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Taking Stock

HSBC Climate Partnership Research

1-5 March 2010

Smithsonian Tropical Research Institute
Panama, Republic of Panama

Welcome to the first scientific meeting of the HSBC Climate Partnership. Researchers from across the world will present scientific results, discuss recent developments in climate change science and policy, and plan for the future of the HSBC Climate Partnership.

HSBC Climate Partnership

Smithsonian Tropical Research Institute

EARTHWATCH® INSTITUTE

SCHEDULE MONDAY, 1 MARCH

9:00	**Welcome** Dan Bebber, Earthwatch Institute
9:05	**Earthwatch-HSBC Research Program** Dan Bebber
9:10	**Smithsonian Tropical Research Institute (STRI)** Eldredge Bermingham, STRI
9:15	**STRI-HSBC Research Program** Stuart Davies, STRI
9:20	**Video Presentation**
9:35	**KEYNOTE: Managing sustainability risk at HSBC** Francis Sullivan, HSBC
10:05	**Forest plots, climate change, and the global carbon cycle** Helene Muller-Landau, STRI
10:35	**BREAK**
11:05	**The response of tropical forests to atmospheric change** Yadvinder Malhi, Oxford University
11:35	**Carbon budgets for intact and recently logged forests on the Maryland Coastal Plain** Geoffrey Parker, Smithsonian Environmental Research Center
12:05	**PANEL DISCUSSION/Q&A**
13:05	**LUNCH** (opportunity for press interviews with researchers)
14:05	**World cities: Engines of low carbon change** Björn Roberts, The Climate Group
14:35	**Understanding ecosystem services in the Panama Canal watershed: The Agua Salud Project** Jefferson S. Hall, Smithsonian Tropical Research Institute
15:05	**Session Close**
18:00	**DRINKS RECEPTION**

9:35-10:05

Managing sustainability risk at HSBC

Francis Sullivan, HSBC

Francis Sullivan will outline HSBC's approach to sustainability risk, focusing on measuring and managing the risks in client business

10:05-10:35

Forest plots, climate change and the global carbon cycle: Linking forest structure and composition to carbon pools and fluxes

Helene Muller-Landau[1], Renato Valencia[2], Muhammad Firdaus[3], Somboon Kiratiprayoon[4], Raman Sukumar[5], Sylvester Tan[4], Supardi Noor[3], Sarayudh Bunyavejchewin[6], Stephen Hubbell[7,1], and Markku Larjavaara[1]

[1]Smithsoninan Tropical Research Institute, [2]Pontificia Universidad Catolica del Ecuador, [3]Forest Research Institute Malaysia, [4]Sarawak Forest Department, [5]Indian Institute of Science, [6]Royal Thai Forest Department, [7]University of California, Los Angeles

Tropical and temperate forests together encompass an estimated 38% of terrestrial carbon pools and 48% of terrestrial net primary production, and thus knowledge of their carbon budgets and of how these budgets respond to natural and anthropogenic global change is key to understanding the global carbon cycle today and in the future. Regrettably, there are still large gaps in our understanding of forest carbon pools, short- and long-term carbon fluxes, the mechanisms underlying these fluxes, and the likely impacts of global change—especially for tropical forests. The CTFS Global Forest Carbon Research Initiative aims to fill these gaps through research quantifying the sizes of forest carbon pools and fluxes, their spatial and temporal variation, and the drivers of this variation at multiple tropical and temperate forest sites around the globe. Here, we use these data to investigate the correlates of spatial variation in aboveground tree carbon stocks within and among plots, and thereby gain insights into the causes and consequences of this variation.

11:05-11:35

The response of tropical forests to atmospheric change: insights from long-term forest monitoring plots

Yadvinder Malhi, Oxford University

Understanding how forests respond to global atmospheric change is an important component of understanding the future of the biosphere and atmosphere over the 21st century. I review the role that forests play in the global carbon cycle, and then explore what long term monitoring of tropical forests is telling us about how these ecosystems are changing over time and how they may respond to atmospheric change in the 21st century. Tropical forests appear to be going through substantial shifts in biomass and dynamics and possible composition over recent decades. Results from elevation transects can give insights into how temperature controls forest function and structure. Expansion of such monitoring to temperate sites, and to fragmented and secondary forests (as is happening the HSBC-supported research network) will yield further important insights into the future of the planet's forest landscapes.

11:35-12:05

Carbon budgets for intact and recently logged forests on the Maryland Coastal Plain

Geoffrey Parker[1], Nancy Kahn[1], Jeffrey Lombardo[1], Dawn Miller[1], Dale Morrow[1], Dan Bebber[2]

[1]Smithsonian Environmental Research Center,
[2]Earthwatch Institute

The project "Sustainable Forest Management in a Changing Climate" is a study of the interactive effects of stand age (intermediate and mature) and management (intact and selectively logged) on the forest carbon balance and its dynamics. Here we report on the major above-ground components of the annual carbon balance for the period immediately after the harvesting. Components include standing biomass and coarse woody debris and the production of wood and litter, coarse and fine. Future efforts will focus on: (1) the below-ground stocks and fluxes, (2) the atmosphere-biosphere exchanges, photosynthesis, autotrophic and heterotrophic respiration and (3) whole-system carbon dynamics of the regenerating stands.

14:05-14:35

World Cities—Engines of low carbon change

Björn Roberts, The Climate Group

Copenhagen divided opinion sharply. For some it was a critical and perhaps unique chance to avoid dangerous climate change - spectacularly missed. Others recognise that, though only a step forward, the summit opened the door to new funding and to closer cooperation among the major emitters.

Reaching an effective international political agreement is not, however, the only show in town. Investment in low carbon economic growth is already substantial and growing rapidly, evidenced for example by HSBC's Climate Change Index, and there is great scope to accelerate that growth, independently of a global deal on climate change.

Major cities have a critical role to play in driving market transformation for emerging radical efficiency technologies. They have the critical mass of population, infrastructure, innovation and finance, and the municipal policy and regulatory leeway needed to overcome key barriers to full commercialisation.

By deploying emerging low carbon technologies like LED lighting and electric vehicles at scale, cities will reduce their own emissions and speed the global uptake of these technologies.

And, by demonstrating the technologies' potentially transformative economic benefits, they will help to move the international politics of climate change beyond the 'burden sharing' paradigm towards one of maximising opportunity.

14:35-15:05

Understanding ecosystem services in the Panama Canal watershed: The Agua Salud Project

Jefferson S. Hall, Smithsonian Tropical Research Institute

With approximately 14,000 ship transits and annual revenue of just under $1.8 billion a year, the Panama Canal is arguably the world's most important inland commercial waterway. The 300,000-ha drainage basin that feeds the canal provides drinking water for almost half of the inhabitants of Panama, is home to hundreds of thousands of people, and is rich in biodiversity. Against this backdrop, the Agua Salud Project—a project with the goal of understanding the role forests play in providing ecosystem services and how they change with land use—was initiated. An experimental platform has been set up on a 700-hectare focal research area where process level studies afford in-depth studies of the hydrological cycle, carbon sequestration, and biodiversity. In addition, interactions between ecosystem services are planned and/or underway. With extensive data collection underway in our focal research site, we are working to link science to policy through studies of economic valuation and partnerships aimed at improving land-use planning and management.

