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Contributed Articles

Honduras Responds to Worst Bark Beetle Outbreak in 50 Years

Ronald F. Billings
Texas A&M Forest Service

As I flew low over the extensive pine forests of the Olancho District in central Honduras in November 2014, all I could see was a sea of red. Dead pine forests stretched to the horizon (Fig. 1), the result of an expanding outbreak of bark beetles, specifically the southern pine beetle (SPB). For the next two years, the National Forest Conservation and Development Institute (Instituto Nacional de Conservación y Desarrollo Forestal, Areas Protegidas y Vida Silvestre or ICF) would be challenged by the worst SPB outbreak since the early 1960s. The following report documents the probable causes of this outbreak, its impact on this small Central American country, and what was done to reduce economic and social losses.

Honduras has an estimated 5.4 million hectares of forest lands, covering almost half of the total area of the country. Of this land, 2.8 million hectares are suited to pine forests (FAO 2004). Much previously forested land has been denuded by poor exploitation practices, shifting agriculture, fuel wood and cattle grazing. By 2013, a total of 2.24 million acres of pine forests remained (ICF 2016).

The principal species of conifers found in Honduras are *Pinus caribaea* and *P. oocarpa*. *P. caribaea* (Caribbean pine) grows from sea level on the Lowland Pine Savanna of eastern Honduras up to elevations of 600-800 m; *P. oocarpa* is found between 500-1200 m. *Pinus maximinoi*, and *P. tucunumani* are commonly found in stands together with *P. oocarpa*

Figure 1. Forests of Pinus oocarpa in the Olancho Region of Honduras affected by the southern pine beetle Dendroctonus frontalis. November 2014.

above 500 m and *P. pseudostrobus* (white pine) grows primarily above 1200 m. *Pinus oocarpa* is the major source of pine for exportation and domestic use, although all species are used to a certain extent.

With the exception of forest fires, the southern pine beetle, *Dendroctonus frontalis*, causes the greatest economic losses to the pine forests of Honduras (Billings et al. 2004). From 1962-1965, more than 2 million hectares were affected by this insect. In 1964, it was estimated that the outbreak was spreading at a rate of 150,000 hectares per month (Hernandez Paz 1975). This remains the most devastating epidemic of southern pine beetle on record. The 1962-1965 outbreak originated at Gualaco, in the Olancho Region (Ketchum and Bennett 1964), and later spread throughout the entire pine zone with exception of the lowland pine savannah (La Mosquitia), prior to subsiding from natural causes.

According to Ketcham and Bennett (1964), during this outbreak infestations typically occurred in stands of *P. oocarpa* on the ridges and steep slopes with shallow, eroded soils. Affected trees in that outbreak were large, overmature, and slow growing, often over 100 years of age. Repeated fires had left extensive stands of pure pine consisting of widely spaced trees and no reproduction. Due to the magnitude of the outbreak, rapid development of the beetle, lack of roads, trained personnel and financing, direct control on an area-wide basis was deemed impractical. Control with 0.5 percent benzene hexachloride (BHC) in diesel oil was recommended on individual segments in fringe areas of the main infestation, but apparently little control was carried out.

Since the collapse of that historic outbreak in 1965, SPB populations remained at endemic levels, except for scattered local outbreaks, until 1982. In 1982-83, a sizable outbreak of *D. frontalis* occurred in second-growth pine stands, primarily in the Yoro Region (Billings 1982). Over 8,000 hectares of young pine forests were attacked and killed.

Following the 1982 outbreak, Honduras developed an effective forest pest management program for pine bark beetles, following my recommendations (Billings 1982, 1988). Under the leadership of National Forest Pest Coordinator Vicente Espino, a bark beetle record-keeping system and regional forest protection coordinators were established in each forested region. Honduras was the first country in Central America to initiate and maintain long-term records of bark beetle infestation occurrence, control efforts, and associated losses. From 1984 to 1998, losses to bark beetles in Honduras were kept to a minimum by early detection and prompt application of control measures, particularly cut-and-leave, a direct control method introduced in 1982 (Billings 1982).

The next major SPB outbreak occurred from 1998 – 2005 and killed an estimated 45,885 ha. of pine forests in this 8-year period. Of the 2.4 million cubic meters of dead timber resulting from this outbreak, only 17% (403,000 cubic meters) was salvaged. The outbreak, which peaked in 2002, occurred principally in young (15-25 year) stands of *Pinus oocarpa* (76%) and *P. caribaea* (20%), with the remainder in stands of *P. pseudostrobus*, *P. maximinoi*, and *P. tucunumani*. Losses were minimized by prompt detection, ground evaluation, and application of cut-and-leave to those infestations showing signs of expansion.

The current outbreak was first detected in 2013 in the Gualaco Region, the same region where the 1960s outbreak first developed. Honduras was in the midst of a severe drought, rendering unmanaged pine stands particularly vulnerable to a bark beetle outbreak. Unfortunately, several factors delayed the government's control action until 2014. The ICF had recently discontinued its Forest Health Department and laid off its experienced forest pest control personnel, some with more than 25 years of experience in SPB management. No funds were immediately available to support a bark beetle control effort. And, ironically, 2013 was a presidential election year. In such years, forestry personnel at all levels are more concerned about maintaining their jobs rather than forest protection. Additional obstacles included poor access to many of the pine forests, forest stands weakened by frequent wildfires, lack of markets for beetle-killed trees, and paucity of heavy equipment to promote rapid harvesting.

