SUSTAINABLE WETLANDS ADAPTATION & MITIGATION PROGRAM (SWAMP)

QUARTER FOUR AND ANNUAL REPORT – FY 2014

October 30, 2014

This report was produced for review by the United States Agency for International Development (USAID). It was prepared by the Center for International Forestry Research (CIFOR), US Forest Service (USFS), and Oregon State University (OSU).

FY2014 Highlights

During FY2014, SWAMP expanded fieldwork, modeling and mapping, capacity-building and outreach. Through both core SWAMP and leveraged SWAMP activities, USFS, CIFOR and OSU were engaged in wetlands & climate change activities in more than fourteen countries in Latin America & Caribbean, Africa, and Asia-Pacific regions.

SWAMP's achievements for FY2014 include the outreach to the global community dealing with wetlands and climate change. These include the United Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC) processes where SWAMP and SWAMP scientists are formally recognized and involved.

Wetlands as high carbon reservoirs are not included in the UNFCCC agenda. Our interaction in a workshop organized by UNFCCC/SBSTA promoted tropical wetlands including peatlands and mangroves was summarized and made available to the Parties in the UNFCCC document.[1] This is expected to be included in the agenda for further negotiations.

Five SWAMP scientists were heavily involved and contributed in various Chapters of the 2013 Supplement of the 2006 IPCC Guidelines for National GHG Inventory from Wetlands. The guideline was launched in December 2013 for countries who are using the supplement for the next round of GHG inventory and National Communication an obligation to the UNFCCC.

FY2014 was also a productive year for field campaigns for data collection. More people were trained and more countries were covered. These include Honduras, Peru, Indonesia, India, Cambodia, Senegal, Liberia, Gabon, and Papua New Guinea. Undoubtedly, more paper and publication will be produced in the near future.

Finally, SWAMP established strong foundations for the program's next phase by initiating new partnerships with host-country government agencies and research institutions, including exploring long-term research sites. Also, the program began investments in new technologies and methods, such as ground-penetrating radar (GPR) and rod surface elevation table (rSET), that will continue to be tested and developed over the next year.

[1] http://unfccc.int/resource/docs/2014/sbsta/eng/inf01.pdf)

SWAMP Contributors

Name	Institution	Position	Country/Region
Louis Verchot	CIFOR	Principal scientist	All
Daniel Murdiyarso	CIFOR	Principal scientist	All
J. Boone Kauffman	CIFOR/OSU	Senior Associate	All
Kristell Hergoualc'h	CIFOR	Scientist	Indonesia, Peru
Joko Purbopuspito	CIFOR	Post doc	Asia, Mozambique
Rupesh Bhomia	CIFOR/OSU	Post doc	India, Peru, West Africa
Nisa Novita	CIFOR	PhD student	Indonesia
Jeffrey van Lent	CIFOR	PhD student	Peru
Jose Gonzalez de Tanago	CIFOR	PhD student	Peru
Reza Nugroho	CIFOR	MSc student	Indonesia
Dede Hendry Tryanto	CIFOR	MSc student	Indonesia
Sofyan Kurnianto	CIFOR	PhD student	Indonesia
Sigit Sasmito	CIFOR	Research assistant	Asia
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Thomas Gumbricht	CIFOR	Consultant	All
Cynthia Mackie	USFS	Lead Scientist	All
Randy Kolka	USFS	Lead Scientist	IPCC liaison
Richard Birdsey	USFS	Senior Scientist	Mexico
Erik Lilleskov	USFS	Senior Scientist	Latin America
John Hribljan	USFS	Post doc	Latin America
Rod Chimner	MTU	Scientist	Latin America
Richard MacKenzie	USFS	Scientist	Asia-Pacific
Patra Foulk	USFS	Technician	Asia-Pacific
Matthew Warren	USFS	Post doc	Indonesia
Belinda Margono	USFS/UMD	Post doc	Indonesia
Christina Stringer	USFS	Post Doc	Africa
Carl Trettin	USFS	Senior Scientist	Africa
Darcy Nelson	USFS	Program Coord	Asia
Jason Ko	USFS	Program Coord	Africa
Erin Carey	USFS	Program Coord	Latin America
Kent Elliott	USFS	Program Coord	All

SWAMP Activities

GLOBAL

Coordination Meetings

In December 2013, the USFS lead scientists and post-docs met in Washington DC to review the technical accomplishments and challenges encountered through the SWAMP program, as well as assess opportunities for future cross-regional collaboration. Rupesh Bhomia participated via conference call.

In February 2014, SWAMP collaborators from CIFOR, USFS, and USAID met in Bogor to assess the progress of workplan implementation and assess priorities for the remainder of the fiscal year. During the meeting, it was agreed that SWAMP would conclude its intensive data collection campaigns to focus more on global and cross-site syntheses, modeling, and outreach activities. A checklist of follow-up items was compiled and circulated.

SWAMP also held a technical working group meeting at CIFOR in August, with participation from Daniel Murdiyarso, Sigit Sasmito, Thomas Gumbricht, Randy Kolka, Matt Warren, Christina Stringer, and Kent Elliott. The main priorities of the meeting were to develop plans for global synthesis documents, review the progress global wet soil map and develop plans for follow-on SWAMP mapping activities, and develop a scheme for better data management. Following the coordination meeting, the SWAMP working group visited the Rimba Makmur Utama ecosystem restoration concession in Katingan, Central Kalimantan to explore opportunities for long-term research. Based on some findings from the trip, Randy Kolka and Daniel Murdiyarso will develop proposals for new tropical peatland research initiatives, for SWAMP and/or leveraged funding.

AFRICA

Carbon stocks of Africa's mangroves are poorly described at present. Especially relevant is their potential values for inclusion in climate change mitigation strategies. Data on the ecosystem carbon stocks and emissions in mangroves are limited, incomplete, or non-existent in many areas of the world, making it difficult to establish ecosystem values for either climate change mitigation or adaptation strategies. The goals were to conduct studies and field trainings with local colleagues that will determine the ecosystem carbon stocks of at least 20-30 intact stands of mangroves in Senegal, Liberia and Gabon in 2014. This field campaign was successful on all accounts. In total SWAMP quantified carbon stocks of 37 mangroves.