SCHEDULE TUESDAY, 2 MARCH

9:00 **Management impacts on forest responses to climate change**
Dan Bebber, Earthwatch Institute

9:20 **Sustainable coffee production in Costa Rica**
Mark Chandler, Earthwatch Institute

9:40 **Counting carbon for REDD: Linking field plots with LiDAR**
Joseph Mascaro, University of Wisconsin, Milwaukee

10:00 **The effect of proximity to forest edge, moisture conditions and soil macrofauna on leaf litter breakdown and decomposition**
Terhi Riutta, Oxford University

10:20 **Initial results from the establishment of a long-term broadleaf monitoring plot at Wytham Woods, UK**
Nathalie Butt, Oxford University

10:40 **Combining chronosequence with census data shows recent accelerated growth of temperate forest stands**
Sean McMahon, Smithsonian Tropical Research Institute & Smithsonian Environmental Research Center

11:00 **BREAK**

11:30 **Belowground responses to climate change in differently managed forests in the Chesapeake Bay**
Daniel Stover, Earthwatch Institute

11:50 **Microclimatic and canopy structural indicators of ecosystem function in a regenerating forest**
Jeffrey Lombardo,
Smithsonian Environmental Research Center

12:10 **The CTFS-SIGEO Large Forest Dynamics Plot at the SCBI, Front Royal, VA: Initial census and future prospects**
Norman Bourg, Smithsonian Conservation Biology Institute (SCBI), National Zoological Park

12:30 **Community Parameters of Four Successional Stages in the Atlantic Rain Forest, Southern Brazil**
Robson Capretz, SPVS – Sociedade de Pesquisa em Vida Selvagem e Educação Ambiental

12:50 **LUNCH**

13:50	**Why do some trees have high density wood? Problems with the traditional explanation, a new hypothesis, and implications for understanding variation in forest carbon stocks** Markku Larjavaara, Smithsonian Tropical Research Institute
14:10	**Vegetation structure and composition of tropical evergreen and deciduous forests in Uttara Kannada District, Western Ghats** Indu Murthy, Indian Institute of Science
14:30	**The impact of human disturbance on forest responses to climate in Gutianshan National Nature Reserve, China** Haibao Ren, Institute of Botany, Chinese Academy of Sciences
14:50	**A reassessment of carbon content in tropical trees: The volatile C fraction and its variability among species** Adam Martin, University of Toronto
15:10	**BREAK**
15:40	**DISCUSSION:** Research output, the end-of-programme conference, and future developments
16:40	**DISCUSSION:** Making the most of volunteers

9:00-9:20

Management impacts on forest responses to climate change

Dan Bebber, Earthwatch Institute

Climate change can alter forest dynamics through warming and changes in weather patterns. Most of the world's forests have been affected by anthropogenic disturbances, from low-intensity harvesting of non-timber forest products to plantations of exotic species. Such disturbances can alter responses to climate. This is most clear in the tropics, where harvesting opens the forest canopy and increase susceptibility to drought and fire. In other regions, human disturbance-climate interactions are less well understood, but may nevertheless be important determinants of forest dynamics, carbon balance, and biodiversity. The aim of the Earthwatch climate change research programme is to quantify how anthropogenic disturbances and climate interact to affect forest dynamics. Methodologies are designed to monitor change on a variety of timescales, thereby capturing both long-term trends and the effects of short-term disturbances. This talk will introduce the research sites and methods employed under the programme, and highlight potential areas of development.

9:20-9:40

Sustainable coffee production in Costa Rica

Mark Chandler, Earthwatch Institute

9:40-10:00

Counting carbon for REDD: Linking field plots with LiDAR

Principle Investigator: Greg Asner, Carnegie Institution for Science & Stanford University
Presenter: Joseph Mascaro, University of Wisconsin, Milwaukee

Nearly 20% of carbon emissions come from the degradation and deforestation of tropical forests. Soon, an international program (REDD) will seek to slow such emissions through financial compensation, but a key obstacle is the quantification of spatial variation in carbon stocks at the scale relevant to land owners. Techniques for quantifying carbon stocks on the ground have existed for decades, but we now must develop techniques for linking ground data to high resolution remote sensing platforms, such as LiDAR (Light Detection and Ranging). I will discuss new approaches developed during carbon mapping campaigns in Hawai'i and Peru, with a specific focus on the surprising importance of regional and species-driven differences in tree height.

10:00-10:20

The effect of proximity to forest edge, moisture conditions and soil macrofauna on leaf litter breakdown and decomposition

Terhi Riutta[1*], Eleanor Slade[2*], Michele Taylor[3], Yadvinder Malhi[1], Philip Riordan[2], David MacDonald[2] and Michael Morecroft[3, 4]

[1]Oxford University, School of Geography and the Environment, [2]Oxford University, Wildlife Conservation Research Unit, [3]Centre for Ecology and Hydrology, [4]Natural England, [*]These authors contributed equally; one of them will present the study

Temperate forests, especially in Europe, are located in fragmented landscapes and a considerable proportion of the forest area is close to the edge. Due to higher evapotranspiration forest edges lose more water than forest core areas. Moisture conditions influence both the microbial decomposition and the leaf litter breakdown by soil macrofauna. This study aimed to compare the leaf litter breakdown and decomposition in forest edge and interior and to quantify the contribution of soil macrofauna to the litter breakdown and decomposition in varying moisture conditions.

The study took place in Wytham Woods in Southern England. The main species in the study area were ash (*Fraxinus excelsior*), oak (*Quercus robur*) and hazel (*Corylus avellana*). Ten plots were set up at 7m (edge plots) and 100m (interior plots) from the forest edge. Half of the plots were watered for 13 weeks during summer 2009, totaling 200mm extra precipitation, which roughly doubled the average June-August rainfall. Leaf litter breakdown and decomposition rates were measured as mass loss from small (macrofauna exclusion) and large (macrofauna access) mesh bags containing 5g of ash and oak leaves. Macrofauna abundance and species composition was surveyed at the beginning and at the end of the study.

The soil water content was approximately 50% lower in the edge than in the interior. Decomposition was moisture limited; mass loss was lower in the edge than in the interior and the watering treatment increased the mass loss in both habitats. The presence of macrofauna increased the mass loss by 50%. Macrofauna abundance did not differ between the habitats or treatments. The contribution of the macrofauna was more important for the breakdown and decomposition of the more recalcitrant oak leaves compared with the easily decomposable ash leaves. The study showed that ecosystem functioning can differ significantly between forest edges and core areas.

10:20-10:40

Initial results from the establishment of a long-term broadleaf monitoring plot at Wytham Woods, UK

Nathalie Butt, Oxford University

During the 2008 field season, a long-term forest monitoring plot was installed in 18 hectares of semi-natural broadleaf woodland across a hillside in Wytham Woods, Oxford, UK. The initial census recorded 23 species and over 20, 000 stems. Late 2008/early 2009 saw coarse woody debris, tree height and topographical surveys carried out. In the 2009 field season, dendrometer bands and long-term ground flora quadrats were installed, leaf area phenology was investigated and a comprehensive soil survey completed. Results show that the distribution of different tree species and dbh size classes reflects historical land use patterns, and that Acer pseudoplatanus is dominant in terms of numbers of individuals and biomass. The soils in the plot were predominantly clay, and soil carbon and nitrogen content and fertility increased with slope. Carbon stocks were calculated for coarse woody debris, aboveground (standing) biomass, belowground (roots) biomass and soil. The carbon stock values, in MgC/ha-1, were, respectively, 3.57, 96.8, 19.36, and 139: the total carbon budget for the whole plot was 258.75 MgC/ha-1.

