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

20 December 2013 - CIFOR

Time to 'connect the dots' among gender, forests, REDD+, experts say

Despite the large quantity of climate-change research focused on adaptation, mitigation and gender, not much of it is leading to transformative action on the ground, said a top forestry expert at the recent U.N. climate talks in Warsaw, Poland.

19 December 2013 – Responding to climate change

Will REDD+ be the saviour of the world's rainforests ?

Last week, representatives from countries across the world gathered in Geneva with a common mission: to figure out how to stop the destruction of the planet's rainforests.

17 December 2013 – CIFOR

Hopes rise for global food security as world's largest agricultural research partnership marks major milestone: doubles funding to $1 billion in five years

Fruits of new investments in CGIAR could include big boost in rice production for Asia, sustainable irrigation for millions of parched farms in Africa, and dramatic drop in forest destruction tied to agriculture.

29 November 2013 - IIED

Payments for ecosystem services: Costa Rica's recipe

Twenty years ago Costa Rica began to pioneer schemes that paid land owners to protect forests in return for the benefits they provide, such as conserving wild species, regulating river flows and storing carbon. Since 1997, nearly one million hectares of forest in Costa Rica have been part of these 'payments for ecosystem services' (PES) schemes at one time or another. Meanwhile, forest cover has returned to over 50 per cent of the country's land area, from a low of just over 20 per cent in the 1980s.

28 November 2013 – World Agroforestry Centre

Africa and the Warsaw Framework for REDD+

If African nations can tackle some of the challenges with implementation, the Warsaw Framework for REDD+ has great potential on the continent. Agreed to at the 19th Conference of Parties to the United Nations Convention to Combat Climate Change (UNFCCC), the Warsaw Framework aims to support developing nations to reduce greenhouse gas emissions from deforestation and forest degradation (REDD+). It is backed by a combined pledge of US $280 million from the United States, Norway and United Kingdom.

27 November 2013 – CIFOR

REDD+ highlights tenure problems, but does not solve them

Preparations for a proposed international scheme to pay local users to cut greenhouse gas emissions through reduced deforestation are directing more attention to forest tenure problems — but they do not solve them, researchers have found.

23 November 2013 - IISD

Warsaw Conference Adopts Decisions on ADP, REDD+, and Loss and Damage

Negotiations during the Warsaw Climate Change Conference focused on the implementation of agreements reached at previous meetings, including pursuing the work of the Ad Hoc Working Group on the Durban Platform for Enhanced Action. The conference, which took place from 11-23 November 2013 in Poland, included the 19th session of the Conference of the Parties (COP 19) to the UN Framework Convention on Climate Change (UNFCCC) and the ninth session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol (CMP 9). The conference also included meetings by three subsidiary bodies: the 39th sessions of the Subsidiary Body for Scientific and Technological Advice (SBSTA 39) and the Subsidiary Body for Implementation (SBI 39), and the third part of the second session of the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP 2).

21 November 2013 – Eco-Business.Com

Norway, UK, US allocate $280 million to stop deforestation

The governments of Norway, Britain and the United States on Wednesday said they will allocate $280 million of their multi-billion dollar climate change finances to a new initiative aimed at halting deforestation. The announcement was made at U.N. talks in Warsaw, where more than 9,000 delegates are meeting to hammer out the foundations of a new global treaty to combat climate change.

II. MULTILATERAL PROCESSES IN CLIMATE CHANGE

Past events

United Nations Framework Convention on Climate Change

11-22 November 2013, Warsaw, Poland

Intergovernmental Panel on Climate Change
The report of Working Group 1 of the Intergovernmental Panel on Climate Change was released on 30 September 2013. This, along with the reports of the Working Group 2 and 3 constitute the IPCC's Fifth Asssessment Report. The full draft of the WG 1 report can be found **here**
For a shorter version of the WG 1 report, please refer to the summary for policy makers by clicking **here**
The reports of working Group 2 and 3 are to be released in due time.

United Nations Framework Convention on Climate Change
The climate change meetings held in Warsaw from 11-23 November included the 19th session of the Conference of the Parties (COP 19) of UNFCCC; the ninth session of Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol (CPM 9). The 39th sessions of the Subsidiary Body for Scientific and Technological Advice (SBSTA 39) and of the Subsidiary Body for Implementation (SBI 39) and the third part of the second session of the *Ad hoc* Working Group on the Durban Platform for Enhanced Action (ADP) were also held.
The following points help to put the Warsaw meetings into perspective:

The devastating impact of super-typhoon Haiyan, which hit the Philippines just before the COP convened, and the recently released climate change findings of the IPCC Working Group 1 underlined the urgency for strong mitigation action.

COP19 marked the half-way point between agreement at Durban in 2011 to negotiate a post-2020 instrument by 2015. Parties and the public are concerned about the slow rate of progress in the negotiations under the ADP.

The so-far expressed level of ambition for emission reductions by developed countries for the second commitment period of the Kyoto Protocol is insufficient to keep global warming to within 2^0 C.

With the Green Climate Fund capitalized to only a minor amount, the Adaptation Fund coffers limited and the price of carbon on the market very low, developing countries view the financial support to help them address climate change (particularly extreme events) as insufficient and are not confident that developed countries will meet their commitment to provide $100 billion per year by 2020.

The number of negotiating groups and items in parallel continues to increase, compounding the complexity of the negotiation process. Also, the proliferation of UNFCCC committees, bodies, etc. has increased the budget needs of the UNFCCC Secretariat. The Secretariat asked COP to approve a 50% increase in its budget.

Key outcomes of the meetings are as follows (see http://unfccc.int/2860.php#decisions for decision texts):

A roadmap from now until December 2015, when the agreement is to be reached on the post-2020 instrument, was adopted. Parties are invited to communicate their (emissions reductions) "contributions" by the first quarter of 2015. A list of elements to be included in the agreement was not annexed to the final decision, so the outlines of the instrument are still to be drawn.

The Warsaw Framework for REDD+, a comprehensive package of seven REDD+ decisions, was adopted, thus causing some to dub the Warsaw climate change meetings " the REDD+ COP".

The "Warsaw international mechanism for loss and damage", a mechanism "under existing Convention bodies" to address loss and damage associated with extreme weather events and slow onset events in vulnerable developing countries was established.

A decision was adopted requesting developed countries to prepare biennial submissions on their strategies and approaches for scaling up climate finance from 2014-2020 and to continue deliberations on long term finance was adopted. Long term finance continued to be a contentious issue; many developing countries, calling for clarity and predictability, asked that developed countries declare mid-term targets on the way to reaching $100 billion per year by 2020, but developed countries rejected giving quantified benchmarks leading up to 2020.

Decisions and conclusions reached on REDD+ and LULUCF

REDD+

COP adopted a comprehensive package of decisions on REDD+, consisting of: three draft decisions agreed at SBSTA 38 in June 2013 (on drivers, national forest monitoring systems, and safeguards) and two draft decisions completed at SBSTA 39 on technical assessment of forest reference emission levels and/or forest reference levels, and on modalities for measuring, reporting and verifying of REDD+ actions. This completes the work of SBSTA's work programme on methodological issues on REDD+, as requested at COP 16 in Cancun. Two more decisions were adopted by COP: one on REDD+ financing, including for results based actions under a COP work programme; and another on coordination of support discussed under a joint SBI/SBSTA agenda item. The decision on financing sends a strong signal, including to the Green Climate Fund, that countries are eager for implementation with results-based payments. For the texts of these seven decisions, see: http://unfccc.int/2860.php#decisions.

The significance of the agreements reached in Warsaw on REDD+ is that the framework for results-based payments for REDD+ is now in place. Countries that have the required elements for REDD+ (a national REDD+ strategy, a national forest monitoring system, a forest reference emission level and/or forest reference level) can begin to access financing from various sources for results on the basis of an agreed metric: tonnes of CO_2 equivalent. Even though further work on REDD+ will be carried out (i.e. on ways and means to transfer payments for results-based actions and the provision of financial resources for alternative approaches; on systems for providing information on how safeguards are being addressed and respected; and on methodological guidance for non-market-based approaches and non-carbon benefits resulting from REDD+ activities), Warsaw represents a key milestone in making REDD+ operational.

More information on the COP decisions on REDD+, indicating the body under which the draft decisions were negotiated, is provided below

SBSTA

Decision on modalities for national forest monitoring systems (NFMS)

Key points**:**

NFMS be guided by the most recent IPCC guidance and guidelines as adopted or encouraged by COP for developing countries , as outlined in the reporting guidelines in decision 17/CP.8 and referred to in decision 2/CP.13, for estimating emissions and removals, forest carbon stocks, C stock changes and forest area changes

NFMS provide data that are transparent, consistent over time, and suitable for MRV for REDD+ as well as consistent with guidance for MRV for NAMAs

NFMS should be built on existing systems, assess different types of forest, be flexible, reflect the phased approach for REDD+, and may provide information related to safeguards

Decision on timing and frequency of presentations of the summary of information on how all the safeguards referred to in appendix I of decision 1/CP.16 (for REDD+) are being addressed and respected

Key points:

The information to be provided by developing countries in their national communications or on the REDD web platform on the UNFCCC website.