Highlights include:

- These are the first measurements of the carbon stocks of mangroves for West Africa.
- West/central Africa mangroves provide habitats for a wide variety of species from the tiny mud skipper to elephants.
- The West Africa mangrove gradient analysis consists of among the largest ranges of soil salinity yet measured for mangroves- we found mean soil salinities to range from <5ppt in riverine mangroves of Liberia and Gabon to >70ppt in basin mangroves of Senegal.
- Soil substrates range from coarse sands to clays. There are huge variations in the carbon stocks of these mangroves and ongoing analyses of relationships between carbon stocks and

latitude, salinity, rainfall, composition and geomorphology are underway.

Liberia *(Kauffman, Bhomia)*

SWAMP sampled C stocks in 10 mangrove sites in 2 watersheds. This was accomplished along with field trainings. Laboratory analysis of soil samples is almost complete; data analysis of this study in underway. All mangroves sampled in Liberia were estuarine. They were partitioned into tall and medium (statured) mangroves.

Capacity Building
A total of 20 participants were trained (18 males and 2 females) were trained on approaches to the measurement, monitoring and reporting of mangrove carbon stocks and emissions.

Senegal *(Kauffman, Bhomia)*

SWAMP sampled C stocks in 6 mangrove sites in the Saloum Delta. This was accomplished along with field trainings. All mangroves sampled in Senegal were either estuarine or basin. They were partitioned into medium and low (statured) mangroves. We encountered the high soil salinity levels ever encountered in mangroves. Some sites had soil salinity levels exceeding 70ppt. Laboratory analysis of soil samples is almost complete; data analysis of this study in underway

Capacity Building
A total of 15 participants were trained (12 males and 3 females) were trained on approaches to the measurement, monitoring and reporting of mangrove carbon stocks and emissions.

Gabon *(Kauffman, Bhomia)*

SWAMP sampled C stocks in 17 mangrove sites in 2 watersheds of the Ndougou Lagoon and the Akanda National Park. The two watersheds vary considerably in its geomorphic characteristics and influence of tides and freshwater influx. Sampled mangroves can be categorized as estuarine and fringing with medium and tall stands. Sampling was accomplished along with field trainings. Laboratory analysis of soil samples is underway.

Capacity-Building
A total of 18 participants were trained (14 males and 4 females) were trained on approaches to the measurement, monitoring and reporting of mangrove carbon stocks and emissions.

West Africa Regional (*Ko, Trettin*)

As a follow up to the SWAMP supported West Africa Regional Workshop described below, and at the request of USAID/West Africa, USFS executed a regional-scale assessment of carbon stocks in mangroves of nine West African countries using remote sensing data. The assessment was intended to provide information to USAID-West Africa in program planning. The assessment was completed in August 2014, in collaboration from the University of North Carolina at Charlotte.

Capacity Building
At the request of USAID/West Africa, in May 2014, USFS SWAMP worked with the USAID Forest Carbon Markets and Communities project (FCMC) to execute a West African Regional Experts' Workshop on Mangroves. The objective of the workshop was to bring together scientists, policy makers and implementers from around the region to raise awareness and identify gaps, needs and opportunities in the area of sustainable mangrove management and research. The final report is forthcoming and resulted in comprehensive country and regional analysis by the regional participants on the priority areas of intervention, support, and regional leveraging. Countries represented included Sierra Leone, Ghana, Cote d'Ivoire, Guinea, and Liberia, as well as representatives from ECOWAS, USAID, and the Mano River Union.

Mozambique *(Trettin, Stringer, Ko, Patton)*

For the Zambezi Delta Mangrove assessment, extensive USFS SWAMP field work straddling the last three (3) years is now complete and reports prepared documenting the distribution of above and below-ground carbon stocks. USFS has leveraged USAID/Mozambique funds to execute complementary LiDAR and LANDSAT analysis of biomass stocks and landcover change respectively. A field mission to ground truth the LANDSAT analysis was conducted with the University of Eduardo Mondlane (UEM) and World Wildlife Fund (WWF) in August 2014. The complementary reports and publications are expected to circulate in Q1 or Q2 2015.

The core team, led by UEM, is currently finalizing the workplan to establish a mangrove research forest. An FY2015 workplan is expected in Q1 FY2015. USFS also met with USAID/Mozambique coastal adaptation project, CCAP, to explore potential collaboration on mangrove restoration sites near Quelimane. This could provide a great opportunity to advance mitigation and adaptation collaborative programming and research.

Capacity-Building
Following a field data validation mission in the Zambezi, a workshop was held at the Univ. Eduardo Mondlane on the application of LANDSAT remote sensing data to assess the change in mangrove area. The field validation and workshop were attended by university students and faculty, government agency staff, and NGO staff.

Tanzania *(Trettin, Stringer, Ko, Doud, Patton)*

SWAMP support to the Tanzania core mangrove assessment team, comprised of key Tanzanian government, research and NGO stakeholders, continues as they advance the process to create a mangrove research forest. The Rufiji delta has been chosen as the potential site, which will create great synergy with the USAID/Tanzania bilateral programs. It is expected that the research forest will be officially designated by mid-2015.

USFS participated in core team meetings in Tanzania and Mozambique in September 2014.

LATIN AMERICA & CARRIBBEAN

Mexico *(Kauffman)*

In July 2014, SWAMP led a field workshop where he sampled estuarine and fringing mangroves of the Pantanos de Centla, Tabasco Mexico. This is among the largest wetlands in the Neotropics. They were also able to quantify the carbon stocks of cattle pasture formed from mangrove.