10:40-11:00

Combining chronosequence with census data shows recent accelerated growth of temperate forest stands

Sean McMahon, Smithsonian Tropical Research Institute &

Smithsonian Environmental Research Center

Changes in patterns of tree growth can have a huge impact on atmospheric cycles, biogeochemical cycles, climate change, and biodiversity. Recent studies have shown increases in biomass across many forest types. Although this increase has been attributed to climate change, without knowing the disturbance history of a forest, growth could also be due to normal recovery from unknown disturbances. Using a unique data set of tree biomass collected at the Smithsonian Environmental Research Center in Edgewater, MD, USA, over the past 22 years from 55 temperate forest plots with known land-use histories and stand ages ranging from five to 250 years, we found that recent biomass accumulation greatly exceeded the expected growth due to natural recovery. We have also collected over a century of local weather measurements and 17 years of on-site atmospheric CO_2 measurements that show consistent increases in line with globally observed climate change patterns. Combined, these observations demonstrate that changes in temperature and CO_2 that have been observed world-wide can fundamentally alter the rate of critical natural processes, as predicted by biogeochemical models.

11:30-11:50

Belowground responses to climate change in differently managed forests in the Chesapeake Bay

Daniel B. Stover, North America Regional Climate Center, Earthwatch Institute

Belowground responses are often excluded or oversimplified in many ecosystem level studies. However, an increasing body of literature indicates plant roots are large sinks for photosynthates (>33% of global NPP), suggesting they are important in long-term soil sequestration and carbon cycling. With atmospheric CO_2 concentrations increasing, plant communities are expected to positively respond with increased belowground allocations due to demands on belowground resources. However, the duration and relative responses of root systems to CO_2 stimulation remain unclear in most forested ecosystems. Additionally, micro-environmental differences and limiting factors (e.g., nitrogen) constrain root production under CO_2 enrichment. Therefore, detailed knowledge of spatial and temporal variation of fine and coarse roots and their dynamics is essential for the development of predictive models of the long-term soil carbon storage. Utilizing root cores and in-growth methods, fine root productivity and biomass estimates will be determined for different aged forests under both (logged and unlogged) forest management regimes. Additionally, coarse root biomass will be estimated through non-destructive ground-penetrating radar methods. These results will help complete a complex carbon budget for this system while leveraging existing Regional Climate Center resources.

11:50-12:10

Microclimatic and canopy structural indicators of ecosystem function in a regenerating forest

Jeffrey Lombardo[1], Geoffrey Parker[1], Nancy Kahn[1], and Dan Bebber[2]

[1]Smithsonian Environmental Research Center,
[2]Earthwatch Institute

Many ecosystem functions are difficult to measure directly but there are a variety of proxy measures of structure and of aggregate functions that can serve as ready, more tractable guides to ecosystem functions. The project "Sustainable Forest Management in a Changing Climate" is a study of the interactive effects of stand age (intermediate and mature) and management (intact and selectively logged) on the carbon balance and dynamics of a mixed-deciduous forest on the Maryland (USA) Coastal Plain. In addition to measurements of the carbon balance we examined variation in microsite factors within and among stands. These factors highlight the functional variation in stands of different age and silvicultural treatment. By monitoring these factors over time, we can observe the influence of the forest canopy on components of ecosystem function as stands regenerate.

Air temperature and humidity were measured in three radiation-shielded sensors mounted at 0.5 m above ground in each plot, sampling hourly. Precipitation interception was measured for selected events using a network of rain gauges (20 in each plot and 8 at outside locations). The penetrance of Photosynthetically Active Radiation (PAR) was measured on clear, midsummer days at midday using high frequency quantum sensor measurements.

The vertical and horizontal structure of the canopy was measured with the Portable Canopy LIDAR (PCL). PAR and LIDAR structure were sampled around the entire perimeter of each plot.
We present results from the early stages of regeneration, compare these to the intact situation, and make predictions as to the rate of recovery. This information is important to understanding ecosystem function in disturbed mid-Atlantic Coastal Plain forests, as well as the influence of these factors on carbon storage and stand structure.

12:10-12:30

The CTFS-SIGEO Large Forest Dynamics Plot at the SCBI, Front Royal, VA: Initial census and future prospects

Norman Bourg, Smithsonian Conservation Biology Institute (SCBI), National Zoological Park

The 25.6 hectare SCBI Large Forest Dynamics Plot is located at the Smithsonian Conservation Biology Institute (formerly Conservation and Research Center) of the National Zoological Park in Front Royal, VA, adjacent to the northern end of Shenandoah National Park. It lies at the intersection of three major physiographic provinces of the eastern US: the Blue Ridge, Ridge and Valley, and Piedmont. The forest type is typical mature secondary eastern mixed deciduous forest, with a canopy dominated by tulip poplar (*Liriodendron tulipifera*), hickories (*Carya* spp.), and oaks (*Quercus* spp.), and an understory composed mainly of spicebush (*Lindera benzoin*), paw-paw (*Asimina triloba*), eastern redbud (*Cercis canadensis*), , and American hornbeam (*Carpinus caroliniana*). Installation and census work began on the plot in May 2008, with the first census and mapping completed by December 2009. 41,384 stems are present, belonging to 67 species of trees and shrubs, 54 of which are native species. The plot also contains a 4-ha fenced exclosure where white-tailed deer have been excluded since 1990, as well as three 1-ha Smithsonian Monitoring and Assessment of Biodiversity Program (SI-MAB) plots, all of which have been censused one to several times since 1990. The plot is participating in the CTFS Global Forest Carbon Research Initiative, with 13km of downed woody debris transects completed, biweekly collection of litterfall data ongoing since April 2009, and a full soil C and nutrients survey scheduled for Spring 2010. Current and future research plans include dendrochronological sampling of tree growth rates to examine herbivory effects, establishment of seedling plots to link with litterfall trap data, and initial analyses of forest structure, composition, species distributions, biomass allocations, and carbon pools/fluxes.

12:30-12:50

Community parameters of four successional stages in the Atlantic Rain Forest, Southern Brazil

R Capretz[1], M Reginato[1], R Britez[1], D Bebber[2], and V Zwiener[1]

[1]SPVS – Sociedade de Pesquisa em Vida Selvagem e Educação Ambiental, [2]Earthwatch Institute

Twelve permanent plots were established in the Atlantic Rain Forest of Southern Brazil, in order to sample a forest gradient from early successional stages to old growth forest. Our goal was to compare how climate parameters influence forest structure and dynamics among differing in age of abandonment from anthropogenic activities. Three study sites of each successional stage were selected: initial secondary forest (~20 yr), medium and advanced secondary (30-60 yr) and primary forest (>80 yr). After one year of forest inventory, we sampled 22143 trees of more than 250 species. All trees were measured at DBH, estimated height, tagged, mapped and identified. The main botanical families found were Lauraceae, Myrtaceae and Rubiaceae. The 20 yr forest stands showed lower basal area, lower richness and higher density of trees when compared to advanced stages. For the 20 yr forests the number of species varied from 62 to 92, with Shannon Diversity Index (H) around 2.8. For the 30-60 yr forests, the number of species varied from 116 to 132 per hectare, with H values around 3.4. For Primary Forests plots, the number of species varied from 120 to 134 (H=4.1). These results emphasize the richness of Atlantic Rain Forest, compared with other tropical forests. The resilience of our forests is related to the level of old anthropogenic disturbances, improved by the location of the study site, inserted in the most preserved region of Atlantic Rain Forest.