Provision of information is to start after the start of implementation of REDD+ activities and be done at the same frequency as the submissions of the countries' national communications and, on a voluntary basis, via the REDD web platform on the UNFCCC website.

Decision on drivers of deforestation and forest degradation

Key points:

Encourages continued work to reduce the drivers of deforestation and forest degradation and to share the results of the work, including on the REDD web platform of UNFCCC website, and encourages developing country Parties to take note of the information from ongoing and existing work.

Decision on guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels and/or forest reference levels

Key points:

Adopted guidelines and procedures for the technical assessment of voluntary submitted reference levels by developing countries. The decision lists the information to be submitted by countries and assessed by an assessment team, the composition of the assessment team (one LULUCF expert from a developed country and one from a developing country), the periodicity and timing of the assessment and of the preparation of the assessment report.

Invites Parties and relevant international organizations to support capacity-building for development and assessment of reference levels

Decision on modalities for measuring, reporting and verifying

Key points:

Decides that the data and information used by Parties to estimate forest related emissions and removals, forest carbon stock, and forest area and carbon stock changes resulting from implementation of REDD+ activities should be consistent over time and with the established forest reference emissions levels and/or forest reference levels, and should be provided by Parties voluntarily in a technical annex in their biennial update reports (BURs), and expressed in tonnes CO2 eq per year

Decides that upon request of a developing country Party to receive payments for results-based actions, two additional LULUCF experts should be participating in Technical Team of Experts for ICA (one from developing and one from developed countries) will carry out an analysis of the technical annex and prepare a report, indicating areas for technical improvement and capacity-building needs.

COP

Work programme on results-based finance to progress the full implementation of the activities referred to in decision 1/CP.16, paragraph 70.

Key points:

Encourages entities financing activities through a wide variety of sources, including the Green Climate Fund in a key role, to channel finance in a fair and balanced manner, including the number of countries to receive payments and to provide financing for alternative policy approaches, such as joint mitigation and adaptation approaches.

Agrees that the actions of countries seeking results-based payments must be fully measured, reported and verified, and recalled that the countries must have all the elements of REDD+ in place (ref. to national REDD+ strategy, reference level/reference emission levels, safeguards information system and NFMS)

Decides to establish an information hub on the REDD web platform on the UNFCCC website and requests the secretariat to insert in the hub the following information provided by each Party: results for each period in tonnes CO_2 equivalent per year and a link to the technical report on the assessment of the annex to the country's biennium update reports (BURs); assessed forest reference emission level(s) and/or forest reference level(s) in tonnes CO_2 eq/yr; summary of information on how the safeguards are being addressed and

respected; a link to the national REDD+ strategy or action plan (as appropriate); information on the NFMS; and the quantity of the results for which payments were received in tonnes CO_2 eq/yr and the entity paying for the results.

Requests the UNFCCC secretariat to organize an expert meeting to discuss the information to be included on the web platform and the format for insertion of it and to prepare the meeting report for consideration by SBI 41 in December 2014

Requests the Standing Committee on Finance to consider ways and means to transfer payments for results-based actions and the provision of financial resources for alternative approaches.

SBI/SBSTA

Coordination of support for the implementation of activities in relation to mitigation actions in the forest sector by developing countries, including institutional arrangements.

Key points:

- Interested Parties are invited to designate a national entity or focal point for liaison with UNFCCC secretariat and bodies under the Convention
- Focal points encouraged to meet together annually in conjunction with June meetings of subsidiary bodies, but with the first meeting to be in December 2014.
- SBI to review in December 2017 the outcome of these meetings and consider need for alternatives for the coordination of support for implementation of REDD+ activities.

LULUCF *(SBSTA conclusion: FCCC/SBSTA/2013/L.26)*

Very little progress was made due to the limited negotiation time allocated to this agenda item.

The issues on the table were:

- possible additional LULUCF activities for inclusion under the CDM
- alternative approaches for addressing non-permanence of CDM activities
- more comprehensive accounting of LULUCF emissions and removals, including
- through a more inclusive activity-based approach or a land-based approach
- application of the concept of additionality of LULUCF activities.

Only the first two issues were discussed. The SBSTA conclusion on this agenda item consisted of a roadmap for addressing them, as follows: i) countries and observers to continue to make submissions on these issues until 28 February 2014; 2) by 26 March 2014 the UNFCCC Secretariat to prepare a technical paper based on these and on submissions already received (see FCCC/SBSTA/2013/MISC.18 and Add.1; FCCC/SBSTA/2013/MISC.19); the secretariat to organize a workshop before SBSTA 41 (Dec 2014) and to prepare the workshop report for consideration at SBSTA 41.

SBSTA 40 will continue consideration of more comprehensive accounting of LULUCF and the concept of additionality. It was agreed that any outcomes on these points would not be applicable for the second commitment period of the Kyoto Protocol.

Other significant developments

On 19 November, a High Level Panel Event on the Land Sector and Forests was held to begin a discussion on the potential role of the land sector, including forests, after 2020 and to determine its role in the future climate regime. A report of the workshop will be made available by the UNFCCC secretariat.

The UN Secretary General, Ban Ki-Moon, announced that he is convening a Climate Change Summit for Heads of State on 23 September 2014 at the UN Headquarters in New York.

An announcement was made that $280 million would be contributed by Norway, the US and the UK to the Initiative for Sustainable Forest Landscapes (ISFL), a new multilateral facility managed by the World Bank to promote reduced greenhouse gas emissions from the land sector, including through REDD+, more sustainable agriculture, as well as smarter land use planning and policies.

Norway announced that it would continue to fund REDD+ activities at least at the current level until 2020.

Upcoming sessions of the COPs/CMPs

The next three COP/CMP meetings will be held as follows:
COP 20/CMP10: Lima, Peru 1-12 December 2014
COP 21/CMP11: Paris, France 30 Nov-11 December 2015
COP 22/CMP12: Dakar, Senegal Nov/Dec 2016

III. EVENTS & MEETINGS

Upcoming events

Forests Asia Conference
20 – 21 March 2014, Shangri-La-Hotel Jakarta, Indonesia

The Center for International Forestry Research (CIFOR) will convene a two-day conference focusing on sustainable forest landscapes to achieve green growth in the countries of the Association of Southeast Asian Nations (ASEAN), taking perspectives from other emerging economies such as China and India. Timed to celebrate the International Day of Forests (March 21) and with the Indonesian President Yudhoyono invited to deliver a keynote address, Forests Asia seeks to position forests and landscapes at the core of the ASEAN Community 2015 process and to inform a common stance among the ASEAN countries on the post-2015 Development Agenda, including the Sustainable Development Goals (SDGs). Alongside rapid economic growth and overall progress in development, Asia is still home to roughly two thirds of the world's poor, and is disproportionately affected by extreme weather, with much of its rural population dependent on climate-sensitive sectors such as forestry, agriculture or fishing. Already a major contributor to global greenhouse gas emissions from agriculture and land use change, Southeast Asia's growing economy and population will add further pressure on the region's forests and landscapes for forest goods, food, nutrition and energy. Attracting the region's leading policymakers, pioneers of the business, civil society, research, donor and media communities, the conference will address governance and trade and investment opportunities to optimize Southeast Asia's forest landscapes for climate change mitigation and adaptation, energy, livelihoods, food security and nutrition. **More**

Third International Climate Change Adaptation Conference
12 – 16 May 2014, Centro de Eventos do Ceará, Fortaleza, Brazil

The Third International Climate Change Adaptation Conference 2014 (Adaptation Futures 2014) will be the nexus between the research community and the users of climate change adaptation information at regional and global scale. This conference follows the successfull pioneer Climate Adaptation Futures Conference, co-hosted by Australia's National Climate Change Adaptation Research Facility and the CSIRO Climate Adaptation Flagship in Australia in 2010, and the Adaptation Futures 2012 International Conference on Climate Adaptation in Arizona in 2012. Inspired by these two conferences, the Third Conference will build on the community that comes together in Fortaleza and foster a connected, collaborative and creative international network of adaptation researchers, decision makers and interested citizens.The conference will bring together researchers, policy makers, and practitioners from developed and developing countries to share insights into the challenges and opportunities that adaptation presents, and to share strategies for decision making from international to local scales. **More**

IV. RESEARCH ARTICLES

Predicting geographic distribution and habitat suitability due to climate change of selected threatened forest tree species in the Philippines
Garcia, K.; Lasco, R.; Ines, A.; Lyon, B.; Pulhin, F
Applied Geography; 2013. 44:12-22