Ground inspections near Gualaco in November, 2014, revealed that the principal causal agent was *Dendroctonus frontalis*. Other species, including *Ips* spp. and the recently-described *D. mesoamericanus* (Armendáriz-Taledano et al. 2015), were present in a secondary role. In many cases, *D. frontalis* adults were killing trees by infesting only a small portion of the bole near the base of the tree crowns, leaving the remainder of the dying tree to be later colonized by secondary bark beetles. In other cases, *D. frontalis* mass attacks extended from the tree's base into the crowns and branches (Billings 2014).

The author and U. S. Forest Service entomologist Dr. Stephen Clarke presented a two-day training course for some 30 ICF technicians, including a field trip to active infestations (Fig. 2). As I had done periodically since 1982 in Honduras and other Central American countries, we described methods used to evaluate stages of SPB attack, potential for infestation growth, and how to set control priorities. These field protocols and how to correctly apply cut-and-leave or buffer cutting were explained in both the short course and in a series of my photo-illustrated field guides in Spanish (available at www.barkbeetles.org/centralamerica/.

Figure 2. Group of Honduran foresters and technicians receiving training on southern pine beetle management near Gualaco, Honduras in November, 2014.

A four-hour survey flight by helicopter was made over the infested regions to evaluate the situation from the air in November, 2014. Most infestations appeared to have originated in unmanaged stands of *P. oocarpa* on hilltops and were progressing downward. Many of these forests were about 50 years of age, presumably regenerated following the 1960s outbreak. By the end of 2014, ICF estimated the beetles had killed 15,242 acres, the highest single-year mortality due to SPB since 1963 (Fig. 1). Controlled infestations were scattered about, but represented less than 10% of the total infestations observed.

A list of recommendations was included in the author's trip report (Billings 2014), with a copies provided to the U. S. Forest Service/International Programs (sponsor of the technical assistance visit) and leaders of ICF. This included modifying the initial ICF action plan to better address the expanding outbreak; reorganize technical personnel to address all aspects of the outbreak (detection, ground evaluation, suppression, harvesting downed trees, etc.); involve private land owners and local communities in the control effort; place emphasis on expanding infestations at the leading edge of the outbreak; seek financial resources to support the control effort at national and local levels, among others.

Accompanied by Dr. Stephen Clarke and private consultant Dr. Jorge Macias, I made a second technical assistance visit sponsored by the U. S. Forest Service/International Programs in September, 2015. In just 10 months, the outbreak had spread from one to twelve forest districts, principally to Francisco Morazán, Comayagua, Olancho Oeste, and Yoro (Fig. 3). The beetles had swept through much of the Forest District of Olancho, which contains some of the country's most valued natural resource areas, including the Rio Platano Biosphere Reserve and the Patuca, Sierra de Agalta, and La Muralla National Parks. Portions of these protected areas were heavily impacted by the outbreak, but now contain mostly dead trees. Control efforts utilizing cut-and-leave were more evident (Fig. 4).

Figure 3. View of active southern pine beetle infestations in pine forests of central Honduras. September, 2015

Figure 4. Aerial view of southern pine beetle control efforts in Honduras, September 2015.

During the 2015 visit, I recommended that the entire outbreak area be divided into 3 zones, each with a different set of priorities. Zone A was defined as those forest districts in which the vast majority of existing pine forests had already been killed and beetles had vacated the infested trees (Fig. 1). The recommendation was to target these areas for recovery of dead and downed timber and prompt reforestation to avoid shifts in land use toward agriculture. Zone B included those districts or areas where SPB was still very active, but there were more green-crowned trees than red-crowned ones. Here, government control crews should be concentrated to halt further expansion of active infestations. I recommended that large infestations be treated by felling only green-infested trees and adjacent buffer trees to expedite the control, leaving brood trees standing. Zone C was defined as all other pine-forested districts or areas, where SPB infestations were just beginning to appear and most were still small. In this zone, emphasis for government and community foresters would be on prompt detection of new infestations and application of cut-and-leave (felling both brood trees (phase 2) and freshly-attacked trees (phase 1), plus the required buffer of adjacent unattacked trees).

The ICF took important steps in 2015 to address the outbreak (ICF 2016). The President of Honduras had declared the outbreak a national emergency in March and the equivalent of $25 million was appropriated in August for the control effort. ICF contracted a group of Honduran forest pest specialists to head up the control effort, including my counterpart Vicente Espino (Fig. 5) and others who had years of experience in bark beetle control with the previous forestry organization (Corporación Hondereña de Desarrollo Forestal or COHDEFOR). The action plan, initiated in response to my 2014 recommendations, was updated and expanded. An Interinstitutional Committee for Control of the Bark Beetle Outbreak, with representatives from 2 dozen public and private organizations, was created to oversee control efforts.

In September, 2015, ICF contracted and trained 5 regional pest coordinators to supervise direct control efforts in 5 different infested regions. Also contracted were some 200 work forces, each consisting of 5 chainsaw operators, 6 field hands and a forest technician to apply cut-and-leave. By the end of 2015, the area affected had grown to a total of ca. 390,000 has. affecting 18.6 million cubic meters of timber, despite intensified control efforts.

Figure 5. Honduran forest pest specialist Vicente Espino (left) and Dr. Ron Billings (orange cruiser's vest), with ICF personnel, evaluate a bark beetle-infested tree near Guimaca, Honduras. September 2015.