13:50-14:10

Why do some trees have high density wood? - Problems with the traditional explanation, a new hypothesis, and implications for understanding variation in forest carbon stocks

Markku Larjavaara & Helene C. Muller-Landau,
Smithsonian Tropical Research Institute

Tree species vary widely in wood density—some are as light as balsa, while others are so heavy they sink in water. Why? Current thinking holds that low wood density allows trees to grow quickly but leaves them vulnerable to breakage, while high wood density endows strength but entails slower growth. However, a fat stem of low density wood can achieve greater strength at lower construction cost than a thin stem of high density wood. Thus, low density wood has the advantage in both strength and economy. What then, is the countervailing advantage of high wood density? We hypothesize that it is lower maintenance costs due to lower stem surface area. This advantage would be particularly important to long-lived trees and would explain why pioneers tend to have light wood. This revaluation of the costs and benefits of high wood density has important implications for understanding the evolution of tree life history strategies, functional diversity, forest carbon stocks, and global change impacts.

14:10-14:30

Vegetation structure and composition of tropical evergreen and deciduous forests in Uttara Kannada District, Western Ghats

IK Murthy, Shilpa S Beerappa, PR Bhat, DM Bhat, Vasudeva, M Khalid, M Prashanth D Bebber, and NH Ravindranath

Western Ghats is one of the biodiversity hotspots in India. Forests in the Western Ghats, like elsewhere in India, are on the one hand protected under the Forest Conservation Act of 1980, from conversion, and on the other hand subjected to human disturbance and use. Disturbed forests are likely to be more vulnerable to projected climate change compared to undisturbed forests. Studies at the Indian Institute of Science have shown that forests are likely to be adversely impacted by climate change in the coming decades. Currently, there is limited evidence of the status and dynamics of tropical forests in the context of human disturbance and climate change. In the present paper, we present the structure and composition of tropical evergreen and deciduous forests monitored under a long-term programme involving Indian Institute of Science, Earthwatch and volunteer investigators from HSBC. The results from monitoring of five 1-ha evergreen and three 1-ha deciduous forest plots will be presented at the workshop. The study would focus on the following aspects: Species distribution, density, dominance and biodiversity

- Forest regeneration status
- Biomass and soil carbon stocks
- Presence of invasive species in relation to disturbance
- Presence of NTFP species and dependence of communities on forest biodiversity and biomass

The study would also present the role played by volunteers from the corporate sector in monitoring the vegetation status and change along with the validation of the measurements made by the volunteers in comparison to the expert investigators of Indian Institute of Science. The study would demonstrate a new opportunity for involving citizens in monitoring ecological change in natural and socio-economic systems, which apart from creating awareness in the participants would also lead to generation of valuable ecological and socio-economic data. Based on the long-term monitoring of the vegetation status and dynamics, it is proposed to generate data for dynamic global vegetation models assessing the impact of climate change on forest ecosystems as well as in promoting sustainable management of forests in the context of climate change.

14:30-14:50

The impact of human disturbance on forest responses to climate in Gutianshan National Nature Reserve, China

Haibao Ren[1], Xiaojuan Liu[1], Qi Jia[1], Jiangshan Lai[1], Xiangcheng Mi[1], Dan Bebber[2], and Keping Ma[1]

[1]Institute of Botany, Chinese Academy of Sciences,
[2]Earthwatch Institute

In order to quantify the impact of climate change on subtropical forest and its feed-back under different human disturbance, the first step should be monitoring the forest structure. IB-CAS mainly focused on this step to obtain the foundation stone for the whole project in late half of year 2009. We selected 12 1-ha plots along a human disturbance gradient with 4-levels. Each level of human disturbance had 3 replicates of 1-ha plots. These plots were gridded into 20 x 20 m quadrats using total station. All free-standing stems >= 10 mm in diameter at breast height were tagged, mapped, measured and identified to species in 11 plots. Inclination, status (alive, dead or broken) and clone characteristic were also recorded for each stem. The Digital Elevation Models (DEMs) have been established for all 1-ha plots, from which topographic variables such as aspect, slope, elevation and so on can be figured out. In addition, 330 traps were made, and 73 of them were set up in four plots. 189 samples of leaf-litter were collected in 3 plots and 7 times in all. They were dried for 15 hours under the consistent temperature of 80˚(, sorted out them by species, bark, branch and so on, and then weighed, recorded and preserved them separately. Based on the digitized data, we found that excepting for planted species, the other species (mainly broad-leaved species) spread over the whole plantation plot, though their individuals were very few. Another interesting finding was that species number was the highest in secondary forest, and the lowest in plantation forest, but the species number in plantation forest was very close to that in primary forest, which went beyond our expectation. We would make efforts to mine data in the near future, focusing on how human disturbance influence forest structure and what are the main processes to regulate the forest structure under different human disturbance regime. The other main objectives in 2010 are (1) to continue monitoring the dynamic of leaf-litter, (2) to investigate carbon storage in coarse debris, root and soil, (3) to examine the decomposition rate of litters, (4) to examine the soil respiration, (5) to set up dendrometer in plots to monitor tree growth rate, (6) to fix sensor in plots to monitor microclimate (soil temperature and moisture).

14:50-15:10

A reassessment of carbon content in tropical trees: The volatile C fraction and its variability among species

Adam R. Martin & Sean C. Thomas, University of Toronto

Currently, nearly all forest carbon models assume woody tissues of trees consist of 50% C on a weight/weight basis. However recent comparative studies indicate that total wood C content varies significantly amongst species, and deviates significantly from 50%. Variation in wood C is likely due to interspecific differences in cellulose: lignin ratios, as well as variation in the volatile C fraction; low molecular weight C-based compounds which are lost upon heating. To date neither total wood C, nor volatile C fraction has been accurately quantified in tropical trees, limiting the accuracy of forest C models. We assayed and compared freeze- and oven-dried wood samples to quantify total and volatile C fraction in 39 Panamanian hardwood species. Analysis suggests the volatile C fraction in tropical trees is significant, averaging 1.06% amongst species and ranging between 0.1-2.3%. Total wood C content excluding the volatile fraction averaged 45.1%, and ranged between 41.9-47.3%. Inclusive of the volatile fraction, total wood C averaged 46.1% and ranged between 42.2-49%. We observed a weak positive

SCHEDULE WEDNESDAY, 3 MARCH

9:00 **Consequences of global change for forest food webs**
John Parker, Smithsonian Environmental Research Center

9:40 **A landscape-scale study of woodland moths**
Eleanor Slade, Oxford University

10:00 **Trees and biodiversity in rural landscapes: Policy, practise and science in imperfect harmony**
Philip Riordan, Oxford University

