach taken in this study allowed detecting that trees growing at southern and low-elevation sites were the most negatively affected by warm and dry summer conditions. Our results emphasize that both (i) an individual-scale approach to quantify tree growth responses to climate and (ii) a detailed evaluation of the potential biotic and abiotic drivers of those individual responses are necessary to understand climate sensitivity of trees.

V. PUBLICATIONS, REPORTS AND OTHER MEDIA

Zambia country profile. Monitoring, reporting and verification for REDD+

CIFOR

Zambia is one of the nine pilot countries for the UN-REDD programme and is currently at the first phase of readiness for REDD+ under the UN-REDD quick start initiative. A National Joint Programme (NJP) is tasked with developing a national REDD+ strategy. Outcome 5 of the NJP Programme Document is to strengthen the Monitoring Reporting and Verification (MRV) capacity for REDD+ in Zambia. A reliable system of Monitoring Reporting and Verification (MRV) is of critical importance to the effectiveness of REDD+. This report provides a comprehensive overview of the national REDD+ strategy and institutional capacity for MRV of REDD+ as well as the current state of knowledge of various elements critical to MRV of REDD+ in Zambia including: Current drivers and rates of deforestation and forest degradation; a review of standing biomass, forest growth rates and carbon stock estimates; and data sets available for MRV in Zambia. The report also identifies knowledge and data gaps that need to be filled in order to develop an effective MRV system for REDD+ in the country. Key knowledge gaps, such as carbon stocks and growth rates within different forest types, are outlined as well as recommendations as to how knowledge gaps and capacity to implement MRV of REDD+ can be addressed. The report also details how CIFOR's research in Zambia, particularly the Nyimba forest project in the Eastern Province, will contribute to MRV of REDD+ for Zambia. **The publication**

Reducing emissions from deforestation and forest degradation (REDD) in Peru: a challenge to social inclusion and multi-level governance

German Development Institute

REDD is one of the latest additions to a series of incentive-based mechanisms for reducing carbon emissions. Many developing and emerging countries have started engaging in REDD. Peru, the country with the world's fourth largest area of tropical forest, is no exception here – with an obvious motivation: about half of Peru's annual greenhouse gas emissions are currently caused by deforestation. Over the last years, public and private initiatives have led to a complex multi-level REDD governance

architecture in Peru. This architecture faces challenges in terms of social inclusion and coordination. This study identifies and analyses key issues, some of which are merely teething problems, while others are deeply rooted in socio-economic imbalances and political culture, such as insufficient financial, technical and human capacities of ministries and regional governments; legitimacy gaps; and information and participation asymmetries across public actors, NGOs, companies and forest users.
The study presents policy recommendations for addressing some of these challenges. These include: streamlining REDD processes with policies of other sectors; formalizing channels of communication and consultation; and providing a clear legal and institutional framework that encompasses the push and pull factors driving deforestation in Peru. **The publication**

Consumer Goods and Deforestation: An analysis of the extent and nature of illegality in forest conversion for agriculture and timber plantations

Forest Trends

This study has sought to estimate for the first time the proportion of recent tropical deforestation that is the result of illegal clearing for commercial agriculture and how much of this was driven by overseas demand. In addition, the study estimates for the first time the scale of primary tropical wood products now being traded globally and originating from forest conversion, as opposed to selective logging. **The publication**

InFO News. A newsletter from FAO Forestry

FAO

Find the latest issue of InFO news. **More**

Community-based adaptation in practice: A global overview of CARE International's practice of community-based adaptation (CBA) to climate change

CARE

The purpose of this paper is to document CARE's current practice of Community-Based Adaptation (CBA) to climate change and how, increasingly, elements of the approach are evolving and being integrated into other development sectors. This synthesis of CBA project examples informs an ongoing process to update our various tools and approaches to CBA for practitioner use in the near future. **The publication**

The IPCC's fifth assessment report. What's in it for South Asia?

Climate and Development Knowledge Network

The Intergovernmental Panel on Climate Change (IPCC) has produced the most comprehensive assessment of climate change ever. The Fifth Assessment Report (http://www.ipcc.ch), which the IPCC is releasing in four parts between September 2013 and November 2014, is the work of 830 expert authors, from 85 countries. Its first three volumes already stretch to 5,000+ pages. Now the Climate and Development Knowledge Network and Overseas Development Institute have released a succinct guide to the assessment for decision-makers in South Asia. The IPCC's Fifth Assessment Report: What's in it for South Asia? distils the richest material on climate impacts and trends in South Asia, and South Asian experiences in adaptation and mitigation, from the thousands of pages of the Fifth Assessment Report and complemented with similar, peer reviewed case studies from the sub-region. The expert research team has worked under the guidance of IPCC Coordinating Lead Authors and Reviewers to ensure fidelity to the original Fifth Assessment material. The IPCC's Fifth Assessment Report: What's in it for South Asia? aims to make the IPCC's important material more accessible and usable to South Asian audiences. This guide responds to wide demand for region-specific information. **The publication**

Coastal Blue Carbon. Methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrass meadows

Conservation International, IUCN, UNESCO and Intergovernmental Oceanographic Commission

There is a rapidly growing body of scientific knowledge on the direct and indirect effects of climate change and human development on coastal ecosystems. Increased attention is being paid to mangroves, tidal salt marshes, and seagrasses for their carbon sequestration capabilities, as well as other important ecosystem services. If properly planned and managed, coastal blue carbon could function as a potential funding mechanism for coastal ecosystem conservation and restoration. To achieve this goal, managers need to be able to assess carbon stocks (total amount of carbon stored within a distinct area) and monitor changes in carbon stocks and greenhouse gas (GHG) emissions over time. Until recently, coastal ecosystem managers and other stakeholders interested in quantifying blue carbon have lacked practical tools and guidance to allow for proper carbon analyses. This is particularly true in developing countries where there may be large data gaps and a lack of

technical and financial resources to carry out complex analyses. New guidelines and methodologies have begun to emerge in the last few years, all of which refer to the need for internationally accepted measuring and monitoring procedures for carbon accounting (Appendix A: Additional Guidance Documents). This guide will provide managers, scientists, and field practitioners with standardized recommendations and techniques for carbon measurement and analysis in blue carbon systems and directly support the assessment and accounting of blue carbon globally. **The publication**

V.I JOBS

Associate Programme Management Officer

UNEP - deadline for application is 26th of October 2014

UNEP is seeking an Associate Programme Management Officer for the UN-REDD programme to be based in Geneva. **More**

Chief Technical Advisor, UN-REDD Sri Lanka Programme

FAO - deadline for application is 15th of November 2014

FAO is seeking a Chief Technical Advisor for the Sri Lanka UN-REDD programme. **More**

VII. ANNOUNCEMENTS

Online search tool for sustainable forest management (SFM) projects within tropical forests

ITTO

ITTO has just released an on-line project search tool, in order to further disseminate, capitalize and enhance the knowledge it has gained through the implementation of field projects in sustainable forest management (SFM) since it began operations in 1986. This information is now available at your fingertips on the ITTO homepage, with just a few clicks away. **More**

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 monthly.

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 compiled by Marc Dumas-Johansen and Susan Braatz.

We appreciate any comments or feedback.

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