Climate change is projected to alter the geographic distribution of forest ecosystems. This study aimed to

evaluate the consequences of climate change on geographical distributions and habitat suitability of 14 threatened forest tree species in the Philippines. Based on the principle of maximum entropy, it utilized a machine algorithm called Maxent to estimate a target probability distribution and habitat suitability of the selected species. Threatened forest tree species occurrence records and sets of biophysical and bioclimatic variables were inputted to Maxent program to predict current and future distribution of the species. The Maxent models of the threatened species were evaluated using Receiver Operating Characteristics Area Under Curve (ROC AUC) and True Skill Statistics (TSS) tests which revealed that the models generated were better than random. The Maxent models ROC AUC values of the 14 species range from 0.70 to 0.972 which is higher than 0.5 of a null model. Based on TSS criteria, Maxent models performed good in two species, very good in ten species, and excellent in two species. Seven species (Afzelia rhomboidea;Koordersiodendron pinnatum; Mangifera altissima; Shorea contorta; Shorea palosapis; Shorea polysperma;Vitex parviflora) were found to likely benefit from future climate due to the potential increase in their suitable habitat while the other seven species (Agathis philippinensis; Celtis luzonica; Dipterocarpus grandiflorus;Shorea guiso; Shorea negrosensis; Toona calantas; Vatica mangachapoi) will likely experience decline in their suitable habitat. This study provided an initial understanding on how the distribution of threatened forest trees will be affected by climate change in the Philippines. The generated species distribution models and habitat suitability maps could be used as basis in formulating appropriate science-based adaptation policies, strategies and measures that could enhance the resilience of those threatened forest tree species and their natural ecosystems to current and future climate.

Uncertainty in the spatial distribution of tropical forest biomass: a comparison of pan-tropical maps

Mitchard, E. T. A.; Saatchi, S. S.; Baccini, A.; Asner, G. P.; Goetz, S. J.; Harris, N. L.; Brown, S
Carbon Balance and Management; 2013. 8(10):(26 October 2013)

Background: Mapping the aboveground biomass of tropical forests is essential both for implementing conservation policy and reducing uncertainties in the global carbon cycle. Two medium resolution (500 m-1000 m) pantropical maps of vegetation biomass have been recently published, and have been widely used by sub-national and national-level activities in relation to Reducing Emissions from Deforestation and forest Degradation (REDD+). Both maps use similar input data layers, and are driven by the same spaceborne LiDAR dataset providing systematic forest height and canopy structure estimates, but use different ground datasets for calibration and different spatial modelling methodologies. Here, we compare these two maps to each other, to the FAO's Forest Resource Assessment (FRA) 2010 country-level data, and to a high resolution (100 m) biomass map generated for a portion of the Colombian Amazon. Results: We find substantial differences between the two maps, in particular in central Amazonia, the Congo basin, the south of Papua New Guinea, the Miombo woodlands of Africa, and the dry forests and savannas of South America. There is little consistency in the direction of the difference. However, when the maps are aggregated to the country or biome scale there is greater agreement, with differences cancelling out to a certain extent. When comparing country level biomass stocks, the two maps agree with each other to a much greater extent than to the FRA 2010 estimates. In the Colombian Amazon, both pantropical maps estimate higher biomass than the independent high resolution map, but show a similar spatial distribution of this biomass. Conclusions: Biomass mapping has progressed enormously over the past decade, to the stage where we can produce globally consistent maps of aboveground biomass. We show that there are still large uncertainties in these maps, in particular in areas with little field data. However, when used at a regional scale, different maps appear to converge, suggesting we can provide reasonable stock estimates when aggregated over large regions. Therefore we believe the largest uncertainties for REDD+ activities relate to the spatial distribution of biomass and to the spatial pattern of forest cover change, rather than to total globally or nationally summed carbon density.

Quantitative assessment of predicted climate change pressure on North American tree species

Potter, K. M.; Hargrove, W. W
Mathematical and Computational Forestry and Natural Resources Sciences; 2013. 5(2):151-169.

Changing climate may pose a threat to forest tree species, forcing three potential population-level responses: toleration/adaptation, movement to suitable environmental conditions, or local extirpation. Assessments that prioritize and classify tree species for management and conservation activities in the face of climate change will need to incorporate estimates of the risk posed by climate change to each species. To assist in such assessments, we developed a set of four quantitative metrics of potential climate change pressure on forest tree species: (1) percent change in suitable area, (2) range stability over time, (3) range shift pressure, and (4) current realized niche occupancy. All four metrics are derived from climate change environmental suitability maps generated using the Multivariate Spatio-Temporal Clustering (MSTC) technique, which combines aspects of traditional geographical information systems and statistical clustering techniques. As part of the Forecasts of Climate-Associated Shifts in Tree Species (ForeCASTS) project, we calculated the predicted climate change

pressure statistics for North American tree species using occurrence data from the USDA Forest Service Forest Inventory and Analysis (FIA) program. Of 172 modeled tree species, all but two were projected to decline in suitable area in the future under the Hadley B1 Global Circulation Model/scenario combination. Eastern species under Hadley B1 were predicted to experience a greater decline in suitable area and less range stability than western species, although predicted range shift did not differ between the regions. Eastern species were more likely than western species, on average, to be habitat generalists. Along with the consideration of important species life-history traits and of threats other than climate change, the metrics described here should be valuable for efforts to determine which species to target for monitoring efforts and conservation actions.

Effects of harvesting on spatial and temporal diversity of carbon stocks in a boreal forest landscape

Ter-Mikaelian, M. T.; Colombo, S. J.; Chen JiaXin
Ecology and Evolution; 2013. 3(11):3738-3750

Carbon stocks in managed forests of Ontario, Canada, and in harvested wood products originated from these forests were estimated for 2010-2100. Simulations included four future forest harvesting scenarios based on historical harvesting levels (low, average, high, and maximum available) and a no-harvest scenario. In four harvesting scenarios, forest carbon stocks in Ontario's managed forest were estimated to range from 6202 to 6227 Mt C (millions of tons of carbon) in 2010, and from 6121 to 6428 Mt C by 2100. Inclusion of carbon stored in harvested wood products in use and in landfills changed the projected range in 2100 to 6710-6742 Mt C. For the no-harvest scenario, forest carbon stocks were projected to change from 6246 Mt C in 2010 to 6680 Mt C in 2100. Spatial variation in projected forest carbon stocks was strongly related to changes in forest age (r=0.603), but had weak correlation with harvesting rates. For all managed forests in Ontario combined, projected carbon stocks in combined forest and harvested wood products converged to within 2% difference by 2100. The results suggest that harvesting in the boreal forest, if applied within limits of sustainable forest management, will eventually have a relatively small effect on long-term combined forest and wood products carbon stocks. However, there was a large time lag to approach carbon equality, with more than 90 years with a net reduction in stored carbon in harvested forests plus wood products compared to nonharvested boreal forest which also has low rates of natural disturbance. The eventual near equivalency of carbon stocks in nonharvested forest and forest that is harvested and protected from natural disturbance reflects both the accumulation of carbon in harvested wood products and the relatively young age at which boreal forest stands undergo natural succession in the absence of disturbance.

Effects of forest type and environmental factors on forest carbon use efficiency assessed using MODIS and FIA data across the eastern USA

Kwon, Y. S.; Larsen, C. P. S
International Journal of Remote Sensing; 2013. 34(23):8425-8448

The carbon use efficiency (CUE) of a forest, calculated as the ratio of net primary productivity (NPP) to gross primary productivity (GPP), measures how efficiently a forest sequesters atmospheric carbon. Some prior research has suggested that CUE varies with environmentalconditions, while other suggests that CUE is constant. Research using Moderate Resolution Imaging Spectroradiometer (MODIS) data has indicated a variable CUE, but those results are suspected because MODIS NPP data have not been well validated. We tested two questions. First, whether MODIS CUE is constant or whether it varies by forest type, climate, and geographic factors across the eastern USA. Second, whether those results occur when field-based NPP data are employed. We used MODIS model-based estimates of GPP and NPP, and forest inventory and anlaysis (FIA) field-based estimates of NPP data. We calculated two estimates of CUE for forest in 390 km2 hexagons: (1) MODIS CUE as MODIS NPP divided byMODIS GPP and (2) F/M ZCUE as the standardized difference between FIA NPP and MODIS GPP. MODIS CUE and F/M ZCUE both varied similarly and significantly in relation to forest type, and climatic and geographic factors, strongly supporting a variable rather than a constant CUE. The CUE was significantly higher in deciduous than in mixed and evergreen forests. Regression models indicated that CUE decreased with increases in temperature and precipitation and increased with latitude and altitude. The similar trends in MODIS CUE and F/M ZCUE support theuse of the more easily obtained MODIS CUE.