With the $25 million in appropriated control funds, the President of Honduras initially wanted to target most of the funds and occupy the control crews in Zone A, to fell dead trees and thereby eliminate the public "eye-sore" they produced. I had the opportunity to meet with the President in person (Fig. 6) to convince him to focus efforts on Zone B and C. A brief photo presentation of the outbreak coupled with an explanation of why cut-and-leave works and the need to focus on fringe areas of the outbreak seemed to change his mind in this regard.

Cut-and-leave consists of felling all currently-infested trees in an expanding infestation, plus an adjacent, horse-shoe-shaped buffer of uninfested trees. The downed trees are left on site, to be salvaged later if feasible (Billings 1982, 2011). This control method is specific to *D. frontalis* and serves to halt further expansion of the infestation by eliminating pheromone (attraction) sources. Except during brief periods of long-range dispersal during spring and fall when most new infestations are initiated, survival of beetles outside treated infestation is low. Within felled trees, immature beetle stages often fail to complete development due to competition with *Ips* bark beetles and unfavorable environmental conditions beneath the bark (Billings 2011, Macias Sámano et al. 2017).

Figure 6. Dr. Ron Billings meets with Honduran President Juan Orlando Hernández (left) to discuss the southern pine beetle outbreak, September, 2015.

By March, 2016, ca. 3,700 persons had been contracted directly or indirectly to implement the control program. The outbreak continued throughout the first 8 months of 2016, but began to decline in September of that year with the arrival of seasonal rains and intensified control efforts. By the end of 2016, an additional 115,000 hectares had become infested for a total of 505,000 ha. or 23% of all pine forests in the country. Since then, only small infestations in fringe areas (Zone C) have been detected as the outbreak winds down. Most of these have either gone inactive (naturally abandoned by the beetles) or have been controlled with cut-and-leave (ICF 2016).

During the course of the outbreak, ICF incorporated the use of satellite imagery utilizing Landsat 8 data to document the rate of infestation spread and the extent of the area affected. This technology was contributed by the government of Taiwan (ICF 2016). Unfortunately, this satellite imagery only detects trees with red or brown-colored crowns (Phase 3) and not the freshly-attacked trees with green crowns (Phase 1) or SPB brood trees in a fading stage of transition (Phase 2). But by monitoring sequential images taken every 1-3 months, the rate of infestation spread with and without control was documented.

The area controlled totaled 4,813 ha. in 2014 and 155,522 ha. in 2015 for a total of 160,335 ha. in these two years. Uncontrolled infestations in 2014 had expanded by a factor of 24.5 by the end of 2015. Thus, assuming a similar rate of expansion was halted by control, a simple calculation suggests that the 160,335 ha. of controlled infestations in 2014 and 2015 combined would have expanded to ca. 3.9 million ha. (160,335 x 24.5) by the end of 2015 if no control had been applied. This is more than all the pine forests in Honduras (2.4 million ha.). Accordingly, ICF is taking credit for saving 1.7 million hectares of pine forests with its control efforts (ICF 2016). Undoubtedly, even more forests could have been saved if the control program had not been delayed for nearly 2 years.

Unfortunately, only a small portion of the affected trees have been harvested and utilized, probably less than 20%. This is due to various factors, including poor markets for beetle-killed trees, lack of equipment and access.

The InterAmerican Development Bank has recently approved a $25 million, 5-year project to assist with reforestation in key watershed areas. This project also has provided funding to reestablish a Department of Forest Health and Protection within ICF and to initiate an early detection system for bark beetle outbreaks utilizing pheromone-baited traps. Hopefully, these funds will serve to demonstrate the value of a permanent forest health system within Honduras, better preparing the country to prevent or promptly address future bark beetle outbreaks.

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Macias Sámano, J. E., R. F. Billings, and V. Espino Mendoza. 2017. Guía para implementar el método de cortar y dejar y la franja de contención como medios de control del gorgojojo descortezador del pino, *Dendroctonus frontalis*, en Centroamérica y México. U. S. D. A. Forest Service, International Programs. 48 p. (In press).

Request for Information on Orphaned Tropical Forest Data

We hope to compile information on orphaned data for tropical forests, including inventory and plot data, that are in danger of being lost. Many projects over the years have generated a lot of tropical forest data. But the information is scattered among different institutions and people, some still only on paper, some digitized but in older formats.

TROPIS and ATROFI-UK are two previous databases that compiled metadata on forest plots and inventories. The data for certain plots are available at www.forestplots.net and its associated networks. But other plots and inventories still need attention, re-discovery even. We would like to compile information on datasets that should be digitized or transformed to an up-to-date digital format. The goal is firstly to make metadata on these datasets available on a publicly accessible website, and then to try to secure the data itself by pushing for appropriate curation with open-access availability.

These legacy datasets are invaluable for understanding how tropical forests change through time, including the cumulative impacts of changes in land use and climate, and changes in patterns of biodiversity and carbon storage. The past can help inform the future.

If you know of any such orphaned databases for tropical forests, please send a message to:

Gillian Petrokofsky gillian.petrokofsky@zoo.ox.ac.uk or
Sheila Ward sheila.emily.ward@gmail.com .

Please pass this message on to anyone else who might be interested.

Mobility in Silviculture: the Field Is Increasingly Connected at Cenibra

Located in the municipality of Belo Horizonte, eastward of the Brazilian state of Minas Gerais, Celulose Nipo Brasileira, known simply as Cenibra, has 254 thousand hectares area planted with Eucaliptus and native species, where the company's operations generate an enormous amount of information, key to guiding the decision-making process. To make this information reach the teams in a faster and more assertive way was the challenge faced by INFLOR along the development of the Mobility in Silviculture Project, terminated in the end of 2016.