- This study quantified the largest carbon stocks measured in the Neotropics. Some of the ecosystem carbon stocks of the mangrove forests exceeded 2000Mg C/ha.
- In contrast the carbon stock one coastal fringe mangrove was less than 1000 Mg/ha suggesting a wide variation in the carbon stocks.
- This study is the first to quantify the carbon stocks of cattle pastures that were formed from mangroves. The C stocks of these pastures is dramatically lower than that of paired adjacent mangroves. SWAMP will be able to calculate the greenhouse gas emissions arising from this land use.
- Primary observations suggest that the emissions arising from the conversion of mangrove to pasture will far exceed those from the formation of cattle pasture from tropical rain forest and will rival those emissions from the conversion of mangrove to shrimp ponds.

Capacity-Building
A total of 9 participants were trained (5 males and 4 females) were trained on approaches to the measurement, monitoring and reporting of mangrove carbon stocks and emissions.

Peru

CIFOR (*Bhomia, Hergoualc'h, van Lent)*

C-stocks were sampled at an intact and a degraded palm swamp-dominated peat forest inside and around the protected area of Quistococha. The vegetation at the intact site was scanned using a ground-based LiDAR for aboveground biomass assessment. The images are still under processing. At the same sites an experiment was setup to assess the impact of peat swamp forest degradation on peat CO_2, CH_4 and N_2O fluxes. The experiment follows the design applied in Indonesian peatlands. Autotrophic and heterotrophic respiration are experimentally separated using the trenching method. The design evaluates the spatial heterogeneity in terms of soil depressions and hummocks. Temporal variation is measured through intense sampling and monthly measurements capturing, respectively, day to day variation and seasonality. Peat CO_2 efflux sampling started in April and August 2014 at the intact and degraded site, respectively. Fluxes of CH_4 and N_2O started being monitored in June when the installation of the gas chromatograph located at the CIFOR laboratory in Lima was completed. Boardwalks have been built to access all monitoring chambers. A replicate pair of intact and degraded sites is under exploration.

Preliminary results at the intact forest site indicate that the trenching is effective with a significant lower soil CO2 efflux measured under root-trenched conditions than that measured in the controls, at both close- and far-from-trees spatial positions. The magnitude of the fluxes is similar to that measured in Indonesian peat forests.

Highlights:

- This is the first study on trace gas fluxes as affected by forest degradation in Peruvian lowland peatlands.
- This is the first time ground-based LiDAR is tested in tropical peatlands.

Peru - USFS *(Lileskov, Hribljan, Chimner, Planas, Chaves)*

A field campaign was conducted to measure peatland carbon stocks and accumulation rates in the Huascarán National Park in the Peruvian Cordillera Blanca mountain range of South America. Sites sampled will compliment carbon stock and accumulation rate research previously conducted in mountain peatland systems of Ecuador and Colombia. Sampling was completed in four different regions within the national park and will be analyzed for carbon content and accumulation rates. Traveling and sampling throughout the park also indicated the highly degraded state of these wetlands, most notably from grazing pressure and increased glacial flows. This trip initiated a collaboration with scientists from the University of Texas (Molly Polk and Kenneth Young) who are currently researching changing land use on the sustainability and adaptability of mountain wetlands in the Peruvian highlands.

SWAMP has made substantial progress on developing remote sensing maps to measure wetland spatial extent and to scale up soil carbon stocks in the lowland peat swamps of the Loreto region in northern Peru and the high altitude mountain peatlands in central Ecuador. Map development is in collaboration with the Michigan Tech Research Institute.

Colombia *(Hribljan, Chimner, Lilleskov)*

SWAMP has made progress developing a collaboration between the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM), University of Tolima, Michigan Technological University and the National University of Colombia to quantify trace gas emissions from degraded and intact mountain peatlands with the intent to be able to calculate greenhouse gas emission factors. SWAMP is actively seeking a Colombian graduate student who will conduct the research for the trace gas research project with a starting date of early 2015.

Ecuador *(Lilleskov, Hribljan, Chimner, Kolka)*

Ground Penetrating Radar

Ground penetrating radar (GPR) was field tested in the Antisana and Cayambe Coca National Preserves of Ecuador. This was the first field deployment of GPR in a South American mountain peatland system. Preliminary analysis of data collected with 30 and 100 MHz MALÅ Rough Terrain Antennas (RTA) recently acquired by the USFS indicates that this system has tremendous potential for quantifying peat depth and to provide estimates of basin morphology for South American mountain peatland systems. This technology could vastly increase the scaling accuracy of mountain peatland carbon stock measurements to the landscape level. Data collection was conducted by Xavier Comas of Florida Atlantic University and Neil Terry of Rutgers-Newark and supported by Esteban Suárez from Universidad San Francisco de Quito.

PALSAR- Based Remote Sensing Techniques for Wetlands

Techniques are currently under development with Laura Bourgeau-Chavez from the Michigan Tech Research Institute using Phased Array type L-band Synthetic Aperture Radar (PALSAR). Products will be used to scale-up Andean carbon stock measurements from the site level to the regional level. The steep slopes and aspect of the mountain ranges closely surrounding many of these peatlands can create challenges when using PALSAR due to reflectance; however, techniques to radiometrically terrain correct images for reflectance are displaying promising results. Ground truthing was initiated by students at the Universidad San Francisco de Quito in the Antisana and Cayambe Coca Preserves to provide field data for validating remote sensing images.

Gas Flux and Carbon Dynamics

María Elisa Sánchez initiated trace gas flux measurements (CO_2 and CH_4) in a highly degraded mountain peatland in the Antisana National Preserve. María Elisa is an Ecuadorian student who will be starting a SWAMP supported joint graduate position between Universidad San Francisco de Quito and Michigan Technological University later this year. Her research will address the effects of grazing on high altitude páramo wetland carbon cycling.