Potential impact of albedo incorporation in boreal forest sector climate change policy effectiveness

Sjolie, H. K.; Latta, G. S.; Solberg, B
Climate Policy; 2013. 13(6):665-679

Forests have an important role to play in climate change mitigation through carbon sequestration and wood supply. However, the lower albedo of mature forests compared to bare land implies that focusing only on GHG accounting may lead to biased estimates of forestry's total climatic impacts. An economic model with a high

degree of detail of the Norwegian forestry and forest industries is used to simulate GHG fluxes and albedo impacts for the next decades. Albedo is incorporated in a carbon tax/subsidy scheme in the Norwegian forest sector using a partial, spatial equilibrium model. While a price of EU Euro 100/t CO_2e that targets GHG fluxes only results in reduced harvests, the same price including albedo leads to harvest levels that are five times higher in the first five years, with 39% of the national productive forest land base being cleared. The results suggest that policies that only consider GHG fluxes and ignore changes in albedo will not lead to an optimal use of the forest sector for climate change mitigation. Policy relevance. Bare land reflects a larger share of incoming solar energy than dense forest and thus has higher albedo. Earlier research has suggested that changes in albedo caused by management of boreal forest may be as important as carbon fluxes for the forest's overall global warming impacts. The presented analysis is the first attempt to link albedo to national-scale forest climate policies. A policy with subsidies to forest owners that generate carbon sequestration and taxes levied on carbon emissions leads to a reduced forest harvest. However, including albedo in the policy alongside carbon fluxes yields very different results, causing initial harvest levels to increase substantially. The inclusion of albedo impacts will make harvests more beneficial for climate change mitigation as compared to a carbon-only policy. Hence, it is likely that carbon policies that ignore albedo will not lead to optimal forest management for climate change mitigation.

Carbon sequestration in freshwater wetlands in Costa Rica and Botswana

Bernal, B.; Mitsch, W. J.

Biogeochemistry; 2013. 115(1/3):77-93

Tropical wetlands are typically productive ecosystems that can introduce large amounts of carbon into the soil. However, high temperatures and seasonal water availability can hinder the ability of wetland soils to sequester carbon efficiently. We determined the carbon sequestration rate of 12 wetland communities in four different tropical wetlands—an isolated depressional wetland in a rainforest, and a slow flowing rainforest swamp, a riverine flow-through wetland with a marked wet and dry season, a seasonal floodplain of an inland delta—with the intention of finding conditions that favor soil carbon accumulation in tropical wetlands. Triplicate soil cores were extracted in these communities and analyzed for total carbon content to determine the wetland soil carbon pool. We found that the humid tropic wetlands had greater carbon content ($P \leq 0.05$) than the tropical dry ones (96.5 and 34.8 g C kg−1, respectively). While the dry tropic wetlands had similar sequestration rates (63 ± 10 g Cm−2 y−1 on average), the humid tropic ones differed significantly ($P < 0.001$), with high rates in a slow-flowing slough (306 ± 77 g Cm−2 y−1) and low rates in a tropical rain forest depressional wetland (84 ± 23 g Cm−2 y−1). The carbon accumulating in all of these wetlands was mostly organic (92–100%). These results suggest the importance of differentiating between types of wetland communities and their hydrology when estimating overall rates at which tropical wetlands sequester carbon, and the need to include tropical wetland carbon sequestration in global carbon budgets.

Channel and landscape dynamics in the alluvial forest mosaic of the Carmanah River valley, British Columbia, Canada

Little, P. J.; Richardson, J. S.; Alila, Y

Geomorphology; 2013. 202:86-100.

The highly diverse shifting-mosaic of forest patches of an alluvial forest within the Carmanah River valley on the west coast of Vancouver Island, British Columbia was studied to examine the hydrogeomorphic disturbance regime that structures it. We used a landscape-scale analysis to quantify historical channel migrations and changes in the extent of specific forest types. This GIS-based analysis using a 70-year aerial photographic record was complemented by field-based research. Thirty-eight plots containing 4509 trees were sampled for forest structure, age, and elevation above the contemporary channel. These data, including a vegetation chronosequence spanning over 500 years, were used to examine channel and landscape dynamics. Our findings support a general conceptual model that describes cycles of patch development and destruction in unconfined alluvial forests of the Pacific Coastal Ecoregion. Over the past century, Carmanah River has eroded nearly 30% of the alluvial forest in this study area, and approximately 65% over the past 500 years. At least 80% of the 2007 channel was forested area within the past 70 years. Younger landforms were disturbed more frequently than mature forest patches, which suggest that as biogeomorphic succession progresses the likelihood of future disturbance decreases. Estimated half lives of landforms ranged from 24 years for pioneer bars to over 1500 years for old growth terraces. Years of regional high magnitude floods resulted in a net loss of floodplain forest area indicating that disturbance was climate driven in this pluvial watershed, whereby rain events result in flood disturbance that converted forests to channel. These events initiate a subsequent course of vegetation succession and geomorphic development, and often result in the deposition of large wood that modifies the channel environment and contributes to channel avulsion and further hydrogeomorphic disturbance. The composition of the landscape is a reflection of the balance between the disturbance rate and successional development. We also observed a relationship between landscape composition and watershed size. Specifically, the ratio of mature to developing alluvial forests was higher in this smaller watershed compared

to larger watersheds in the region. Results imply that larger flood events predicted to occur with climate change may change the disturbance regime of floodplain forests and alter landscape composition.

Extended leaf senescence promotes carbon gain and nutrient resorption: importance of maintaining winter photosynthesis in subtropical forests

Zhang YongJiang; Yang QiuYun; Lee, D. W.; Goldstein, G.; Cao KunFang

Oecologia; 2013. 173(3):721-730.

The relative advantages of being deciduous or evergreen in subtropical forests and the relationship between leaf phenology and nutrient resorption efficiency are not well understood. The most successful deciduous species (Lyonia ovalifolia) in an evergreen-dominated subtropical montane cloud forest in southwest (SW) China maintains red senescing leaves throughout much of the winter. The aim of this study was to investigate whether red senescing leaves of this species were able to assimilate carbon in winter, to infer the importance of maintaining a positive winter carbon balance in subtropical forests, and to test whether an extended leaf life span is associated with enhanced nutrient resorption and yearly carbon gain. The red senescing leaves of L. ovalifolia assimilated considerable carbon during part of the winter, resulting in a higher yearly carbon gain than co-occurring deciduous species. Its leaf N and P resorption efficiency was higher than for co-occurring non-anthocyanic deciduous species that dropped leaves in autumn, supporting the hypothesis that anthocyanin accumulation and/or extended leaf senescence help in nutrient resorption. Substantial winter carbon gain and efficient nutrient resorption may partially explain the success of L. ovalifoliaversus that of the other deciduous species in this subtropical forest. The importance of maintaining a positive carbon balance for ecological success in this forest also provides indirect evidence for the dominance of evergreen species in the subtropical forests of SW China.

Managing forests and fire in changing climates

Stephens, S. L.; Agee, J. K.; Fule, P. Z.; North, M. P.; Romme, W. H.; Swetnam, T. W.; Turner, M. G

Science (Washington); 2013. 342(6154):41-42.

This paper describes future forest fires brought about by climate warming. The paper establishes that fire policy focusing on suppression only delays the inevitable, promising more dangerous destructive future forest fires.

Liana impacts on carbon cycling, storage and sequestration in tropical forests

Heijden, G. M. van der; Schnitzer, S. A.; Powers, J. S.; Phillips, O. L.

Biotropica; 2013. 45(6):682-692

Mature tropical forests sequester large quantities of atmospheric CO_2, which they store as plant biomass. These forests are changing however, including an increase in liana abundance and biomass over recent decades in Neotropical forests. We ask here how this increase in lianas might impact the tropical forest carbon cycle and their capacity for carbon storage and sequestration. Lianas reduce tree growth, survival, and leaf productivity; however, lianas also invest significantly in leaf production, and the increase in lianas could conceivably offset liana-induced reductions in tree canopy productivity with no adverse effects to the forest-level canopy productivity. By contrast, lianas decrease the total ecosystem uptake of carbon by reducing tree biomass productivity. Lianas themselves invest little in woody biomass, and store and sequester only a small proportion of the biomass in tropical forests. As lianas increase they may effectively displace trees, but the greater liana carbon stocks are unlikely to compensate for liana-induced losses in net carbon sequestration and storage by trees. A potentially important additional consideration is the impact of lianas on the tree community. By competing more intensely with shade-tolerant, more densely wooded trees than with fast-growing, light-wooded trees, lianas may shift tree composition toward faster-growing species, which store relatively little carbon, and thereby further reduce the carbon storage capacity of tropical forests. Overall, current evidence indicates that the increase in lianas will negatively impact the carbon balance of tropical forests, with potentially far-reaching consequences for global atmospheric CO_2 levels and associated climate change.