Odair da Silveira Gonçalves, INFLOR's PMO and head of the project, explains that the solution implemented was elaborated by INFLOR's GIS/Mobile Suite, GISagri Operations, INFLOR's communication hub and INFLOR's Forest System for SAP®, known at Cenibra as GPF (Forest Process Management).

The app will replace the need for manual records (on paper) of over 11.000 monthly newsletters on Silviculture. This operation demanded a few days to be completed, until the information could be fully available. With the solution developed by INFLOR, the information will be made available in the morning following the day in which it was generated.

The solution will allow for the field operations to be followed more efficiently and closer to execution, with notes being directly released onto the GPF, from a cell-phone or a tablet. Cenibra uses the devices in the following office locations: Rio Doce (Belo Oriente, Ipaba and Pompeu regions), Guanhães (Sabinópolis and Virginópolis) and Nova Era (Cocais, Piracicaba and Santa Bárbara), all of them located in the state of Minas Gerais.

Of the various benefits the solution offers, Odair Silveira Gonçalves highlights the communication standardization through the different areas of the company, the end-to-end information exchange tracking, data access & system access control, among others.

The app is currently in use in 10 devices, involving about 15 people (coordinators, office technicians and leaders), and may reach 150 people when the usage is initiated by the field teams and in the tractors of the Silvicultural process, scheduled for mid-2017.

Ronaldo Ribeiro, CENIBRA's CIO, declares that this is an innovative project and brings the reality of forest operations closer to the centralized management system. This project is one of the IoT's (Internet of Things) concept application, with the purpose to improve corporate results. "The partnership between Cenibra and INFLOR, consolidated in various other projects, has provided great advances to our forest management", adds Ribeiro.

SAP is the trademark registered by SAP AG in Germany and many other countries.

From the archives:

Scene at a timber yard, Rangoon, Burma, 1907.

Photo by Philip Klier. The National Archives UK. No known copyright restrictions.

https://www.flickr.com/photos/nationalarchives/sets/72157629783313688/with/7215509112/

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Note from the editor

Feel free to send this newsletter on to others.

If you would like to be added to the distribution list for the newsletter, send an email to Blair Orr (blairorr@ymail.com)

- Blair Orr, IFWG Newsletter Editor
(blairorr@ymail.com)

SAF World Forestry Committee News

SAF Gregory Award

The Society of American Foresters is now accepting applications for the 2017 Gregory Award. The award brings two outstanding students or young professionals from outside of the US and Canada to the SAF Convention to have meaningful engagement with SAF and forestry and natural resources professionals from across the nation. Please help us spread the word about this exciting opportunity. The upcoming convention is in Albuquerque, New Mexico. The deadline to apply is May 8, 2017. For more information, visit

http://www.eforester.org/Main/Community/Scholarships/Gregory_Award.aspx.

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As a member of the Society of American Foresters you can join SAF working groups by going to the website:

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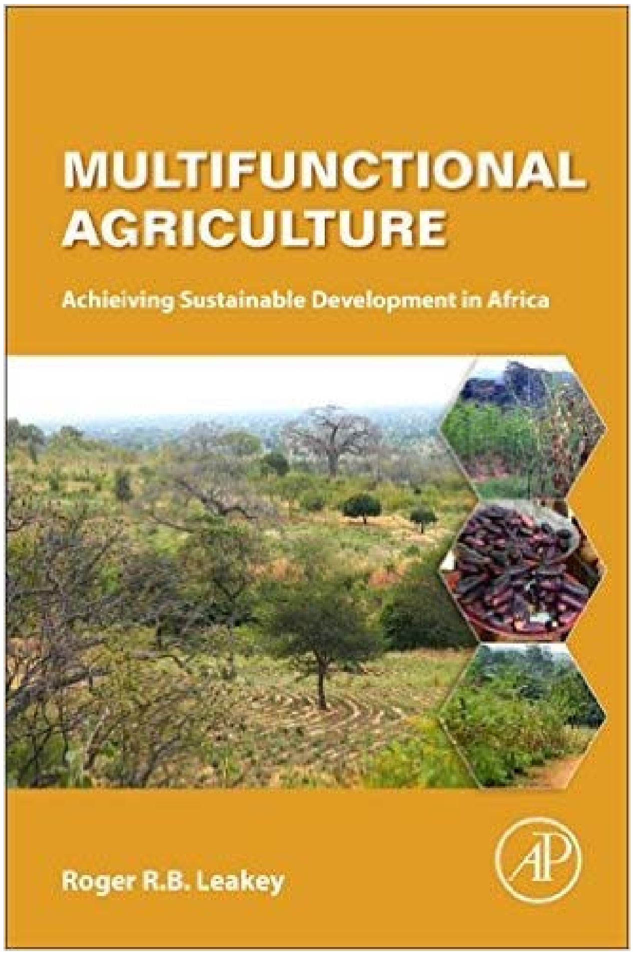
If you want to join this working group, we are B3, the International Forestry Working Group. Please pass this information along to SAF members who might be interested in joining a working group – especially B3, the International Forestry Working Group.

Recent Publications



Leakey, RRB. (forthcoming). Multifunctional Agriculture: Achieving Sustainable Development in Africa. Academic Press.