John Hribljan and Erik Lilleskov participated in a regional workshop in Quito to help build protocols for monitoring Andean páramo carbon dynamics. The workshop was hosted by the Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN) and included participants from Universidad Nacional de Tucumán, PRODERN, LandCare Research, Instituto de Ecología de la UMSA, Ministerio de Ambiente de Perú (MINAM), Ministerio de Ambiente de Ecuador (MAE),and Programa ONU-REDD. For the forthcoming protocols, SWAMP will contribute a chapter on measuring soil carbon dynamics in Andean wetlands.

Capacity Building

USFS and Michigan Technological University (MTU) is training a graduate student in Ecuador in methods for quantification of trace gas flux, including chamber methods for net ecosystem exchange and ecosystem respiration of CO2, and net flux of methane.

ASIA-PACIFIC

Indonesia

Carbon Stocks and Gas Flux *(Novita, Kauffman, Hergoualc'h, Basuki, Hendry)*

SWAMP has continued the studies of the C dynamics of peat forests in Kalimantan Barat. Laboratory and data analysis are ongoing. Further, the team is quantifying CO_2 emissions from intact forest, oil palm, degraded agricultural lands and logged forests. In addition, they are quantifying net primary productivity and net ecosystem productivity in these land cover types. Field work is led by OSU Indonesian student Imam Basuki (OSU).

SWAMP continued analysis of C stocks in 28 mangroves of the Mahakem Delta, Kalimantan Timur. This includes sites of intact mangrove, Nypa palm and shrimp ponds. Laboratory and data analysis are ongoing. Studies to quantify trace gas emissions from intact mangrove and shrimp ponds were established in late FY 2014. Field work was led by Indonesian grad student Virni Arifanti (OSU).

SWAMP completed the measurements of selected trace gas fluxes (CO_2, CH_4, and N_2O) in intact forests and oil palm sites in and near Tanjun Puting National Park, Kalimantan. Field work was led by Nisa Novita and Dede Hendry. The results indicate similar soil respiration rates in the forests and oil palm plantations but the contribution to total soil respiration of the heterotrophic component was higher in the oil palm plantations than in the forests. Methane emissions were high in the forests and almost inexistent at the oil palm sites. The opposite was observed for nitrous oxide emissions. SWAMP is currently continuing carbon dynamics research including measurements of DOC in these ecosystems as well as a fractionation of peat carbon in these land uses. Ms. Novita and Mr. Dede Hendry have delivered several presentations on their research this year.

Capacity Building
Four Indonesian graduate students are receiving training from USAID funds; one is exclusively funded by SWAMP and the other three receive some funding and collaboration from SWAMP (2 females, 2 males).

Mangrove Sedimentation and Surface Accretion *(Murdiyarso, Sasmito)*

Training and field work on the installation of Rod Surface Elevation Table (rSET) for surface accretion and sedimentation observation in Bintuni Bay, West Papua, on 12-20 May 2014. It was also attended by an intern from the University of Toronto, Canada and a trainer from the National University of Singapore.

Fifteen rSETs were installed to monitor sedimentation, surface accretion and subsidence processes in the mudflat, fringe and interior of mangrove ecosystems that were logged 5 and 15 years ago. Measurement and sampling were carried out to determine biomass and soil carbon in addition to assessment of sedimentation rate using radio nuclide technique.

India *(Murdiyarso, Bhomia, Halperin)*

Indian mangrove forests occupy an area of 4,628 km^2, which accounts to about 3% of global mangroves extent. They are spread across 12 coastal states and union territories, however Sundarbans in West Bengal accounts for about half of the total mangrove forests in India.

The current methodology employed for carbon stock assessment in India's forests does not differentiate between dry land and mangrove forests, which may inadvertently result in underreporting of total C stocks in these carbon rich ecosystems.

The workshop on Mangrove Inventory and Monitoring was organized by Forest Service of India (FSI) – USFS – CIFOR in Dehradun, 27-28 August 2014. It was designed to understand the global processes including UNFCCC and the available guidelines provided by IPCC and methodology to assess mangrove carbon stock, such as that of SWAMP Protocol. It was also to give participants the opportunity to explore and discuss the possibility of adopting methodologies appropriate for future Indian mangroves carbon assessment.

Cambodia *(Mackenzie, Blate, Lebow, Folk, Nelson)*

Capacity Building

At the request of officials from the Government of Cambodia, USFS SWAMP and USAID's Low Emissions Asian Development (USAID LEAD) program conducted a training on implementing the carbon stock assessment protocol in forested wetlands. From April 21 to May 2, 2014, 34 people from the government agencies responsible for forested wetland management or forested wetland inventory, universities, USAID implementing partner projects, and local nongovernmental organizations participated classroom lectures, demonstrations, hands-on field data collection and post-field data processing. Ultimately, this comprehensive course allowed government field staff and researchers to understand and apply the protocol. After the rainy season, there will be a follow-on training where a subset of trainees will collect data from four more forested wetland sites in Cambodia. This will consolidate the skills and knowledge learned during the original 12-day course. The forest carbon data from additional key forested wetlands across Cambodia will also feed into the national GHG inventory.

Philippines *(Mackenzie, Lebow, Nelson)*

USFS began a partnership with the Philippines Department of Environment and Natural Resources (DENR) Ecosystem Research and Development Branch (ERDB) Coastal Zone Division, Mangrove Section to install rSETs for long-term mangrove monitoring and research purposes. The overall goal of the partnership is to increase the effectiveness of mangrove conservation in the Philippines by identifying mangroves that may be more resilient to sea level rise as well as effective mangrove restoration techniques. In July 2014 USFS conducted an initial visit to visit field areas with ERDB and identify sites for rSET installation. Equipment was also procured and sent to Philippines. This will be followed-up in FY15 with rSET installation and training for ERDB staff on reading rSETs and quantifying carbon pools for long-term mangrove monitoring.