10:20 **DISCUSSION:** Integrating animal ecology into permanent sample plot methodologies

11:00 **BREAK**

11:30 **The state of REDD+ negotiations under the UNFCCC**
Emily Brickell, WWF

12:10 **The use of classic and new technologies in the study of Agua Salud hydrology and biogeochemistry**
Robert Stallard, US Geological Survey & Smithsonian Tropical Research Institute

12:30 **Agua Salud project hydrologic studies and water balance: Preliminary indications**
Fred Ogden, University of Wyoming

12:50 **LUNCH**

13:50 **Forest regrowth at Agua Salud: Sponge effect or not?**
Beate Zimmermann,
Smithsonian Tropical Research Institute

14:10 **Agua Salud in a pan-tropical context**
Helmut Elsenbeer, University of Potsdam

14:30 **Variation of carbon stocks across different land-use types in a tropical rural landscape**
Michiel van Breugel,
Smithsonian Tropical Research Institute

14:50 **Functional importance of species diversity in tropical secondary forests**
Dylan Craven, Yale University

15:10 **DISCUSSION:** Potential for ecosystem service research, particularly hydrology

16:10 **BREAK**

16:40 **DISCUSSION:** Research methods: Are we measuring the right things?

9:00-9:40

Consequences of global change for forest food webs

John D. Parker, Principle Investigator,
Smithsonian Environmental Research Center
Eric M. Lind, Postdoctoral Fellow,
Smithsonian Environmental Research Center

Widespread changes in land use, biological invasions, and climate have resulted in history's most rapid and intensive modification of natural communities. Here, we report results from field and laboratory experiments examining the consequences of these stressors for temperate forests. First, we installed a manipulative, factorial experiment at the Smithsonian Environmental Research Center in Edgewater, Maryland, USA to test the direct and indirect effects of logging, alien plant invasions, and herbivory by white-tailed deer on a variety of forest health metrics, including the abundance and composition of plants, insects, and rodents, but also the amount of photosynthetically active radiation, soil moisture, soil compaction, and coarse woody debris. Preliminary results indicate that logging alters food webs by altering several metrics, most notably by increasing soil compaction, disproportionately enhancing the cover and diversity of alien plants, and decreasing insect diversity. Second, these patterns mimic results from landscape scale analyses, in which historical patterns of land use history are linked to contemporary patterns of invasion, again with soil compaction as a plausible mechanism enhancing invasions. Finally, we explore the implications of these enhanced alien plant invasions on trophic transfer by examining their nutritional quality and palatability to herbivores relative to native plants. Results from this research can inform management strategies to minimize the impacts of global change while maximizing native biodiversity and ecosystem function in temperate forest food webs.

9:40-10:00

A landscape-scale study of woodland moths

Eleanor Slade, Thomas Merckx, Philip Riordan, David Macdonald
Wildlife Conservation Research Unit, Oxford University

Temperate woodlands have become increasingly fragmented, which has resulted in reduced core woodland habitat, increased

edge habitats, and reduced connectivity between patches. Fragmentation, and concomitant reductions in population size and dispersal ability, is an acknowledged threat to conservation. Furthermore, climate change is likely to exacerbate these fragmentation effects. In this study we used macro-moths to look at how woodland patch size and connectivity affects species abundance, diversity, composition and movement on a landscape-scale.

Moths are an excellent group with which to study the combined effects of climate change and woodland fragmentation. They are a large and diverse group, with a large subset of species that depend on woodland during some stage of their life-cycle. They are known to be good indicators of habitat quality and respond rapidly to climate change effects, making them good surrogates for other insect groups.

During June and July 2009 we initiated a landscape-scale mark-release-recapture (MRR) study to document the use of core and edges of woodland fragments of a range of sizes, from 360 ha down to single isolated trees. Forty-four trap sites were sampled in ten fragments and at isolated and hedgerow oak trees. By marking and releasing every individual of a focal set of 92 woodland associated species, we were able to monitor their movements within the landscape.

In total, 15,427 individual moths from 89 species were marked and released. The overall recapture rate was 4.8%. We found that both woodland size and connectivity were important parameters. Moth abundance and species richness declined gradually with declining fragment size, but small woodland fragments still had a large abundance and richness of moths. However, unconnected fragments had lower abundances and species richness than connected fragments. Moreover, many moths appear to be moving large distances across the landscape, and recaptures along hedgerows and at isolated oak tress indicate that they are using these landscape features as corridors and stepping stones to move through the agricultural matrix.

10:00-10:20

Trees and biodiversity in rural landscapes: Policy, practise and science in imperfect harmony

Philip Riordan & David Macdonald
Wildlife Conservation Research Unit, Oxford University

Landuse pressures in rural areas place limitations on the occurrence of trees within these landscapes. As vehicles for provisioning biodiversity, trees offer potential biodiversity gains at varying scales from single isolated trees, trees within hedgerows to copses, woodlands and forests. Agricultural impacts upon biodiversity and efforts to reverse declines have emerged through policy tools such as agri-environment schemes. Here we examine the use and efficacy of policy instruments for biodiversity restoration across rural landscapes

11:30-12:10

The state of REDD+ negotiations under the UNFCCC

Emily Brickell, WWF

Since 2005, when the Coalition for Rainforest Nations first proposed the idea of reducing emissions from deforestation and forest degradation in developing countries (REDD), substantial progress has been made to develop the idea of REDD. The outputs from Copenhagen show that many areas—such as methodologies, scope, financing and safeguards—are being defined within the UNFCCC, while there still remains a few key outstanding issues that must be developed. The presentation will provide an overview of the state of play following Copenhagen and outline focal areas for moving forward—in the UNFCCC and broader policy developments. It will also include suggestions for how the policy debate might benefit from links with implementation and science relating to REDD+ and the forests role in climate change.

12:10-12:30

The use of classic and new technologies in the study of Agua Salud hydrology and biogeochemistry

Robert Stallard,
US Geological Survey & Smithsonian Tropical Research Institute

The “Agua Salud Project,” located in the central Panama Canal

Watershed, encompasses protected mature forests and a wide variety of land uses typical of rural Panama. Experiments at the small-watershed scale include four types of reforestation treatments and three types of controls that serve to distinguish between effects of treatments and climate variation. This complex interdisciplinary hydrologic and biogeochemical research project, involves parallel forestry and hydrology-biogeochemistry initiatives that seek to describe processes in sufficient detail that they may be rigorously modeled for current and future conditions. Hydrologic and biogeochemical studies utilize a mix of techniques and approaches. The project is designed around the classical use of rain gages and calibrated weirs to assess watershed mass balances including water, bedrock derived dissolved and solid weathering products, nutrients, and salts from the ocean and perhaps long-range air pollution. In addition, we are utilizing newer approaches to completing the water balance and carbon-dioxide flux including the use of eddy covariance measurement, evapotranspiration meters, wells, overland-flow samplers, and oxygen and hydrogen isotopes in water and sap. Geographic Information Systems are being used to describe the contemporary landscape and reconstruct the landscape history through time. The modeling framework is to be supported by independent digital elevation models developed from photogrammetry, synthetic aperture radar, and LIDAR. Archival research, GPS field work, and ongoing geologic studies in the region aid these efforts.