> Description: In a world increasingly challenged by the need to integrate and understand highly specialized knowledge in a multidisciplinary way, this book is innovative and perhaps unique in addressing this challenge. It focuses on ideas, strategies, techniques and practices spanning many disciplines at the interface of agriculture with: forestry, horticulture, plant physiology, genetics, ecology, soil science, food science, economics, and the social and environmental sciences as delivered by intensified and enriched agroforestry. **Multifunctional Agriculture** addresses this complexity, using case studies and insights from the needs of African farmers whose livelihoods are constrained by complex interactions between social, environmental and economic factors and problems underlying agricultural sustainability in Africa. This book, therefore, provides an important resource for those trying to understand the role of agriculture in the achievement of the new Sustainable Development Goals by providing easily implementable, practical and effective methodologies and practices.

Leakey, RRB. (2014). The role of trees in agroecosystems and tropical agriculture. Annual Reviews of Phytopathology 52:113-133.

Abstract: Shifting agriculture in the tropics has been replaced by sedentary smallholder farming on a few hectares of degraded land. To address low yields and low income both, the soil fertility, the agroecosystem functions, and the source of income can be restored by diversification with nitrogen-fixing trees and the cultivation of indigenous tree species that produce nutritious and marketable products. Biodiversity conservation studies indicate that mature cash crop systems, such as cacao and coffee with shade trees, provide wildlife habitat that supports natural predators, which, in turn, reduce the numbers of herbivores and pathogens. This review offers suggestions on how to examine these agroecological processes in more detail for the most effective rehabilitation of degraded land. Evidence from agroforestry indicates that in this way productive and environmentally friendly farming systems that provide food and nutritional security, as well as poverty alleviation, can be achieved in harmony with wildlife.

Leakey, RRB. (2013) Twelve Principles for Better Food and More Food from Mature Perennial Agroecosystems. Chapter 22 in Perennial Crops for Food Security: Proceedings of the FAO Expert Workshop, August 28-30, 2013.

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Leakey, RRB. et al. (2012) Tree Domestication in Agroforestry: Progress in the Second Decade (2003–2012). Chapter 9 in Agroforestry – The Future of Global Land Use. Springer.

Abstract: More than 420 research papers, involving more than 50 tree species, form the literature on agroforestry tree domestication since the 1992 conference that initiated the global programme. In the first decade, the global effort was strongly led by scientists working in humid West Africa; it was then expanded to the rest of Africa in the second decade, with additional growth in Latin America, Asia (mostly SE Asia) and Oceania. While the assessment of species potential and the development and dissemination of techniques for improved germplasm production were the principal activities in the first decade, the second decade was characterized by a growing research agenda that included characterization of genetic variation using morphological and molecular techniques, product commercialization, adoption and impact and protection of farmers' rights. In parallel with this expanding research agenda, there was also an increasing use of laboratory techniques to quantify genetic variation of the chemical and physical composition of marketable products (e.g. essential oils, food-thickening agents, pharmaceutical and nutriceutical compounds, fuelwood). Looking to the third decade, suggestions are made for further development and expansion of both the science to

underpin agroforestry tree domestication and applied research in support of development programmes to enhance the livelihoods of poor smallholder farmers worldwide.

Leakey, RRB. (2014) An African Solution to the Problems of African Agriculture. Nature & Faune 28(2):17-20.

Summary: In response to requests by farmers in Cameroon, a novel approach has been developed by researchers in Cameroon that is based on the integration and domestication of indigenous fruit and nut trees into agroforestry systems that rehabilitate degraded farm land, promote food and nutritional security and create income generating opportunities for both rural and urban populations. The benefits have been impressive and so the need now is for up-scaling. This initiative now needs the support of African policy makers.

http://www.fao.org/3/a-i4141e.pdf

TROPICAL NOTES

Frank H. Wadsworth and Library Staff
International Institute of Tropical Forestry
USDA Forest Service
San Juan, Puerto Rico

THE SAHEL:
LATENT END OF FOREST LIVELIHOOD

The Sahel region of North and Central Africa stretches from the Atlantic Ocean eastward through Senegal, Mauretania, Mali, Burkina Faso, Niger, Nigeria, Chad, and into the Sudan. It is a region of an estimated 37 million population with livelihood dependent on a low, dry woodland and food insecurity, of which 6.3 million people with nowhere to go are in need of emergency food assistance. The woodland of the region, beset with drought, rising temperatures, and oversight from world forestry assistance programs, is disappearing due to overuse for vital shelter, fodder, and fuel for boiling water and for cooking. Regreening the historic forest livelihood, possibly with *Eucalyptus tereticornis*, has been tested, but with land ownership and tenure not clear, human incentives for tree planting are lacking. The World Bank, in a search for investments that are financially, socially, and environmentally sustainable, restores degraded landscapes and reinforces the rights of the most vulnerable families to make a place to live, adapting to climate adversity and improving food security.

More information from Terry Sunderland (t.sunderland a cgiar. org) or Houria Djoudi (h.djoudi a cgiar. org), or Boris Matejcic,(N. Tesla 15, 51000 Rijeka, Croatia).

25-year tropical forest trends

With the completion of the articles from 2016 and the gradual appearance of those of 2017 a review was made of the tropical forestry trends exposed by the FAO Global Forest Resource Assessments of 1990 and 2015.
The 25-year global forest loss mostly in the low icome countries. During 2015 it wwas only 3Mha/year. Forest area declined in Central America, South America, South and Southeast Asia, and Africa. Growing stock volume increased in the Caribbean. Only 37% of the low income countries have forest inventories. Only 6% of tropical forests are Certified. Industrial forest plantations dominate in South America, Oceania, and Eastern and Southern Africa. Africa will need to increase plantations to offset continuing deforested area. Legally protected forests in the tropics increased from 12% to 26%. Forest CO^2 emissions were reduced about a quarter between 2011 and 2015. Most of this reduction recently took place in Brazil. Monitoring of forest cover in tropical countries ranged from good to very good from 38% in 2005 to 66% in 2015. Tropical forest are expected to continue at risk for conversion to agriculture. Young regenerating forests constitute a modest portion of the forest estate. Multiple use forests account for 17% of those of the tropics.