Papua New Guinea *(Mackenzie, Lebow, Nelson)*

USFS worked with USAID/Pacific Islands Mangrove Rehabilitation for Sustainably Managed Healthy Forests (MARSH) to implement a five-day Mangrove Carbon Assessment Training in Manus Island, PNG. The hands-on training was primarily for participants from local communities and provided trainees with field and classroom training in implementing a methodology for estimating carbon in mangroves.

Outreach and Publications

Outreach

UNFCC Workshop (*Kauffman, Murdiyarso*)

UNFCCC Workshop on technical and scientific aspects of ecosystems with high-carbon reservoirs not covered by other agenda items under the Convention was organized in Bonn 24-25 October 2013. SWAMP was invited to update the Parties on the recent development in terms of scientific

findings around wetland ecosystems. SWAMP reported the work in mangroves and peatlands, which are among the highest carbon reservoirs on earth.

UNFCCC Side Event (*Murdiyarso*)

CIFOR organized a side event in the UNFCCC/SB40 in Bonn, 7 June 2014. The effort was meant to attract feedback from the audience on the importance of synergizing adaptation and mitigation in the coastal wetland. The event will lead to the production of a "Guiding Principle for Carbon Projects in Coastal Wetlands". We collaborate with UNEP and supported by partners (Environmental Science Associate, USA; Silvestrum, the Netherlands; and Carbon Focus, Switzerland).

Database development *(Sasmito)*

SWAMP Database[2] has been updated featuring new publications, Forest Carbon Database, Global Wet Soil Map and SWAMP Project Inventory.

New appearance of the website together with other project website hosted by CIFOR will be displayed in mid-November. The statistic of visitor indicate 1,500 visitors and 3,700 page viewers per year along April 2012 until September 2014.

Publications and Blogs

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[2] http://www1.cifor.org/swamp/home.html

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A good practice case study published through African Climate network platform (AfricanClimate.net) documenting SWAMP activities and field campaign in Senegal. Inclusive and participatory training and sampling of carbon stocks in the mangrove ecosystems of Saloum Delta. More info can be found here.

Presentations

Arifanti, V. B. and J. B. Kauffman. 2014. Carbon dynamics of Eastern Borneo mangrove ecosystems, Indonesia: Preliminary results. Presentation and abstract. Joint Aquatic Sciences

Meeting. Portland, Oregon, May 19-23, 2014: http://www.sgmeet.com/jasm2014/viewabstract.asp?abstractid=15571.

Basuki, I. and J.B. Kauffman, 2014. Land use change effects on the carbon dynamics of Indonesian tropical peatland forests. Presentation and abstract. Joint Aquatic Sciences Meeting (Society of Wetland Scientists). Portland Oregon, May 19-23, 2014. [http://www.sgmeet.com/jasm2014/viewabstract.asp?AbstractID=15573]

Bhomia, R and J.B. Kauffman 2014. Changed Climate and Extreme Weather Events: Vulnerability of Coastal Carbon Stocks in the Tropics Presentation and abstract. Joint Aquatic Sciences Meeting. Portland, Oregon, May 19-23, 2014. http://www.sgmeet.com/jasm2014/viewabstract.asp?AbstractID=15577

Bhomia, R., 2014. Importance of Natural Coasts for Climate Change Mitigation: Mangrove Ecosystems and Associated Services. Presentation given at Lagrac, Dept. of Geography, University of Omar Bongo, Libreville, Gabon. 23 September, 2014.

Bhomia, R., 2014. Macronutrient processing and retention in wet environments: Case studies from Florida Everglades and Honduran mangroves. Invited guest lecture at monthly seminar series in the School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, 29 Aug, 2014.

Bhomia, R., 2014. SWAMP program: Overview of goals and objectives and case studies from Central America and West Africa. Presentation and participation in 'Mangrove inventory and monitoring: Workshop to review status and assess opportunities for carbon stocks determination in Indian mangrove forests', 27-28 August, 2014, Forest Survey of India, Dehradun, India.

Bhomia, R., 2014. Values of coastal ecosystems, threats to their existence and conservation options, Restitution de la formation participative et échantillonnage sur le terrain pour le suivi et rapportage des stocks de carbone dans les mangroves du Delta du Saloum. Presentation given to various stakeholders and officials from government, university and NGO sector with preliminary results of field sampling efforts in Saloum delta. Dakar, Senegal. 15 March 2014.

Chimner, R., J. Hribljan, and E. Lilleskov. 2014. Carbon storage and accumulation rates of tropical mountain peatlands of South America. Society of Wetland Scientist Conference. Portland, OR.

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Chimner, R.A., Hribljan, J.A., Lilleskov, E.A. Carbon storage and accumulation rates of tropical mountain peatlands of South America. Joint Aquatic Sciences meeting. May 18-23, 2014. Portland, Oregon.

Hergoualc'h, K. 2013. Factores de emisión de gases de efecto invernadero provenientes del uso y cambio de uso del suelo. Ministry of Environment (MINAM), Lima, 12 December 2014

Hergoualc'h, K., Aini, F., Comeau, L.-P., Hartill, J., Hendry, D., Oktarita, S., Novita N., Kauffman, B., Verchot, L. 2014. Soil GHG emissions from forest conversion and oil palm cultivation:

An update on emission factors. 4th International Conference on Oil Palm and Environment (ICOPE), Bali, Indonesia, 12 - 14 February 2014

Hribljan J, Lilleskov E, Chimner R. Overview of SWAMP protocols for peatland carbon dynamics in the Andes. Taller de discussion metodologica caraterizacion de ecosyistemas herbaceous altoandinos y monitoreo de dinamicas de carbona. Quito, 2 - 3 June 2014

Hribljan, J. Programa de Adaptación y Mitigación Sostenible de Humedales (SWAMP). Universidad Nacional Santiago Antúnez De Mayolo. Hauraz, Peru. 16 May, 2014.

Kauffman, J Boone 2014. A global view of mangroves. Invited presentation to the Native Plant Society of Oregon. Corvallis, OR 14 April 2014.