Tree species effects on soil properties and greenhouse gas fluxes in East-central Amazonia: comparison between monoculture and diverse forest

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Biotropica; 2013. 45(6):709-718

Tropical plantations are considered a viable option to sequester carbon on abandoned agricultural lands, but implications of tree species selection for overall greenhouse gas budgets on plantations have been little studied. During three wet seasons, we investigated the influence of nine tree species on soil pH, temperature

(ST), bulk density (BD), moisture content water filled pore space (WFPS), and greenhouse gas fluxes in diverse forest sites and monoculture plantation plots. All sites were on clay-rich soils of the Barreiras formation, in east-central Amazônia, Brazil. We found that ST and BD were 0.6°C and 0.2 g/cm3 higher in the plantation relative to the forest, and soil CH4, CO,2 and N2O fluxes were, respectively, 38, 12, 62, percent lower in the plantation. Tree growth rates were highly variable on the plantation, with the mean comparable to the forest sites. Tree species identity mattered (P < 0.01) for all soil properties and gas fluxes on the plantation, but only for pH, BD, WFPS, and N2O fluxes in the forest. The species rank order of pH and N2O fluxes in the forest, however, were unlike the plantation. Tree growth rates were a strong predictor for soil WFPS, and together with location, they also explained 75 percent of the mean N2O flux variation. Our study indicates that: (1) tree species influence soil processes; and (2) high tree growth and low soil gas emissions imply a reduced climate forcing effect from plantations, especially when planted with fast-growing legume species on abandoned farmland.

The neglect of governance in forest sector vulnerability assessments: structural-functionalism and "black box" problems in climate change adaptation planning

Wellstead, A. M.; Howlett, M.; Rayner, J

Efforts to develop extensive forest-based climate change vulnerability assessments have informed proposed management and policy options intended to promote improved on-the-ground policy outcomes. These assessments are derived from a rich vulnerability literature and are helpful in modeling complex ecosystem interactions, yet their policy relevance and impact has been limited. We argue this is due to structural-functional logic underpinning these assessments in which governance is treated as a procedural "black box" and policy-making as an undifferentiated and unproblematic output of a political system responding to input changes and/or system prerequisites. Like an earlier generation of systems or cybernetic thinking about political processes, the focus in these assessments on macro system-level variables and relationships fails to account for the multi-level or polycentric nature of governance and the possibility of policy processes resulting in the nonperformance of critical tasks.

From carbon projects to better land-use planning: three Latin American initiatives

Rival, L. M

I start with a discussion of the limits of the United Nations' Reducing Emissions from Deforestation and Forest Degradation and cobenefits (REDD+) program and the need to embed forest carbon within integrated ecosystem services on a landscape scale. By comparing a REDD+ project with two non-REDD+ projects, I show that there are diverse ways of applying the Earth system governance lens to address the continuing deterioration of goods and services provided by ecological systems. I then compare the valuation of ecosystem services and the governance of their provision in the three projects under review: Bolsa Floresta in the state of Amazonas, Brazil; Aracuai Sustentavel in the state of Minas Gerais, Brazil; and the Yasuni-Ishpingo Tambococha Tiputini Initiative in Ecuador. I show how each project has given birth to innovative mixed policies based on citizen mobilization. These dynamic hybrid policies are uniquely fitted to the particular ecological, historical, sociocultural, and political contexts in which they took root, contexts they help to transform. I conclude that result-based payment systems such as those envisaged for REDD+ have the potential to increase the production of additional carbon absorption capacity. However, they are not always appropriate or cost effective, nor do they substitute for command-and-control instruments, or for popular mobilization.

Uncertain emission reductions from Forest conservation: REDD in the Bale Mountains, Ethiopia.

Watson, C.; Mourato, S.; Milner-Gulland, E. J

The environmental integrity of a mechanism rewarding Reduced Emissions from Deforestation and Degradation (REDD) depends on appropriate accounting for emission reductions. Largely stemming from a lack of forest data in developing countries, emission reductions accounting contains substantial uncertainty as a result of forest carbon stock estimates, where the application of biome-averaged data over large forest areas is commonplace. Using a case study in the Bale Mountains in Ethiopia, we exemplify the implications of primary and secondary forest carbon stock estimates on predicted REDD project emission reductions and revenues. Primary data estimate area-weighted mean forest carbon stock of 195 tC/ha+or-81, and biome-averaged data reported by the Intergovernmental Panel on Climate Change underestimate forest carbon stock in the Bale Mountains by as much as 63% in moist forest and 58% in dry forest. Combining forest carbon stock estimates and uncertainty in voluntary carbon market prices demonstrates the financial impact of uncertainty: potential revenues over the 20-year project ranged between US$9 million and US$185 million. Estimated revenues will influence decisions to implement a project or not and may have profound implications for the level of benefit sharing that can be

supported. Strong financial incentives exist to improve forest carbon stock estimates in tropical forests, as well as the environmental integrity of REDD projects.

Community monitoring for REDD+: international promises and field realities

Danielsen, F.; Adrian, T.; Brofeldt, S.; Noordwijk, M. van; Poulsen, M. K.; Rahayu, S.; Rutishauser, E.; Theilade, I.; Widayati, A.; Ngo The An; Tran Nguyen Bang; Budiman, A.; Enghoff, M.; Jensen, A. E.; Kurniawan, Y.; Li QiaoHong; Zhao MingXu; Schmidt-Vogt, D.; Prixa, S.; Thoumtone, V.; Warta, Z.; Burgess, N.;

Ecology and Society; 2013. 18(3):Art. 41

Will community monitoring assist in delivering just and equitable REDD+? We assessed whether local communities can effectively estimate carbon stocks in some of the world's most carbon rich forests, using simple field protocols, and we reviewed whether community monitoring exists in current REDD+ pilots. We obtained similar results for forest carbon when measured by communities and professional foresters in 289 vegetation plots in Southeast Asia. Most REDD+ monitoring schemes, however, contain no community involvement. To close the gulf between United Nations Framework Convention on Climate Change texts on involving communities and field implementation realities, we propose greater embedding of community monitoring within national REDD+ pilot schemes, which we argue will lead to a more just REDD+.

Spatial variability of selected forest soil properties related to carbon management in tropical lowland and Montane forests

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Journal of Tropical Forest Science; 2013. 25(4):577-591

A better understanding of spatial variability of forest soil properties related to carbon (C) sequestration will improve management strategies towards conserving forest areas that project higher C stocks. This study was aimed at determining spatial variability of soil C, C:N (nitrogen) and forest floor depth in tropical lowland and montane forests at varying topographic positions. Quadrants of 10 m x10 m were established for soil (0-15 cm depth) and forest floor sampling along three slope positions. This amounted to 120 quadrants at the montane forest and 60, in the lowland forest. Soil and forest floor samples were geo-referenced using global positioning system. Univariate statistics, including normality check, non-spatial outlier detection and data transformation were performed on test variables, followed by variography and kriging analyses to quantify spatial variability. Results showed that spatial structure of test variables differed across topographic positions and within the lowland forest. Surface maps showed distinct spatial clustering and displayed acceptable accuracy of interpolated values. Soil C stocks were highest in the summit, followed by toeslope, sideslope and Jengka Virgin Jungle Reserve. Site specific management for carbon sequestration monitoring in tropical forest should be based on topographic delineation.

Mangrove carbon stock assessment by optical satellite imagery

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Journal of Tropical Forest Science; 2013. 25(4):554-565.

Matang Mangrove Forest Reserve or known as Matang Mangroves is the largest single mangroves in Peninsular Malaysia. Covering an area of about 41,000 ha, majority of this area is forest reserve. Mangroves have long been known as extremely productive ecosystem that cycle carbon (C) rapidly, but studies related to carbon in this ecosystem are limited. This study was carried out to assess the carbon stock and quantify their changes following deforestation, wood extraction and forest degradation. Landsat-TM and SPOT-5 satellite images for 1991 and 2011 respectively were utilised to identify mangroves. Vegetation index generated from the images was used as a variable to indicate carbon stock and it was correlated to forest inventory information through regression. The study showed that carbon stocks of Matang Mangroves ranged from 1.03 to 263.65 t C ha-1 and 1.01 to 259.68 t C ha-1 for the years 1991 and 2011 respectively. Total carbon stock in Matang Mangroves was estimated at about 3.04 mil t C in year 1991 and 2.15 mil t C in 2011. The study suggested that the traditional use of vegetation index from optical imagery systems is still relevant and viable in vegetative studies.