Forest Ecology and Management 352 2015.

RIL vs. convential logging

At Paragominas, Brazil in 24 5-ha plots a comparison was made in forest with 211-237M^3/ha of biomass (70-80m^3/ha of bole volumes) of reduced impact logging(RL) and conventional logging(CL).One year later the biomass was reduced 24% (CL) and 14% (RL). The reduction in merchantable timber volume was 31%(CL) and 21%(RL).After 20 years recovery of biomass was 72-76%(CL) and 95-98%(RL), timber volumes were recovered 53%(CL) and 81%(RL).Twenty-year increments of commercial species were 0.08m^3/ha/yr(CL) and 0.72m^3/ha/yr(RL).

Vidal and others. Recovery of biomass and merchantable timber volumes twenty years after conventional and reduced impact logging in Amazonian Brazil. [Forest Ecology and Management 376:1-8 2016’

Brazil deforestation

Observadorio do Clima, a consortium of 40 environmental groups in Brazil, reported a 3.5% forest loss in the past year,. almost 2,400 square miles. They cite a proportional decline in CO_2 sequestration by Brazil. The report cited as purposes for the forest loss: sustainable energy and hydraulic water storage projects. The interpretation of this information is unclear to forestry. Certainly all of Brazil need not remain in forests. As Brazilian land use priorities become clarified, we should argue for and be concerned with those that should remain in forests.

Climatewire – Forests , Hilda Soltero Harrington

Sacred groves and trees in India

All of 129 Sacred Groves and Sacred Trees found on the eastern bank of the Hoogly River in West Bengal are under threat due to urbanization. Of these, 84 are well maintained, 29 are irregularly maintained and 15 are deserted. Among the eight municipalities, Naihati has the most well maintained and Titagarth has the most abandoned.

Chakraborti, U. and others. Studies on Sacred Groves and Sacred Trees along the eastern bank of River Hoogly of North 24 Parganas, West Bengal. {Indian Forester 242(2):156-166 2016]

Edible bamboo products

Of 18 species of bamboo found in the territory of four Indian villages 7 were found edible. The species grown by the communities include *Bambusa balcooa, B. tulda*, *Dendrocalamus hamiltonii. D. strictus,* and *D. iganteus.* Bamboo shoots are largely utilized fresh, fermented, dried, boiled, or liquid. Modern harvesting and processing promise sustainable employment. Production and marketing require capacity-building in communities.

Kithan, N. Traditional edible bamboo products and their impact on livelihood of Tribal Village Community of Wokha District, Nagaland [Indian Forester 142(6):595-600 2016]

Andaman Island Forests

The Andaman island group, with a total land area of about 1665 km^2, is largely covered with tropical forests. The tree layer in unlogged forests was found dominated by *Dipterocarpus* spp, *Knema andamanica*, and *Tetrameles nudiflora*, respectively in evergreen, semievergreen, and deciduous forests. In logged forests, *Knema andamanica*, *Dipterocarpus* spp, and *Pajanelia longifolia* dominated in evergreen, semievergreen, and deciduous forests respectively.

Similarity between unlogged and logged forests was more than 50%. Biodiversity rich areas should be maintained.

Rajesh. Comparative vegetation analysis and regeneration status of unlogged and logged over forests of South Andaman Island.[Indian Forester 142(8):717-726 2016]

Soaking mahogany seed

Studies of mahogany direct seeding on abandoned slash and burn sites in Mexico expose the seeds to predation from rodents or insects. Exposure is serious during the pre-germination period. It can be controlled by soaking the seeds two weeks before sowing, accelerating germination and reducing the period of exposure to predators prior to germination.

P. Negreros-Castillo and others. Survival of *Swietenia macrophylla* seed sown in slash-and-burn fields in Quintana Roo, Mexico.[Bois et Forets des Tropiques 329 2016]

Slow recovery

In the Australian wet uplands 29 regrowth sites developed some of the structural atibutes of rainforest in 40 years. At that time species richness (origins, family, and ecological functions) had recovered less than 50% of rainforest values. Development of richness of native trees and shrub was particularly slow with species with wind dispersed or animal dispersed large seeds. Even plantings and regrowth showed slow recovery of overall resemblance of rainforest in species composition.

Shoo, L. P. and others. Slow recovery of tropical old-field rainforest regrowth and the value and limitations of active restoration. [Conservation Biology 30 (1):121-132 2016]

Protected area effectiveness

Protected areas considered key to effective conservation have negative impacts on local people. Results from an analysis of 171 published studies indicate that protected areas associated with positive socioeconomic outcomes were more likely to report positive conservation outcomes. Strict protection may be necessary under some circumstances and yet management strategies can maximize both conservation performance and the social development of preserves.

Oldekop, J. A. and others. A global assessment of the social and conservation effectiveness of preserved areas. [Conservation Biology 30 (1):133-141 2016]

Tiger law enforcement

To counter a severe threat, the government of Thailand established an intensive patrolling system to protect and recover its largest population of wild tigers in the Huai Kha Khaeng Wildlife Sanctuary. Sampling of 1026 km^2 with 200 camera traps yielded 90 individuals, ranging from 1.25 to 2 tigers per 100 km^2. Intensified patrolling after 2006 appeared to reduce poaching and was correlated with marginal tiger improvement but less than assumed by global strategies of doubling per decade.