Kauffman, J Boone 2014. Blue Carbon Science: Mangroves. An invited presentation to the US State Department Blue C Science and Policy Seminar: a discussion with the USA delegates to the UNFCCC and other US policy makers. Washington DC 17 April 2014.

Kauffman, J Boone 2014. Carbon dynamics of Indonesia's Peat Swamp Forests and Mangroves. Presentation to the USAID, Jakarta Indonesia 30 June 2014

Kauffman, J Boone 2014. El potencial del carbono azul y la conservación de manglares en América Latina. Presentation at the Universidad Juarez Autonoma de Tabasco. Villa Hermosa Mexico 28 July 2014

Kauffman, J Boone 2014. Mangroves and the Deep Blue C: Exceptionally valuable ecosystems in exceptionally vulnerable times. Keynote Presentation: 2nd International Symposium on mangroves as fish habitat. Mazatlán Mexico, 9 April 2014.

Kauffman, J Boone 2014. Protocole relatif au calcul de dimensions, au suivi et à la rédaction de rapports sur la structure, la biomasse et les stocks de carbone dans les forêts de mangroves. Presentation at the Smithsonian Conservation Biology Institute, Gamba, Gabon. 3 September 2014.

Kauffman, J Boone 2014. Tropical Wetlands of Borneo and Beyond. Invited presentation to the National Audubon Society. Corvallis, OR 20 March 2014.

Kauffman, J Boone. 2014. Atelier sur l'échantillonnage et le suivi des réserves de carbone des écosystèmes de mangroves. Presentation given to Village chiefs of the Saloum Delta Region and Senegalese participants of the 2014 Senegal field training/mangrove carbon stocks research campaign. Foundinigue, Senegal. 2 March 2014.

Kauffman, J Boone. 2014. Importance of mangroves for climate change mitigation. Presentation given to Liberian participants of the 2014 Liberia field training/mangrove carbon stocks research campaign. Buchanan Liberia. 26 February 2014.

Kauffman, J Boone. 2014. Importance of mangroves for climate change mitigation. Presentation given to Senegalese participants of the 2014 Senegal field training/mangrove carbon stocks research campaign. Foundinigue, Senegal. 4 March 2014.

Kauffman, J Boone. 2014. Protocols for the measurement, monitoring, and reporting of structure, biomass and carbon stocks in mangrove forests. Presentation given to Liberian participants of the 2014 Liberia field training/mangrove carbon stocks research campaign. Buchanan Liberia. 18 February 2014.

Kauffman, J Boone. 2014. Protocols for the measurement, monitoring, and reporting of structure, biomass and carbon stocks in mangrove forests. Presentation given to Senegalese

participants of the 2014 Senegal field training/mangrove carbon stocks research campaign. Foundinigue, Senegal. 3 March 2014.

Kauffman, J. B., R Bhomia, and M. Cifuentes, 2014. Potential emissions arising from mangrove conversion: the jumbo carbon footprint of a little shrimp. Presentation and abstract. Joint Aquatic Sciences Meeting (Society of Wetland Scientists). Portland Oregon, May 19-23, 2014. http://www.sgmeet.com/jasm2014/viewabstract.asp?abstractid=14813

Kauffman, J.B. and D. Murdiyarso. 2013. Recent and ongoing carbon stock assessments in mangrove and related ecosystems (Invited Presentation). International Blue Carbon Science Working Group (IUCN, IOC, CI) Meeting Paris, France. 28-30 October 2013. Results of the SWAMP project was shared with the global community concerned with Blue Carbon.

Kauffman, J.B. and D. Murdiyarso. 2013. Services, emissions and values of mangroves and their importance for inclusion in climate change mitigation and adaptation strategies (Invited Presentation). UNFCCC Workshop on technical and scientific aspects of ecosystems with high-carbon reservoirs not covered by other agenda items under the Convention. October 24-25, 2013; Bonn Germany. http://unfccc.int/files/adaptation/application/pdf/kauffman_mangrove.pdf

Kauffman, J.B. and D. Murdiyarso. 2013. The Values of Mangrove Ecosystems for Climate Change Mitigation (Invited Presentation). International Workshop on Blue Carbon: From Indonesia to the Blue Planet. Jakarta Indonesia, 10-11 December 2013.

Kauffman, J.B., G. Anshari, D. Hadriyanto, F. Rhaman, D. Murdiyarso J. Peterson, V.B. Arifanti, I. Basuki, and S. Kurnianto. 2013. C dynamics of Peat Swamp Forests and Mangroves: The Kalimantan Wetlands and climate change study. Invited presentation describing SWAMP and KWACS research progress to the USAID Indonesia, December 9, 2013, Jakarta Indonesia.

Lilleskov E, Hribljan J, Chimner R. Generación sobre dinámicas de carbono en humedales altoandinos. Diálogo andino entre la ciencia y la politíca Quito, 4 - 5 June 2014

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MacKenzie, R.A., P.B. Foulk, J.V. Klump, K. Weckerly, J. Purbospito, D. Murdiyarso, K. Krauss, N. Cormier. 2014. Using a Pacific-wide network to understand the resilience of mangroves to sea level rise. Joint Aquatic Sciences Meeting, Portland, OR, May 18-22, 2014.

MacKenzie, R.A., R. Kolka, C. Mackie, M. Warren, J.B. Kauffman, J. Purbospito, D. Murdiyarso, C. Trettin, E. Lilleskov. 2014. Sustainable Wetlands Adaptation and Mitigation Program. 2014. Forests Asia Summit, Jakarta, Indonesia, May 5-6, 2014.

McFadden TN, Bhomia R, Kauffman JB. The effects of nesting waterbirds on nutrient levels in mangroves, Gulfo de Fonseca, Honduras. Poster session presented at: 2nd International Symposium on Mangroves as Fish Habitat; 2014 April 7-12, Mazatlan, Mexico.