12:30-12:50

Agua Salud project hydrologic studies and water balance: Preliminary indications

Fred L. Ogden, [1] Trey D. Crouch, [1]
Edward W. Kempema, [1] and Aquilino Alveo-Sanchez [2]

[1] University of Wyoming, [2] Smithsonian Tropical Research Institute

The Agua Salud Project study catchments have been instrumented with a comprehensive suite of instrumentation to enable detailed examination of the water balance at a variety of scales. Instruments installed to date include: flow measuring weirs, recording rain gages, shallow groundwater monitoring wells, meteorological stations, surface energy balance systems, and two eddy-covariance systems. These sensors are distributed in space across six different land-surface treatments including: pasture, native-species plantation, teak plantation, old-regrowth forest, secondary succession, and canal grass. Placement of measurement sites is designed to maximize the detectable signal due to land-surface treatment. This talk will focus on instrumentation installed to date, as well as provide examples of data collected, and laboratory studies of weir sedimentation.

13:50-14-10

Forest regrowth at Agua Salud: Sponge effect or not?

[1] Beate Zimmermann & [2] Helmut Elsenbeer

[1]Smithsonian Tropical Research Institute, [2] University of Potsdam

Efficient water management is of great importance in the Panama Canal Watershed, particularly in terms of sufficient dry season flow. Due to the widespread belief that forests promote water storage during the rainy season and therefore slowly release water in dry periods—the "sponge effect"—reforestation has become popular throughout the area. Whether the hope becomes reality depends on the gain in infiltration opportunities after reforestation, which has to outweigh the high water use and interception loss of the regrowing forest. Due to forest aging and a multitude of possible secondary forest types, this tradeoff between infiltration and evapotranspiration is far from static and uniform.

With several reforestation experiments in an area of uniform geology, the Agua Salud Project enabled us to initiate soil hydraulic and interception monitoring campaigns, which provide a basis to explain observed changes in stream runoff in the course of reforestation. With the help of our monitoring results and regional surveys we evaluate the potential of Agua Salud's young forests to develop a sponge effect: If at all, where and when can it be expected to happen?

14:10-14:30

Agua Salud in a pan-tropical context

Helmut Elsenbeer[1] & Beate Zimmermann[2]

[1] University of Potsdam, [2] Smithsonian Tropical Research Institute

Forest regrowth occurs across the entire intertropical region and hence over wide spectra of soils, landscapes and rainfall regimes. These three factors control the movement of water at the Earth's surface, and hence they determine the extent to which the effect of forest regrowth is actually a salutary one ("sponge effect"). Our survey of data-rich research sites in the humid tropics, including Agua Salud, yields three scenarios:

1) The no-sponge-effect environment: forest regrowth has no relevant effect because the soilscapes in question act like a sponge anyway for abiotic reasons, regardless of what grows on them; do plant trees, but for other reasons.

2) The small-sponge-effect environment: forest regrowth has little effect because the soilscapes in this category can hardly act like a sponge for abiotic reasons, regardless of what grows on them, so don't hold your breath upon planting trees.

3) The big-sponge-effect environment: forest regrowth has a relevant effect because the hydrological behavior of such soilscapes is strongly controlled by what grows on them; by all means, do plant trees and expect a big sponge effect.
The million-dollar question is: how can we predict the sponge-friendly domain of that trinity soils-landscape-climate?

14:30-14:50

Variation of carbon stocks across different land-use types in a tropical rural landscape

Michiel van Breugel, Smithsonian Tropical Research Institute

Tropical deforestation contributes significantly to the global emission of greenhouse gases. In part, the net emission of carbon that results from deforestation is determined by the uptake of carbon by the vegetation that replaces the forest. In parts of the Tropics, plantation establishment, forest restoration and secondary forests regeneration may offset a significant proportion of emissions from deforestation. Consequently, the long-term carbon balance of a tropical landscape depends on the spatial-temporal patterns of land-use and resulting dynamics in vegetation cover.

To predict the long-term carbon balance of tropical landscapes, we need to understand how regeneration rates and hence rates of carbon sequestration vary with biophysical factors and land-use patterns. As yet, there is still little agreement among estimates of the role of regeneration in offsetting emissions. Important sources of uncertainty include the choice of allometric models for the estimation of carbon stocks, the calibration of remote sensing models with ground data, the lack of long-term monitoring programs and the inherent problems of space-for-time substituting methods that are used instead.

The Agua Salud project initiated a long-term monitoring project that include 108 randomly located early-secondary forest transects and plantations of teak and mixed native timber species. Annual inventories and the development of improved site-specific allometric regression equations will enable direct estimates of biomass, improve our understanding of the relationships between factors that drive forest growth, stand dynamics and carbon sequestration and allow for direct comparison between alternative land-use choices. Integration of this data with remote-sensing methodologies such as Lidar is planned through collaboration with outside research groups, and will allow for upscaling to the whole Panama Canal Watershed region.

14:50-15:10

Functional importance of species diversity in tropical secondary forests

Dylan Craven, Yale University

Tropical secondary forests are unique, dynamic ecosystems that reflect the extent and nature of land-use history and proximity to human populations. While there is considerable overlap of plant species in secondary and old growth forests in the Panama Canal Watershed, the two forest types differ markedly in terms of species composition and abundance patterns. In recently abandoned pastures and cultivated fields, plant species interact with and respond to a distinct cohort of environmental conditions, birds, mammals, insects and pathogens than to those of old growth forests. To investigate species distribution and abundance patterns of trees and lianas, annual inventories of 110 randomly located transects are being performed in the secondary forests of the Agua Salud Project, Panama. Within the same transects, data on leaf morphology, physiology, phenology, and plant reproductive strategies are also being collected to evaluate the relationship between species abundance patterns and plant functional characteristics. Integrating demographic information with plant functional characteristics will improve our understanding of the functional importance played by species diversity in tropical secondary forests and, notably, how it relates to their carbon sequestration potential and hydrological function.

SCHEDULE THURSDAY, 4 MARCH

9:00	**WORKSHOP** Scientific exercise: The future of HCP research
13:00	**LUNCH**
14:00	**EXCURSION**

SPEAKER BIOGRAPHIES

Dr. Dan Bebber joined Earthwatch as Head of Climate Change Research in 2007. He is responsible for scientific research at the five global climate change field centres, in the UK, USA, Brazil, China and India, where the relationship between forest management and climate change will be investigated. His doctorate considered the influence of El Nino-related droughts on forest regeneration in Borneo, and he has research experience in reduced-impact silviculture in Canada, sustainable harvesting of medicinal plants in India and Nepal, and the biology of woodland fungi in the UK. His professional interests are the ecology and management of forests, and experimental design and statistics. Dan also holds a Research Fellowship in Biology at St. Peter's College, Oxford University, where he teaches ecology and statistics.

Dr. Norm Bourg research interests focus on the population biology of plants, their pollination biology, the interactive effects of perturbations such as climate change, fire and herbivory on their dynamics, the influence of invasive species on ecological communities, and the application of GIS technology and spatial modeling methods to predict species distributions and better understand the factors influencing their occurrence and population structure across landscapes. Applications of his research to addressing plant and biodiversity conservation issues is another important area of interest, as is the development of new technologies for increasing the accessibility to and appreciation of plants and natural habitats. Norm obtained his PhD in Biology from the University of Maryland – College Park, and currently works at the Smithsonian Conservation Biology Institute (SCBI) at the National Zoo as plant ecologist and ecological research programs manager. Among his duties are the coordination of large-scale ecological projects such as NEON and CTFS-SIGEO at the SCBI NEON Domain 2 core site, and serving as the Domain 2 DSECC liaison to NEON, Inc.