Carbon dynamics in the future forest: the importance of long-term successional legacy and climate-fire interactions

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Global Change Biology; 2013. 19(11):3502-3515

Understanding how climate change may influence forest carbon (C) budgets requires knowledge of forest growth relationships with regional climate, long-term forest succession, and past and future disturbances, such as wildfires and timber harvesting events. We used a landscape-scale model of forest succession, wildfire, and C dynamics (LANDIS-II) to evaluate the effects of a changing climate (A2 and B1 IPCC emissions; Geophysical

Fluid Dynamics Laboratory General Circulation Models) on total forest C, tree species composition, and wildfire dynamics in the Lake Tahoe Basin, California, and Nevada. The independent effects of temperature and precipitation were assessed within and among climate models. Results highlight the importance of modeling forest succession and stand development processes at the landscape scale for understanding the C cycle. Due primarily to landscape legacy effects of historic logging of the Comstock Era in the late 1880s, C sequestration may continue throughout the current century, and the forest will remain a C sink (Net Ecosystem Carbon Balance >0), regardless of climate regime. Climate change caused increases in temperatures limited simulated C sequestration potential because of augmented fire activity and reduced establishment ability of subalpine and upper montane trees. Higher temperatures influenced forest response more than reduced precipitation. As the forest reached its potential steady state, the forest could become C neutral or a C source, and climate change could accelerate this transition. The future of forest ecosystem C cycling in many forested systems worldwide may depend more on major disturbances and landscape legacies related to land use than on projected climate change alone.

Response of an old-growth tropical rainforest to transient high temperature and drought

Silva, C. E.; Kellner, J. R.; Clark, D. B.; Clark, D. A.
Global Change Biology; 2013. 19(11):3423-3434

Tropical rainforests have experienced episodes of severe heat and drought in recent decades, and climate models project a warmer and potentially drier tropical climate over this century. However, likely responses of tropical rainforests are poorly understood due to a lack of frequent long-term measurements of forest structure and dynamics. We analyzed a 12-year record (1999-2010) of 47 817 annual measurements of canopy height to characterize the response of an old-growth Neotropical rainforest to the severe heat and drought associated with the 1997-1998 El Nino. Well-drained soils on slopes and plateaus experienced a threefold increase in the fraction of the landscape in gaps (<=2 m) and a reduction in the fraction in high canopy (>15 m) causing distributions of canopy height to depart from equilibrium for a period of 2-3 years. In contrast, forests on low-lying alluvial terraces remained in equilibrium and were nearly half as likely to experience upper canopy (>15 m) disturbance over the 12 years of observation. Variation in forest response across topographic positions suggests that tropical rainforests are more sensitive to moisture deficits than high temperature and that topography likely structures landscape-level variation in the severity of drought impacts.

An imperative need for global change research in tropical forests

Zhou XuHui; Fu YuLing; Zhou LingYan; Li Bo; Luo, Y. Q.;
Tree Physiology; 2013. 33(9):903-912.

Tropical forests play a crucial role in regulating regional and global climate dynamics, and model projections suggest that rapid climate change may result in forest dieback or savannization. However, these predictions are largely based on results from leaf-level studies. How tropical forests respond and feedback to climate change is largely unknown at the ecosystem level. Several complementary approaches have been used to evaluate the effects of climate change on tropical forests, but the results are conflicting, largely due to confounding effects of multiple factors. Although altered precipitation and nitrogen deposition experiments have been conducted in tropical forests, large-scale warming and elevated carbon dioxide (CO_2) manipulations are completely lacking, leaving many hypotheses and model predictions untested. Ecosystem-scale experiments to manipulate temperature and CO_2 concentration individually or in combination are thus urgently needed to examine their main and interactive effects on tropical forests. Such experiments will provide indispensable data and help gain essential knowledge on biogeochemical, hydrological and biophysical responses and feedbacks of tropical forests to climate change. These datasets can also inform regional and global models for predicting future states of tropical forests and climate systems. The success of such large-scale experiments in natural tropical forests will require an international framework to coordinate collaboration so as to meet the challenges in cost, technological infrastructure and scientific endeavor.

Carbon forestry in West Africa: the politics of models, measures and verification processes

Leach, M.; Scoones, I.
Global Environmental Change; 2013. 23(5):957-967.

In a context of neo-liberal environmental governance, imperatives for global climate change mitigation are motivating a new round of policy initiatives and projects aimed at carbon forestry: conserving and enhancing forest carbon stocks, and trading these values in emerging carbon markets. In this context modelling and measurement, always significant in framing and justifying forest policy initiatives, are of renewed importance, with a growing array of protocols focused on counting and accounting for forest carbon as a commodity. This article draws on perspectives from science and technology studies and environmental discourse analysis to explore how these modelling and measurement processes are being co-constructed with forest carbon policies and political economies, and applied in project design in local settings. Document analysis and key informant

interviews are used to track and illustrate these processes in a pair of case studies of forest carbon projects in Sierra Leone and Ghana. These are chosen to highlight different project types - focused respectively on forest reserve and farm-forestry - in settings with multi-layered histories of people-forest relations, landscape change and prior project intervention. The analysis shows how longer established framings and assessments of deforestation are being re-invoked and re-worked amidst current carbon concerns. We demonstrate that measurement processes are not just technical but social and political, carrying and thus cementing particular views of landscape and social relations that in turn make likely particular kinds of intervention pathway, with fortress style conservation or plantations becoming the dominant approach. In the process, other possibilities - including alternative pathways that might treat and value carbon as part of complex, lived-in landscapes, or respond more adaptively to less equilibrial people-forest relations, are occluded.

Carbon fluxes, evapotranspiration, and water use efficiency of terrestrial ecosystems in China

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The magnitude, spatial patterns, and controlling factors of the carbon and water fluxes of terrestrial ecosystems in China are not well understood due to the lack of ecosystem-level flux observations. We synthesized flux and micrometeorological observations from 22 eddy covariance flux sites across China, and examined the carbon fluxes, evapotranspiration (ET), and water use efficiency (WUE) of terrestrial ecosystems at the annual scale. Our results show that annual carbon and water fluxes exhibited clear latitudinal patterns across sites. Both annual gross primary productivity (GPP) and ecosystem respiration (ER) declined with increasing latitude, leading to a declining pattern in net ecosystem productivity (NEP) with increasing latitude. Annual ET also generally declined with increasing latitude. The spatial patterns of annual carbon and water fluxes were mainly driven by annual temperature, precipitation, and growing season length. Carbon fluxes, ET, and water use efficiency (WUE) varied with vegetation type. Overall, forest and cropland sites had higher annual fluxes than grassland sites, and the annual fluxes of coastal wetland sites were similar to or slightly higher than those of forest sites. Annual WUE was associated with annual precipitation, GPP, and growing season length. Higher-productivity ecosystems (forests and coastal wetlands) also had higher WUE than lower-productivity ecosystems (grasslands and croplands). The strong relationships between annual GPP and ET demonstrated the coupling of the carbon and water cycles. Our results show that forest plantations had high annual NEP and WUE, and could provide larger carbon sequestration capacity than natural forests. The coastal salt marsh and mangrove ecosystems also had high carbon sequestration capacity. Efforts to strengthen China's terrestrial carbon sink should focus on ecosystems such as forest plantations in southern China where heat and water are ideal for maintaining high productivity. This strategy is especially important because efforts to increase carbon sequestration in areas of limited water may inadvertently contribute to the ongoing water crisis in northern China.

Quantification by allometric equations of carbon sequestered by *Tectona grandis* in different agroforestry systems

Jain, A.; Ansari, S. A.

Non destructive methods for quantification of carbon sequestration in tropical trees are inadequately developed. We described a standardized method for estimating carbon stock in teak (Tectona grandis Linn. F.). We developed linear allometric equations using girth at breast height (GBH), height and age to quantify above ground biomass (AGB). We used AGB to estimate carbon stock for teak trees of different age groups (1.5, 3.5, 7.5, 13.5, 18.5 and 23.5 years). The regression equation with GBH, $y = 3.174x - 21.27$, $r^2 = 0.898$ ($p < 0.01$), was found precise and convenient due to the difficulty in determination of height and age in dense natural forests of teak. The equation was evaluated in teak agroforestry systems that included Triticum aestivum (wheat), Cicer arietinum (gram), Withania somnifera (ashwagandha), Avena fatua (wild oat) and Hordeum vulgare (barley) as agricultural crops established at Tropical Forest Research Institute, Jabalpur, M.P. (India). The annual carbon stock gain in teak in different agroforestry systems was in the order: teak-barley (60.47%) > teak-wheat (56.92%) > teak-wild oat (54.94%) > teak-gram (37.15%) > teak-ashwagandha (11.86%). The results from GBH-based regression equations provided satisfactory estimates of carbon stock in tropical trees.

Mathematical model on the effects of global climate change and decreasing forest cover on seasonal rainfall in Northern Thailand

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This research involves the study of the long-term behaviors of Northern Thailand rainfall as affected by changes to its forest area and the rise in global temperature. Global temperature and forest data are considered annually while rainfall data are considered seasonally to best capture the effects of severe weather hazards such as draught and flood. A differential equation model was developed and verified using the mean global temperature data collected annually during 1880-2010, Northern Thailand forest area data collecting during 1973-2008, and data on the daily amounts of rainfall in Northern Thailand during 1971-2011. The rise in global temperature as well as the decline in Northern Thailand's forest area can be, as shown in the paper, represented by logistic equations. Northern Thailand rainfall is, however, represented as a periodic function; hence, second order differential equation, of which the solution is periodic, is used to represent the rate of change in the amount of rainfall. In addition, by correlation analysis, the predator-prey terms of forest, global temperature and rainfall are presented in the models. All parameters in the models are validated by minimizing sum squared error.