Murdiyarso D and Kauffman B. Mangrove for Climate Change Mitigation. Workshop on Mangrove Inventory and Monitoring, Forest Service of India (FSI) – USFS – CIFOR, Dehradun, India, 27-28 August 2014

Murdiyarso D and Kolka R. Mangrove in the UNFCCC and IPCCC Processes. Workshop on Mangrove Inventory and Monitoring, Forest Service of India (FSI) – USFS – CIFOR, Dehradun, India, 27-28 August 2014.

Murdiyarso D, Kauffman B, Kolka R. Providing science-based information for public policy making on tropical wetlands. Blue Carbon Indonesia Workshop. Jakarta, 10 December 2013.

Murdiyarso D, Kolka R, Hergoualc'h K, and Warren M. 2014. Tropical peat swamp forests: Current knowledge, gaps and science needs. The Status and Challenges of Peatland Management in Indonesia. Jakarta, 10 February 2014.

Murdiyarso D, Kolka R, Hergoulac'h K and Warren M. Tropical peat swamp forests: Current knowledge, gaps and science needs. Peat Dialogue @america, Jakarta 2 July 2014

Murdiyarso D, Pramova, E, Locatelli B. Mangrove for Climate Change Adaptation. Workshop on Mangrove Inventory and Monitoring, Forest Service of India (FSI) – USFS – CIFOR, Dehradun, India, 27-28 August 2014

Murdiyarso D. Development and potentials of global wetland carbon database. The Fourth Global Forest Carbon Working Group Meeting. Woods Hole, 23-27 June 2014

Murdiyarso D. Implications for Sustainable Wetland Mitigation and Adaptation. UNFCCC Side Event, Bonn, 3-12 June 2014.

Murdiyarso D. Introducing SWAMP in Asia. Workshop on Mangrove Inventory and Monitoring, Forest Service of India (FSI) – USFS – CIFOR, Dehradun, India, 27-28 August 2014.

Murdiyarso D. Vulnerability of Mangrove Ecosystems: The way forward for Adaptation Strategies. Workshop on the Resilience of Coastal Livelihood. Mangrove Action Program/Oxfam/ Ministry of Fishery and Marine Affairs, Bogor, 17-20 February 2014.

Novita, N., Hergoualc'h, K., Kauffman, B. 2014. CO2 emissions associated with forest conversion to oil palm plantation on peat in Tanjung Putting, Central Kalimantan. 4th International Conference on Oil Palm and Environment (ICOPE), Bali, Indonesia, 12 - 14 February 2014

Novita, N., K. Hergoualc'h and J. B. Kauffman, 2014. CH4 and CO2 emissions associated with land use change of tropical peat ecosystem in Tanjung Putting, Central Kalimantan. Presentation and abstract. Joint Aquatic Sciences Meeting (Society of Wetland Scientists). Portland Oregon, May 19-23, 2014. http://sgmeet.com/jasm2014/viewabstract.asp?abstractid=14657

Shapiro, A. Assessing Change in Mangrove Cover – Plans to Quantify the Zambezi River Delta 1990 – 2014. Seminar presented at Univ. Eduardo Mondlane, Maputo. (July, 2014)

Trettin CC, Stringer CS. Carbon Stocks in the Zambezi River Delta. Presented at: First Friday Seminar Series, Southern Research Station, Eastern Forest Threats Center. (June, 2014).

Trettin, C., and C. Stringer. 2014. Characterizing carbon stocks in mangroves of the Zambezi River Delta, Mozambique. Webinar for the First Friday All Climate Change Talks. USDA Forest Service Southern Research Station.

Trettin, Carl, and CE Stringer. A presentation entitled "Carbon Pools in East African Mangroves: Assessing Issues at Multiple Scales" was given at the West Africa Regional Mangrove Project Workshop, 21 May, 2014, Ghana.

Trettin, Carl, and CE Stringer. Webinar (6 June, 2014)was presented summarizing the mangrove carbon inventory in the Zambezi River Delta. The webinar was hosted by the Eastern Forest Threat Assessment Center.

Tryanto, D. H., Hergoualc'h, K. 2014. How does peat swamp forest conversion to oil palm plantation influence total and heterotrophic soil respiration: A case study in Tanjung Putting, Central Kalimantan? 4th International Conference on Oil Palm and Environment (ICOPE), Bali, Indonesia, 12 - 14 February 2014

Verchot L and Hergoualc'h K. 2014. IPCC emission factors for greenhouse gas inventories in tropical peatlands. International Indonesia Peatland Conversation. Jakarta, 11-12 February 2014.

Leveraged Project work (externally funded)

USAID/Indonesia - Kalimantan Wetlands and Climate Change Study *(Murdiyarso, Kauffman)*

The KWACs study is a companion study with the goals to train Indonesian students and professors on approaches to the quantification of stocks and emissions from tropical wetlands. The principal participants are Dr. Daniel Murdiyarso and Dr. J Boone Kauffman.

We obtained substantial in-kind funding this year from the Center for Environmental Cooperation for work in Tabasco Mexico, and from the Smithsonian Institute for work in Gabon. In addition, we received great support from Counterpart International in Senegal, and the USAID in Liberia. The Principal SWAMP scientists were Dr. J Boone Kauffman, Dr. Rupesh Bhomia, and Dr. Daniel Murdiyarso.

USDOS/OES- Indonesian Peatland Network *(Murdiyarso)*

The Indonesia Peatland Network (IPN) was established in collaboration with the Indonesian Climate Change Center and supported by US Department of State and USFS. The objective is to enhance the capacity of Indonesian universities on issues around sustainable peatland management. The activities include internship and publication awards and the development of Peatland Toolbox.