S. Duangchantrasiri and others. Dynamics of a low density tiger population in Southeast Asia in the contaxt of improved law enforcement. [Conservation Biology 30(3):639-648 2016].

Birds return with restoration

In Kibale National Park, Uganda birds were sampled along a 3-16-year restoration period. The abundance of arboreal insect and fruit-eating forest specialists increased, whereas the foliage-gleaning forest visitors decreased, both lineal with time. At the study rate the bird communities could reach the pre-disturbance state in about 20 years, although other studies suggest slower total recovery.

P. Latja and others. Active restoration facilitates bird community recovery in an Afrotropical rain forest. [Biological Conservation 200:70-79 2016]

Butterfly feeding ecology

In Singapore 190 butterfly species were recorded on 149 flowering plant species in forests and urban parks. More species were flower generalists than specialists in both habitats. Flower specialists used a higher proportion of native flower species than the generalists and tended to be forest dependent. Results indicate that while landscape transformation might benefit some generalist butterflies, specialist species might increase their dependence on remaining native flower sources.

Jain and others. Flower specialization of butterflies and impacts of non-native flower use in a transformed tropical landscape. [Biological Conservation 201:184-191 2016]

Andean forests buffered

Secondary forests in the Colombian Andes were found to average lower maximum temperatures and higher minimum temperatures than primary forests, serving as thermal buffers for climate change, seen as an investment in the value of these forests that should be recognized.

P. Gonzalez de Pliego and others. Thermally buffered microhabitat recovery in secondary tropical forests following land abandonment. [Biological Conservation 201:385-395 2016]

Dominican Republic/Haiti border forest

The geological and climatic conditions of Anse-a-Pitre and Padernales are both the same. Thirty years ago in the Dominican Republic grazing of dry forest was discontinued. In Haiti it has continued. In the Dominican Republic abundant tree species include *Acacia scleroxylon*, *Amyris elemifera*, *Bursera simarouba*, *Capparis ferruginea*, and *Guaiacum sanctum*. In Haiti more abundant are *Acacia macracantha, Senna atomaria, Phyllostolon brasieliense* and two cacti species unsuited for fuelwood or charcoal.

T. May and others. Interpreting the contrasting effects of wood-cutting on dry forest in the Dominican Republic. [Bois et Forets des Tropiques 326(4):3 2016].

White sand in Amazonia

White sand soils and ecosystems occur in patches throughout tm azonia. They have distinct ecosystems in common. Despite their common geology, hydrology, snd histories, there is significant variation that is distinct and should be saved as part of Amazonia.

J. Adeney and others. White sand ecosystems in Amazonia. [Biotropica 48(1):7-23 2016]

Amazonian dark earth

Amazonian dark earths are considered to be results of human modification since Columbus's time. They have a lower acid content and act as though more fertile than the general average for the Amazon.

E. Quintero-Vallejo and others. Amazonian dark earth shapes the understory plant community in a Bolivian forest. [Biotropica 47(2):152-161 2016]

Growth increase with mixture

Five fast growing tree species were grown for 13 years in monoculture and mixture on a fertile soil in high rainfall Costa Rica. The monoculture produced the highest yield per unit of land area but the mixture accrued more biomass than the average, apparently due to complimentarity in use of light and soil nutrients, possibly increased over time.

J. J. Ewel. Steeply increasing growth differential between mixtures and monocultures of tropical trees. [Biotropica 47(2):162-171 2015].

The southern monarch

A southern monarch butterfly, *Danaus erippus,* is reported from Bolivia and Argentina. Like the northern species, it is attracted to milkweed. In the highlands of Bolivia seen only in summer and autumn months, in northwest Argentina with persistent directed southwesterly flight during March to May. The species uses residents and migrants in the Bolivian lowlands, elevational migrants in the Bolivian Andes, and latitudinal migrants in northwestern Argentina.

H. Slager and others. Evidence for partial migration in the Southern Monarch Butterfly, *Danaus erippus*, in Bolivia and Argentina. [Biotropica 47(3):355-362 2015]

Litter fate in Borneo

The percent of litter decomposition in different forest fragments in Borneo was assessed after 120 days. The fastest rates of decomposition were in undisturbed, continuous forest sites, a loss of 52%. Next in order was litter of unlogged fragments, 32% mass lost. In logged forest fragments it was 28% mass lost. Leaves of a light-demanding species (*Parashorea*) decomposed faster than those of shade-tolerant species. Since leaf decomposition is recycled, its rate may affect nutrient supplies and the rate of forest recovery.

Yeoung, K. L. and others. Leaf litter decomposition rates in degraded and fragmented tropical rain forests of Borneo.[Biotropica 48(4):443-452 2016]

Tourism and hunting in Namibia

Tourism and hunting, together may provide the greatest incentives for conservation on the communal lands of Namibia. A singular focus on either tourism or hunting would have grave percussions for conservation. A review of 77 communal conservancies promoted as a land use complementing subsistence agriculture showed that the main benefits from hunting were broad income for the conservancy. The benefits from tourism were salaried jobs at lodges. A ban on trophy hunting reduced the number of communes that could cover costs of conservation.

R. Naidoo and others. Complementary benefits of tourism and hunting in communal conservanc in Namibia. [Conservation Biology 30(3):628-638 2016].