Estimating realized and potential carbon storage benefits from reforestation and afforestation under climate change: a case study of the Qinghai spruce forests in the Qilian Mountains, northwestern China

Xu, Zhonglin; Zhao, Chuanyan; Feng, Zhaodong; Zhang, Fang; Sher, Hassan; Wang, Chao; Peng, Huanhua; Wang, Ying; Zhao, Yang; Wang, Yao; Peng, Shouzhang; Zheng, Xianglin;

Greenhouse gas emission has been scientifically shown to be the primary cause of observed global climate change. The reduction of greenhouse gas levels in the atmosphere deserves international attention. Aside from strategies to reduce emissions, increasing carbon (C) storage by forests has become an alternative method to lower carbon dioxide (CO) levels. The present study assesses the potential of C storage to decrease gas emission by restoring cleared and disturbed spruce (picea) forests in the Qilian Mountains, northwestern China. We first introduced and tested a new method for live aboveground biomass (AGB) estimation. We then used the method to define the relationship of AGB with topographic wetness index (TWI) and precipitation seasonality for total AGB estimation and quantification of the realized C storage in the live AGB of existing spruce forests. The same strategies were adopted to estimate the total AGB and the related potential C storage in the projected potential spruce forest distribution. A species distribution model was used, and the results showed that the AGB of the Qinghai spruce forests ranged between 2.30 and 4.96 Mg per plot (0.021 ha), i.e., 110 Mg hap# to 236 Mg hap#). Actual total AGB was measured at 33 Tg, and C storage was 17.3 Tg in existing spruce forests. Potential total AGB and potential C storage were greater if the cleared and the potential C storage was ~50 Tg.

The carbon sequestration potential of tree crop plantations

Kongsager, Rico; Napier, Jonas; Mertz, Ole

Carbon (C) conservation and sequestration in many developing countries needs to be accompanied by socio-economic improvements. Tree crop plantations can be a potential path for coupling climate change mitigation and economic development by providing C sequestration and supplying wood and non-wood products to meet domestic and international market requirements at the same time. Financial compensation for such plantations could potentially be covered by the Clean Development Mechanism under the United Nations Framework Convention on Climate Change (FCCC) Kyoto Protocol, but its suitability has also been suggested for integration into REDD+(reducing emissions from deforestation, forest degradation and enhancement of forest C stocks) currently being negotiated under the United Nations FCCC. We assess the aboveground C sequestration potential of four major plantation crops cocoa (Theobroma cacao), oil palm (Elaeis guineensis), rubber (Hevea brasiliensis), and orange (Citrus sinesis) cultivated in the tropics. Measurements were conducted in Ghana and allometric equations were applied to estimate biomass. The largest C potential was found in the rubber plantations (214 tC/ha). Cocoa (65 tC/ha) and orange (76 tC/ha) plantations have a much lower C content, and oil palm (45 tC/ha) has the lowest C potential, assuming that the yield is not used as biofuel. There is considerable C sequestration potential in plantations if they are established on land with modest C content such as degraded forest or agricultural land, and not on land with old-growth forest. We also show that simple C assessment methods can give reliable results, which makes it easier for developing countries to partake in REDD+ or other payment schemes.

Potential for forest carbon plantings to offset greenhouse emissions in Australia: economics and constraints to implementation

Polglase, P. J.; Reeson, A.; Hawkins, C. S.; Paul, K. I.; Siggins, A. W.; Turner, J.; Crawford, D. F.; Jovanovic, T.; Hobbs, T. J.; Opie, K.; Carwardine, J.; Almeida, A.

The theoretical potential for carbon forests to off-set greenhouse gas emissions may be high but the achievable rate is influenced by a range of economic and social factors. Economic returns (net present value, NPV) were calculated spatially across the cleared land area in Australia for environmental carbon plantings. A total of 105 scenarios were run by varying discount rate, carbon price, rate of carbon sequestration and costs for plantation establishment licenses for water interception. The area for which NPV was positive ranged from zero ha for tightly constrained scenarios to almost the whole of the cleared land (104iu Miu ha) for lower discount rate and highest carbon price. For the most plausible assumptions for cost of establishment and commercial discount rate, no areas were identified as profitable until a carbon price of AUD$40iu t CO p# was reached. The many practical constraints to plantation establishment mean that it will likely take decades to have significant impact on emission reductions. Every 1iu Miu ha of carbon forests established would offset about 1.4iu % of Australias year 2000 emissions (or 7.4iu Mt CO yearp#) when an average rate of sequestration per ha was reached. All studies that predict large areas of potentially profitable land for carbon forestry need to be tempered by the realities that constrain land use change. In Australia and globally, carbon plantings can be a useful activity to help mitigate emissions and restore landscapes but it should be viewed as a long-term project in which co-benefits such as biodiversity enhancement can be realised.

The global South in environmental negotiations: the politics of coalitions in REDD+

Allan, J. I.; Dauvergne, P

Third World Quarterly; 2013. 34(8):1307-1322.

During international environmental negotiations developing countries have commonly employed a unified strategy through the G-77 and China (G-77/China). Compared with other negotiations, such as those on trade and security, this strategy has been relatively successful in securing financial and technical benefits. Unity among developing states is not, however, a characteristic of all environmental negotiations. This paper analyses the case of Reducing Emissions from Deforestation and Degradation plus conservation (REDD+), where unity has been absent. It argues that the negotiation positions, strategies and coalition politics from 2005 to 2013 have been a result of identifiable power asymmetries among developing states (shifting over time). Some states with vast forest resources have held an effective veto, while others have had considerable moral influence and expert authority. Coalitions have courted such relevant and reputational leaders. At the same time some developing states have had enough diplomatic capacity and economic power to stand alone in negotiations. Taking a broad, historical view of the diverse forest interests and power asymmetries among developing states helps to explain the recent stagnation in negotiations to establish an international REDD+ mechanism to mitigate climate change.

Managing climate change adaptation in forests: a case study from the U.S. Southwest

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Journal of Applied Ecology; 2013. 50(6):1311-1320

Forest mortality related to climate change is an increasingly common global phenomenon. We provide a case study of the U.S. Southwest to investigate the interactions among forest restoration treatments that alter stand density, tree growth and drought resistance in trees of different size classes. Using cores taken from five positions in large trees (coarse roots, breast height, base of live crown, midcrown branch and treetop) and breast height in small trees, we investigated how radial growth response to thinning and precipitation availability varied in 72 ponderosa pines *Pinus ponderosa* Dougl. in northern Arizona. Ten years after thinning, growth of small trees did not respond significantly to thinning, whereas growth of large trees increased following moderate and heaving thinning, and this response was similar across within-tree core sample positions. The intensity of thinning treatment did not significantly affect dry-year growth in small trees. In large trees, dry-year growth after thinning was maintained at pre-thinning levels in moderate and heavy thinning treatments but decreased in the light thinning and control treatments.

Synthesis and applications Our findings indicate that more aggressive thinning treatments used for forest restoration stimulate growth throughout large residual trees from coarse roots to branches and also improve drought resistance, providing a greater resilience to future climate-related stress. These responses to treatment are more pronounced in large trees than small trees. Forest thinning is therefore recommended in systems that are likely to experience increased temperature and decreased precipitation as a result of climate change.

Evaluating the relative impact of climate and economic changes on forest and agricultural ecosystem services in mountain regions

Briner, S.; Elkin, C.; Huber, R.

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Provisioning of ecosystem services (ES) in mountainous regions is predicted to be influenced by (i) the direct biophysical impacts of climate change, (ii) climate mediated land use change, and (iii) socioeconomic driven

changes in land use. The relative importance and the spatial distribution of these factors on forest and agricultural derived ES, however, is unclear, making the implementation of ES management schemes difficult. Using an integrated economic-ecological modeling framework, we evaluated the impact of these driving forces on the provision of forest and agricultural ES in a mountain region of southern Switzerland. Results imply that forest ES will be strongly influenced by the direct impact of climate change, but that changes in land use will have a comparatively small impact. The simulation of direct impacts of climate change affects forest ES at all elevations, while land use changes can only be found at high elevations. In contrast, changes to agricultural ES were found to be primarily due to shifts in economic conditions that alter land use and land management. The direct influence of climate change on agriculture is only predicted to be substantial at high elevations, while socioeconomic driven shifts in land use are projected to affect agricultural ES at all elevations. Our simulation results suggest that policy schemes designed to mitigate the negative impact of climate change on forests should focus on suitable adaptive management plans, accelerating adaptation processes for currently forested areas. To maintain provision of agricultural ES policy needs to focus on economic conditions rather than on supporting adaptation to new climate.