USAID/Mozambique - Zambezi River Delta Mangrove Carbon Inventory (*Trettin, Stringer, Ko*)

USAID/Mozambique bilateral funds have been supported by SWAMP funding for USFS to execute this work. The project is focused on developing a carbon inventory of mangroves within the Zambezi River Delta. Two field campaigns were conducted during FY14. The first was the completion of the field work to inventory the carbon stocks in the Zambezi River Delta. The scope of work included training of participants in the field crew, which included Univ. Eduardo Mondlane, Dept. of Natural Resource Inventory, and WWF-Mozambique. A second field campaign (July 2014) was conducted in July 2014 to develop a data set for validating land cover classes from remote sensing data. That work included a workshop on the detection of land-cover change that was held at Univ. Eduardo Mondlane. The report of the carbon inventory was developed, and the final project documents will be delivered in the first half of FY15.

USAID/Africa Bureau - East African Coast Mangrove Carbon Project *(Trettin, Stringer, Ko, Doud, Paton)*

USFS initiated the East African Coast Mangrove Carbon Project in FY14 with leveraged funding from USAID/Africa bureau to SWAMP funds. The project will utilize the establishment of research forests in mangroves in Tanzania and Mozambique as the foundation to assess carbon cycle science and ecosystem service questions. The intent is to utilize the Research Forests for experiments, demonstration, and training activities. Country-teams have been organized to establish the forest, with plans to commence monitoring, research and training in FY15.

USAID/Mozambique - Mozambique Coastal City Adaptation Project – *(Trettin, Stringer, Ko, Doud, Paton)*

Building on the current SWAMP and USAID/Mozambique mangrove work, USFS participated in a collaborative field visit with USAID/Mozambique and a USAID/Mozambique adaptation project (CCAP) to explore potential synergies and work at CCAP sites. There promises to be good possibility to support the CCAP project to execute a mangrove restoration site near Quelimane, Mozambique, that could also serve as a way to examine combined mangrove adaptation and mitigation research and management topics in the same site. Any synergetic work should be elaborated in Q1 FY15.

NASA Carbon Monitoring Systems - Total Carbon Estimation in African Mangroves and Coastal Wetlands in preparation for REDD+ and Blue Carbon Credits *(Trettin)*

The project will utilize 3D mapping methodology to quantitatively characterize forest structure and extent as well as change over time and to inform the field measurements, thereby providing a basis for inventory and MRV reporting. The approach will be to utilize publically available data with advanced analytical tools that can be used for REDD+. Field validation exercises will be conducted in Gabon, Mozambique and Tanzania. The project also includes provisions for a Mangrove Carbon Working Group composed of in-country and US experts to coordinate, disseminate and inform field, remote sensing and GIS experts on the use and generation of the data products from this study.

USAID/Indonesia - Ground Penetrating Radar and Electrical Resistivity Imaging *(Warren)*

In Quarter 4, the USFS continued a highly successful research collaboration. With onsite assistance from Dr. Harris Gunawan (Riau University), the team explored the use of geophysical methods to obtain high resolution profiles of peat layers in Riau, one of Indonesia's most peatland rich provinces. The area investigated was within the Siak District, an area known for particularly deep peat, high rates of peat swamp conversion, and problematic peat fires such as those which impacted Singapore and Malaysia in June, 2013. The campaign included GPR and ERI imaging along several transects on multiple landforms, with concurrent peat coring and sampling to assist interpretation of the radar images. Data analysis is currently underway.

In addition, the team submitted a manuscript to Biogeosciences, a journal of the European Geosciences Union. The article describes the very first application of geophysical methods to obtain high resolution images of peat layers in tropical systems. Their research demonstrates that the methods can be used to determine peat thickness in a fast and efficient way across multiple peat formations, thus reducing uncertainties in peat thickness and volume at local scales.

USAID/ Indonesia - IFACS Kamoro Wetlands Collaborative Management Program *(Warren)*

USFS and collaborators at Indiana University continue in their efforts to produce high resolution maps of wetland forests in Mimika District, south Papua. This includes over 250,000ha of mangrove forests, most of which are intact. A supervised classification of land cover, including several mangrove forest types was completed and delivered to IFACS geospatial analysts to assist in their efforts to produce a collaborative coastal management plan with multiple local stakeholders. Canopy Height Models of aboveground biomass were also developed to produce a spatially explicit model of landscape carbon storage in living biomass. Soil carbon stocks are also being quantified, however data analysis is still underway. Over 1,000 soil samples from the project have been analyzed by a carbon analysis laboratory at the Bogor Agricultural University, established by the USFS and CIFOR through SWAMP affiliated programs.

USAID/Indonesia - IFACS Vulnerable Peatlands Carbon Assessment *(Warren)*

Throughout the fourth quarter, USFS implemented a "Vulnerable Peatlands Carbon Assessment" in the Ketapang and Kayong Utara districts of West Kalimantan. This activity initiated with a highly successful workshop in which participants used newly introduced IPCC guidelines on wetland greenhouse gas inventories to calculate the magnitude of carbon emissions produced from the conversion of peatlands classified as "Areal Penggunaan Lain" , (translated "other (non-forestry) land uses") in each district. Calculations produced in the workshop represent Tier 2 emission estimates and indicated that if all APL lands were converted to Oil Palm, which is not an unrealistic scenario, emissions over thirty years would amount to 168-190 million tons of greenhouse gases for the district of Ketapang. This is equivalent to emissions generated from 33 million automobiles!

Following the workshop, USFS contracted field crews conducted surveys of APL peatlands to verify current maps of peat cover and depth and quantify C storage. The results from the study will be used to inform spatial planning efforts at local to national scales, and demonstrate the climate mitigation potential of these important, yet often overlooked peatlands which are currently slated for conversion.

USAID/South America - Restoration of Mountain Wetlands in Peru *(Chimner, Carey)*

USFS initiated a project in the highlands of central Peru for the restoration of mountain peatlands in collaboration with The Mountain Institute, Huascaran National Park, Universidad Nacional Agraria La Molina, and University of Texas, funded by USAID/South America Region and USFS International Programs. The SWAMP component will consist of measuring greenhouse gas emission to quantify the effects of livestock grazing on peatland carbon cycling and to develop regional greenhouse gas emissions factors.