Hunting in Southeast Asia

Hunting is by far the greatest threat to the region's endangered vertebrates. Causes of recent overhunting include improved access, improved hunting technology, and escalating demand for wild meat, wildlife-derived medical products, and pets. Hunting cannot be considered sustainable, and enforcement legislation is weak. Unless wildlife exploitation is reduced to sustainable levels, the region will lose most of its species within the next few years.

M. Rao and others. Impacts of hunting on tropical forests in Southeast Asia.[Conservation Biology 30(5) 2016].

Pine savannas in Belize

A review of 128 sites found a top density of 700 trees/ha, (*Pinus caribaea hondurensis*) but commonly less than 300. Maximum height was 16 m and diameters of less than 20 cm. Protected and passively managed areas had 10 trees/ha to 40 cm dbh. Densities and tree heights vary with protection and management.

Michelakis and others. Woody structure and population density of *Pinus caribaea* var. *hondurensis (*Caribbean pine*)* dominated lowland tropical savanna woodlands under different protection and managementits regimes. [Caribbean Journal of Science 49(1):1-16 2016].

Root biomass

Tropical forests are the biome with the largest belowground biomass and as yet little is known about its variation. A review of published data revealed that the root/shoot biomass ratio reacted negatively to mean annual precipitation and positively to stand age.

G. Waring and others. Overlooking what is underground: Root:shoot ratios and coarse root allomeric equations for tropical forests. [Forest Ecology and Management 385(1):10-15 2017]

Ferns on deforested slopes

A common sight on wet roadside slopes is dense, pure stands of bracken fern (*Pteridium* spp.). Their persistence amid reforested slopes suggests that they delay forest recovery. Tests in the Bolivian Andes shed light on this situation. There the fern does not delay or prevent the recruitment of trees from among the ferns. It actually can be helpful for this. The delay in reforestation is limited by a lack of tree seeds among the ferns.

S. C. Gallegos and others. Factors limiting montane forest regeneration in bracken-dominated habitats in the tropics. [Forest Ecology and Management 381:168-176 2016]

Short-rotation thinning

Acacia hybrid in South Viet Nam is widely planted for pulpwood. It is thinned to increase productivity of sawlogs. Plantation density was reduced from 1,111/ha to 833/ha or 600/ha at year 2 or 3. Three years after thinning to 833 trees/ha stand volume had recovered and mean stem diameter had increased 7.5%. Three years after thinning to 600 trees/ha stand volume was still reduced 15.8% but stem diameters had increased 16.7%. It was concluded that thinning to 600 trees/ha at 2 years or to 833 trees/ha at 3 years produced the largest diameters.

V. D. Huong and others. Growth and physiological responses to intensity and timing of thinning in short rotation tropic-al *Acacia* hybrid.[Forest Ecology and Management 380:232-241 2016]

Impact of logging

A review of logging studies indicates variability in forest impacts dictated primarily by the intensity of the logging (Timber volume removed per hectare) If this is held comparable, reduced impact logging (RIL) caused less forest damage than conventional logging but particular effects on stand biomass and species richness are difficult to discern because of usual low logging intensity, where these effects tend to be minor. Species richness appeared to increase at low intensities and decrease at high intensities.

P. A. Martin and others. Impacts of tropical selective logging on carbon storage, and tree species richness [Forest Ecology and Management 356:224-233 2016]

Dipterocarp diversity

The lowland tropical forests of Southeast Asia are dominated by canopy and emergent trees of the Dipterocarpaceae with a fine-scale spatial genetic structure (FSGS) (favoring inbreeding) and with losses at a cost to genetic diversity. FSGS was detected in 15 of 19 species of Borneo, India and the Seychelles. Maintenance of genetically diverse stands to favor resilience of logged forests can be guided by wood density and flower size.

T. de Morais and others. Understanding local patterns of genetic diversity in dipterocarps using a multi-site, multi-species approach: Implications for forest management and restoration. [Forest Ecology and Management 358:153-165 2016].

Fate of logging damaged trees

Trees damaged but surviving logging may make up 2-5% of residual stands. In transitional forest in the Bolivian Amazon. Mortality peaks the first year after logging and declines thereafter. Inclined trees were most subject to loss. Crown damage was reflected in growth. Damaged trees that survive 8 years, thereafter their survival becomes like that of undamaged trees.

Shenkin and others. Fate of trees damaged by logging in Amazonian Bolivia. Forest Ecology and Management 357:50-59 2016]

Stemwood vs. rootwood

The relation of rootwood traits (density, lignin and nitrogen concentrations, and carbon-nitrogen ratio) to those of stemwood was compared in 53 tree species of Malaysian Borneo. It was found that stemwood traits are indicative of those of rootwood measured,with the exception of lignin concentration, which was significantly greater in rootwood than in stemwood.

M. Nakagawa and others. Relationships of wood density and wood chemical traits between stems and coarse roots across 53 Bornean tropical tree species. [Journal of Tropical Ecology 32 (2):175-178 2016]

Restoration with food crops

To restore forests in Panama 5 native species and *Tectona* were interplanted with food crops and survival and growth were followed for 2 years. Survival planted with *Manihot* was increased to 8 times that of pure plantations. Maize had a negative effect on survival, reduced to one fourth that in pure plantations. *Astronium*, *Cedrela*, and *Terminalia* showed significantly superior growth in association with maize and *Cajanus,* up to four times in height compared to pure plantations.

C.Paul and others. Effects of planting food crops on survival and early growth of timber trees in Panama. [New Forests 47(1):53-72 2016]

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