Dr. Emily Brickell is the Climate & Forests officer for WWF-UK. Emily has been following the climate talks for the last 2 years and has been coordinating WWF's international policy work on REDD+ over the past 18 months. She is also supporting WWF offices working to pilot and build awareness and capacity for REDD+ and now will be focussing particularly on bringing lessons to the policy debate from initial steps to implement REDD+.

Dr. Nathalie Butt is a member of the Ecosystems Group at the ECI and her research is concerned with the interaction of climate and biodiversity in both tropical and temperate systems. Her thesis research characterised these interactions in terms of forest ecosystem dynamics across Amazonia, and considered changes in productivity in terms of changes in carbon stocks. She was involved in the establishment of, and currently co-ordinates work in, the CTFS-SIGEO long-term broadleaf monitoring plot in Wytham Woods, UK.

Dr. Robson Louiz Capretz is an ecologist with an MSc in Agroecosystems Ecology and Doctorate with Forest Paleoecology and Natural History of plants. He has eight years of experience with forest ecology, dealing with forest inventories and bioestatistical analysis with field experience in the Amazon Forest, Seasonal Deciduous Forest, Forest Savanna and Atlantic Pluvial Forest (Mata Atlântica). His major scientific interests are in plant ecology, interactions among species, ecological processes and development of forest remnants and native forests.

Dylan Craven is a PhD candidate at Yale University's School of Forestry and Environmental Studies working on his dissertation, titled "Functional diversity of secondary succession plant communities within a tropical agricultural landscape in the Republic of Panama." Dylan received an MFS from Yale's School of Forestry and Environmental Studies in 2006 and spent the following year working with the Applied Ecology program of CTFS and the Environmental Leadership and Training Initiative in Panama. Previous to this, he received a BA in Foreign Affairs with a minor in Spanish from the University of Virginia and has worked extensively throughout Latin America.

Prof. Helmut Elsenbeer is Professor of Landscape Ecology and Soil Science and the head of the Department of Earth and Environmental Sciences at Potsdam University. He holds a Diploma (1980) in Biology from the University of Munich, an MSc (1982) in Soil Science from the University of California, Davis, and a PhD (1989) in Soil Science from North Carolina State University. The great theme of his research is "Surficial Processes and Their Controls," which means the movement of water, solutes, and sediment through vegetation and soils and along the Earth`s surface. For historical reasons, the preferred—but not the only—playground for this research has been the humid tropics, and tropical rainforests in particular, which stretch from Queensland to central Brazil and from Panama to western Brazil and places in between. Emerging sub-themes of his research have been the influence of land-cover change on such processes and spatial patterns. As to methodology, he has focused more on data collection, monitoring, and experimentation and less on modeling.

Dr. Jefferson Hall is a Staff Scientist in the Center for Tropical Forest Science (CTFS) – Smithsonian Institution Global Earth Observatory (SIGEO) in the Smithsonian Tropical Research Institute. He is the Director of PRORENA, a project that studies the ecological and socioeconomic aspects of reforestation in Panama, and Principal Investigator on the Agua Salud Project, an Ecosystem Services project that is evaluating hydrological, carbon storage, and biodiversity services provided by forests—and how they change with land use—within the Panama Canal Watershed. He has a BA from Miami University, MFS and PhD from the School of Forestry & Environmental Studies, Yale University. Jeff has worked in conservation biology and development for over 25 years, working over 20 years in Central Africa. His current research focus is related to forest management, including restoration, reforestation, and natural forest management.

Dr. Markku Larjavaara earned an MSc in Forestry in 1999 from the University of Helsinki, Finland. Since then, he has been working in development cooperation in a bush-fire management project in Burkina Faso and in Bioversity International in Malaysia. In between, he continued studies at the University of Helsinki and obtained a DrSc by focusing on forest fires and natural-disturbance dynamics in boreal forests. He has been a postdoctoral fellow at STRI, Panama, working on the HSBC-funded CTFS Global Forest Carbon Research Initiative since December 2007.

Jeffrey Lombardo is a Biological Science Technician in the Forest Ecology Lab. He shares responsibility for technical guidance and leadership for field teams on implementation of research protocols. He is originally from Rochester, NY, and received a Master of Science degree from Ohio University in 2006.

Prof. Yadvinder Malhi is the Programme Leader of the Ecosystems Group at the Environmental Change Institute (ECI) and Professor of Ecosystem Science at Oxford University. Yadvinder's research focuses on the impact of global atmospheric change on the ecology, structure and composition of terrestrial ecosystems, and in particular temperate and tropical forests. His research addresses fundamental questions about ecosystem function and dynamics, whilst at the same time providing outputs of direct relevance for conservation and adaptation to climate change.

Adam Martin is a PhD student at the University of Toronto. Based in Dominica and Panama, his dissertation research focuses on size-related changes in ecophysiology and functional biology of tropical trees. Specifically, his current research aims to quantify and understand size-related changes in shade tolerance, leaf physiology, and carbon content. Broadly, Adam's is interested in research which integrates ecophysiological principles and knowledge of tree functional biology, to answer applied conservation-based questions. Previously, Adam conducted his Master's research in managed forests in central Ontario, Canada, quantifying rates of tree mortality following single-tree selection harvesting.

Dr. Sean McMahon, a postdoctoral fellow at STRI's Center for Tropical Forest Science, studies temperate and tropical forest dynamics. Focuses of his research include understanding forest biodiversity and modeling changes in forest biomass due to climate change, canopy dynamics, and patterns of leaf abscission. He received his PhD In Ecology and Evolutionary Biology and an MS in Statistics from the University of Tennessee, Knoxville. Prior to joining STRI, he worked as a postdoctoral researcher at the Nicholas School of the Environment at Duke University, simulating forest dynamics from data.

Dr. Helene Muller-Landau is a Staff Scientist at the Smithsonian Tropical Research Institute (STRI) and is the lead scientist for the CTFS Global Forest Carbon Initiative. She received her PhD in Ecology and Evolutionary Biology from Princeton University in 2001 and has been at STRI since 2008. Helene's research is broadly concerned with the patterns, causes and consequences of plant diversity. The patterns of interest include the diversity of ways in which plant species make a living, the diversity of plant species that can coexist within the same area, and the diversity of plant communities around the globe. In terms of causes, she examines proximate correlates such as climatic factors and functional traits as well as the ultimate causes deriving from selective forces, physiological constraints and underlying tradeoffs. The consequences of most interest to her at this time are those concerning carbon pools and fluxes—specifically, how the plant species composition of a forest affects the quantity of carbon stored in various pools (e.g., living trees, dead and decomposing trees, and the soil), the residence times in these pools, the fluxes in and out of them, and their sensitivity to climate variation. Helene uses a combination of empirical and theoretical approaches to investigate these questions.