Implementing REDD+ in the Democratic Republic of Congo: an analysis of the emerging national REDD+ governance structure

Aquino, A.; Guay, B

The national governance structure for REDD+ refers to the institutions, processes, decision-making mechanisms that enable the country to channel resources from the international level to measures on the ground that address the drivers of deforestation. The emerging national governance structure for REDD+ in DRC has a hybrid nature, combining the establishment of a national REDD+ fund and independent REDD+ projects at the local level. The authors argue that, in the DRC context, the legitimacy and effectiveness of this emerging governance structure is higher than that of other options. This hybrid structure would experience a fairly high level of legitimacy from government entities, civil society organizations and private sector given its participatory design and broad accessibility to funding for different stakeholders. This structure would be more effective in that it allows the country to target both underlying causes of deforestation through international payments conditioned to policy reforms through the National REDD+ Fund; and direct drivers of deforestation through REDD+ projects. The efficiency of the system is difficult to assess at present, as it is not yet known what type of activities would be supported by the National REDD+ Fund or what REDD+ projects would be implemented. However, this governance structure is likely to attract more financing to REDD, both from donors and private sector. The authors suggest that institutional and policy indicators should be used to measure and reward REDD+ "performance" at a national level in lieu of emissions reductions in the REDD+ investment phase, paving the way for DRC to capture payments for verified emissions reduction in the long term. Informing policy reforms through project interventions is a key element of this governance structure, and particularly important in a country where deforestation rates may increase dramatically in the future given new emerging pressures. The authors recognize, however, that structural policy changes will face vigorous opposition from vested interests, and implementation challenges typical of a fragile state.

Opportunities for and capacity barriers to the implementation of REDD+ projects with smallholder farmers: case study of Awae and Akok, Centre and South Regions, Cameroon.

Cerbu, G. A.; Sonwa, D. J.; Pokorny, B.

There is increasing consensus over the inclusion of smallholder farmers in REDD+ (Reduced Emissions through reduced Deforestation and Degradation) initiatives, expected to be one essential component within the new set of "Flexible Mechanisms" in the post-Kyoto Climate Change Agreement. However, with few long-term REDD+ pilot projects implemented with smallholders, this paper attempts to anticipate potential synergies and constraints of such initiatives from smallholders' point of view by developing a framework to examine the capacities of two rural communities in Cameroon as a case study. Smallholder experiences with REDD+ pilots and their predecessors such as integrated conservation and development projects (ICDPs), Payments for Environmental Services (PES) and the Clean Development Mechanism's Afforestation/Reforestation Projects (CDM AR), are outlined in order to highlight local-level REDD+ project requirements. This paper assesses the capacity for smallholders in the South and Centre Provinces of Cameroon to respond to these requirements through data collected from individual and small-group key informant interviews. The two case study communities possess similar but different livelihood capitals regarding proximities to market, forest cover, livelihood strategies and access to extension services. For both villages smallholder capacity for future REDD+ project adoption was found to require reinforcement to guarantee local feasibility of REDD+ projects. Possibilities to encourage already in use agroforestry systems under a REDD+ scheme are discussed. From these results, we outline recommendations, areas of concern and key targets for capacity building for future REDD + initiatives with smallholders in rural Africa.

V. PUBLICATIONS, REPORTS AND OTHER MEDIA

The Little Book of Big Deforestation Drivers

Global Canopy Programme

The Little Book of Big Deforestation Drivers, launched at COP 19 on the 18th November 2013, outlines the global context to the drivers of deforestation, provides a detailed overview of the most critical forest risk commodity supply chains, and presents a clear and realistic framework of 24 regulatory, market and supply chain catalysts that can act to reduce deforestation caused by these commodities. **The publication**

REDD+ and rights: extending carbon rights in the DRC to climate-regulating services

IIED

In the Democratic Republic of Congo (DRC) the state has ultimate ownership rights to all resources, adjudicating land use rights and revoking them if public interest demands. Community rights, although weak, are acknowledged in a dual system of tenure and resource rights. This is the legal environment within which REDD+ projects are exploring climate change mitigation through more sustainable land use practices. But REDD+ requires long-term commitment from land users, and commitment needs secure rights. DRC has introduced carbon rights agreements and a fiscal system into contracts for private sector investment in REDD+ but clarity on how (or whether) carbon rights can be transferred, and careful assessments of existing local interests will be needed to scale up REDD+ projects to a successful national approach. **The publication**

Learning from 20 years of Payments for Ecosystem Services in Costa Rica

IIED

Costa Rica's Payments for Ecosystems Services (PES) programme has become something of an icon in the world of PES. Its hitches and successes provide a valuable source of information and inspiration for other countries interested in exploring 'policymixes' of economic and regulatory instruments to promote ecosystems conservation and regeneration. In this paper we explore how the governance of the PES programme has evolved over time, how the context in which it sits has changed, and how it prepares to face future challenges by incorporating new tools and strengthening its alliances with other institutions. We discuss the policies used by the programme to affect the way forests are managed and the reported outcomes on the ecosystem services they are expected to provide. Since PES is for society as much as the environment, we also look in detail at the impacts on those directly receiving PES, and what policies and personal characteristics may affect how PES funding seeps into rural economies. Also published in Spanish, this paper is aimed at local practitioners, international researchers and donors interested in the Costa Rican experience and the lessons that emerge from it. **The publication**

Real-time Evaluation of Norway's International Climate and Forest Initiative (NICFI)

LTS International

This brief presents the main findings and recommendations from an evaluation of measurement, reporting and verification activities supported by Norway's International Climate and Forest Initiative. **The publication**

REDD+ Measurement, Reporting and Verification (MRV) Manual

USAID

The purpose of this manual is to provide an overall review of data, models, techniques and accounting methods that should, or could, be part of a Measurement, Reporting and Verification (MRV) program for reducing emissions from deforestation and forest degradation (REDD+). This is in the context of REDD+ as a mechanism within the United Nations Framework Convention on Climate Change (UNFCCC). This manual is intended to inform policy makers on REDD+, as well as implementers of MRV at the national level. **The manual**

Building REDD+ for people and Nature: From lessons learned across Indonesia, Peru and the Democratic Republic of Congo to a new vision for REDD+

WWF

Forests cover one-third of Earth and breathe life into our world, with tropical forests alone producing more than 40 per cent of the world's oxygen. Forests are also the largest storehouse of carbon after oceans, holding 289 gigatonnes of carbon – more than all the carbon in the atmosphere. So it is no surprise that when we cut

down or damage our forests, we release huge amounts of carbon emissions that contribute to devastating climate change – enough to equal 20 per cent of annual global emissions, and more than that produced by all the automobiles, trucks, trains, ships and planes in the world combined. **The publication**

NAMAs and REDD+. Relationship and main issues for consideration – with a focus on Southeast Asia

GIZ

This study provides a timely opportunity to forward understanding on issues regarding integrating mitigation efforts under NAMAs and REDD+ in the actual circumstances of Asian countries. In conjunction with work under its Asia program climate mitigation capacity-building initiatives, GIZ is working to carry out a suite of background studies and advisory services to support policy advisers in assisting national governments with design and implementation of integrated REDD+ and NAMA programs. This paper aims to improve the understanding of the relations between REDD+ and NAMAs, how they might be combined and any implications

of their merging, and recommend advice for Asia region GIZ Programs and experts. **The publication**

Improving governance of forest tenure. A practical guide

FAO & IIED

Forests help us breathe and they give us homes, food and energy. Moreover, human well-being and the health of our whole planet depend on whether and how we grow and look after forests. So 'forest governance' – or who is allowed to decide what about forests and how – is a matter of life and death for millions of people around the world and is profoundly relevant for us all. But decisions about forests and trees are often in the wrong hands or made badly. Much depends on 'tenure' – on who owns and controls the forests and trees themselves. The owners may be those who need the forests and look after them well or those who degrade them with no regard for the well-being of others. In short, it is about power. This Practical Guide aims to inspire and arm those who want to try to improve things so that power is used well for forests; it describes how practical tools can be used to shape better governance of forest tenure. **The publication**

V.I JOBS

Communications Officer: REDD+, Governance and Locally Controlled Forests

IUCN – Deadline for application is 15th of January 2014

IUCN's Global Forest and Climate Change Programme is seeking a motivated and creative communications professional to contribute to the delivery and uptake of targeted knowledge and communications for its thematic work on REDD+ and Locally Controlled Forests. **More**

VII. ANNOUNCEMENTS

Call for Concept Notes CCAFS Flagship 1: Climate smart agriculture
CCAFS
The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is making a call for concept notes for innovative research-for-development ideas to help develop CCAFS portfolio of work related to climate smart agricultural practices, specifically around the area of local adaptation planning processes, and scaling up and out approaches (Flagship 1). **More**

Call for Concept Notes CCAFS Flagship 2: Climate Information Services and Climate-Informed Safety Nets

CCAFS

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is making a call for concept notes for innovative research-for-development that contributes to the resilience and adaptive capacity of agriculture through climate information services and climate-informed food security safety nets. **More**