Dr. Indu K. Murthy is a biologist at the Centre for Ecological Science, Indian Institute of Science. She has been working on forest ecological aspects over the years. Currently, she is focusing on climate change mitigation assessments in the forest sector. She has worked extensively in the Western Ghats, assessing the socio-economic implications of climate change on the livelihoods and economy of forest dependent populations.

Prof. Fred L. Ogden is the Cline Distinguished Chair of Engineering, Environment, and Natural Resources at the University of Wyoming. He holds a joint appointment with the Department of Civil & Architectural Engineering, and the Haub School of Environment and Natural Resources. Prof. Ogden has been developing hydrologic models since 1990, and is co-developer of the physics-based Gridded Surface/Subsurface Hydrologic Analysis (GSSHA) model that is in widespread use within the U.S. Army Corps of Engineers. Prof. Ogden and students have been examining runoff generation mechanisms in the tropics with a focus on Panama since 2003, aiming to improve the ability of hydrologic models to account for shallow subsurface flow and the influence of watershed-scale biota on runoff generation.

Dr. Geoffrey "Jess" Parker is the Head Scientist in the Forest Ecology lab at the Smithsonian Environmental Research Center

(SERC) in Edgewater, Maryland. He received his PhD from the University of Georgia in 1985 and has been at SERC since 1987. His previous research concerned the effects on forests of acid deposition and the nutrient balance and microclimate of logged tropical forests. His current research involves the energy, water and carbon balance of forests, and explores how forest structure influences those functions.

Dr. John Parker is an Ecologist and Senior Scientist at the Smithsonian Environmental Research Center. His research interests include: invasive, nuisance and endangered species in aquatic, marine and terrestrial systems; global change; biodiversity and ecosystem function; community ecology; consumer-prey interactions and chemical ecology. He will be leading a deer-exclusion study which is additional and supplemental to the original research.

Dr. Haibao Ren is an ecologist at the State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, Chinese Academy of Sciences. He earned his doctoral degree in 2005, on the altitudinal gradient in species diversity in Tianshan Mountain, Xinjiang Uygur Autonomous Region and Dongling Mountain, Beijing. He worked both with Alberta University as a Visiting Scholar in 2006 and with the Centre for Tropical Forest Science. He has a professional interest in his community assembly and global biodiversity patterns such as species-area relationships, species-range gradients and the impacts of global change on the dynamics of forest ecosystems. Currently, he focuses on community assembly rule, species-area relationships and population dynamics of subtropical forests in China.

Dr. Philip Riordan is a Researcher with the Wildlife Conservation Research Unit (WildCRU) which is a part of the University of Oxford, Department of Zoology. His research has been focused on the impact of badger culling strategies for the control of bovine tuberculosis through the perturbation project. He also manages the Upper Thames Project aimed at examining the effects of improved habitat connectivity within lowland agricultural landscapes, through the targeted implementation of agrienvironment schemes. Phil will lead participants undertaking small mammal trapping during the centre experience.

Dr. Terhi Riutta is a postdoctoral Research Assistant for the Oxford University Centre of the Environment. Terhi completed her PhD with the Department of Forest Ecology at the University of Helsinki. Her research area is carbon dynamics in peatland ecosystems in changing climatic conditions. Terhi also completed her Master's degree in Forest Sciences at the University of Finland.

Bjorn Roberts is The Climate Group's Corporate Partnership Manager for the HSBC Climate Partnership. He is also responsible for developing and monitoring progress indicators across The Climate Group. Before joining The Climate Group, Bjorn worked for eight years with the Tropical Forest Trust (TFT) linking wood product retailers to legal and sustainable forest operations in the tropics. He helped to found the TFT in 1999, becoming Operations Manager and Client Manager to manage the organisation and develop relationships in the NGO and business sectors. His degrees are in Geography (BA Hons), International Relations (MSc) and Forestry (MSc) from London and Oxford universities.

Dr. Eleanor Slade has recently completed her doctorate in Tropical Forest Ecology at the Department of Zoology, University of Oxford. She studied the effects of selective logging on seedlings, herbivorous insects, and dung beetles in Sabah, Malaysian Borneo. As part of her MSc in Ecology, she conducted surveys of insects, small mammals, birds and bats in the Philippines.

Dr. Robert Stallard studies how land-cover and climate change affect water movement through soils, weathering, and erosion, and how these, in turn, affect the composition and dispersal of dissolved and solid phases in rivers and trace gases in the atmosphere. He is a Research Hydrologist and Biogeochemist in the National Research Program of the Water Resources Discipline at the U.S. Geological Survey, having studied natural and human-altered landscapes, in the Americas, Southeast Asia, and Africa, including most of the Amazon, Orinoco, Mississippi and Panama Canal Basins. As a STRI scientist, he leads the hydrology component of the Agua Salud Project.

Dr. Daniel Stover joined Earthwatch in March 2008 as director of the North America Regional Climate Center based at the Smithsonian Environmental Research Center (SERC) in Edgewater, Maryland. Dan is a plant ecologist and holds a Ph.D. in Ecological Sciences from Old Dominion University (2007) in Virginia, as well as an MSc in Environmental Plant Biology and three bachelor's degrees in Biology, Agriculture, and Interdepartmental Studies-all from West Virginia University.

Francis Sullivan is Adviser on the Environment for HSBC Holdings plc. After studying Agriculture and Forestry at Oxford University, Francis joined WWF-UK in 1987, helping to build their International Programme. In the early 1990s Francis worked on WWF forest policy and was part of the British Delegation to the International Tropical Timber Organisation. He helped set up the Forest Stewardship Council (FSC) and, what is now known as, the UK Forest and Trade Network. In 1995 he directed the international "Forests for Life: Campaign which attained over 20 national pledges for forest protection and a target of 10 million hectares of FSC approved forest. He later ran WWF's internal change team "Action Network," to identify how WWF could achieve quicker results for conservation and development. In 1999 he became Director of Conservation at WWF-UK, overseeing their conservation work worldwide and was heavily involved in establishing WWF's major role in the HSBC "Investing in Nature" programme. In 2004 he was seconded to HSBC as their Adviser on the Environment. HSBC now has an environmental action plan covering diverse topics such as property and purchasing, lending, and asset management, and are the world's first "carbon neutral" major bank.

Dr. Michiel van Breugel is a postdoctoral fellow at the Smithsonian Tropical Research Institute. His research interests include: secondary forest succession, reforestation and restoration and forest ecosystem services and biodiversity in human-modified landscapes. Michiel earned an MSc (1997) in Forestry and a PhD (2007) in Production Ecology & Resource Conservation, both from Wageningen University, The Netherlands. For his PhD and for other projects he worked for several years in Mexico in close collaboration with the Centro de Investigaciones en Ecosistemas (CIEco) of the National University of Mexico. He works on the forest-ecology component of the Agua Salud Project.

Dr. Beate Zimmermann is a geoecologist and postdoctoral fellow at the Smithsonian Tropical Research Institute and the University of Potsdam. Her research interests include: spatial-temporal patterns of key properties in the hydrologic cycle, the influence of land-use changes on hydrological plow paths, application and development of new techniques in spatial-temporal modeling, and development of efficient sampling procedures for environmental monitoring. Beate earned her PhD in Geoecology from the University of Potsdam in 2008. She works on the soils and hydrology components of the Agua Salud Project.