



Food and Agriculture
Organization of the
United Nations

243/244

ISSN 0041-6436

unasyuva

An international journal of forestry and forest industries

Vol. 66 2015/1-2



**FORESTS, TREES
AND DISASTERS**



WFC2015

XIV World Forestry Congress

Forests and People: Investing in a Sustainable Future

7-11 SEPTEMBER 2015 Durban | South Africa

XIV World Forestry Congress REGISTER NOW

Registration for the XIV World Forestry Congress is now open! The Congress will be the most significant opportunity in 2015 for the world's foresters and forest supporters to share expertise and experience, forge new partnerships and define a coherent, global vision of the roles of forests and forestry in sustainable development.

Who can attend?

People from a wide range of sectors and all parts of the world are encouraged to take part in the Congress. Whether you are a forest user, work for a government organization, NGO, private company, scientific or professional body, or simply have a personal interest, you are welcome to take part.

Registration fees

Spaces are limited and we are expecting great demand, so take advantage of the Congress's "early bird" rates by registering before 30 June 2015.

Full registration will give you access to all events during the five days of the Congress, while partial registration is available for people wanting to attend only one, two or three days.

Special prices are available to citizens of South Africa and eligible countries. Reduced rates are also available for students, retirees, and people accompanying participants. To register and book accommodation, please visit the official XIV World Forestry Congress website: www.wfc2015.org.za.

STANDARD*		
CATEGORIES	EARLY BIRD (until 30 June)	REGULAR (July–September)
FULL (5 days)	ZAR 7050 USD 600	ZAR 8250 USD 700
PARTIAL (1–3 days)	ZAR 4250 USD 360	ZAR 5400 USD 460
STUDENT/RETIREE Proof of status required	ZAR 2200 USD 200	ZAR 3300 USD 280
COMPANION Limited access	ZAR 1650 USD 140	ZAR 2150 USD 180

SPECIAL*		
Participants from South Africa and eligible countries		
CATEGORIES	EARLY BIRD (until 30 June)	REGULAR (July–September)
FULL (5 days)	ZAR 4150 USD 350	ZAR 5300 USD 450
PARTIAL (1–3 days)	ZAR 2650 USD 225	ZAR 3550 USD 300
STUDENT/RETIREE Proof of status required	ZAR 2200 USD 200	ZAR 3300 USD 280
COMPANION Limited access	ZAR 1650 USD 140	ZAR 2150 USD 180

*Fees are fixed in South African rand (ZAR). US dollar (USD) prices are indicative and subject to exchange rates.

The Congress programme will be professionally and culturally rewarding, with a variety of sessions, events and dialogues, to ensure that all participants are engaged in defining a vision and strategies for the sustainable future of forests and forestry.





unasylyva

An international journal of forestry and forest industries

Vol. 66 2015/1–2

Editor: S. Lapstun

Editorial Advisory Board: S. Braatz,
I. Buttoud, P. Csoka, L. Flejzor, T. Hofer,
F. Kafeero, W. Kollert, S. Lapstun,
D. Mollicone, D. Reeb, S. Rose, J. Tissari,
P. van Lierop

Emeritus Advisers: J. Ball, I.J. Bourke,
C. Palmberg-Lerche, L. Russo

Regional Advisers: F. Bojang, P. Durst,
A.A. Hamid, J. Meza

Unasylyva is published in English, French and Spanish. Free subscriptions can be obtained by sending an e-mail to unasylyva@fao.org. Subscription requests from institutions (e.g. libraries, companies, organizations, universities) rather than individuals are preferred to make the journal accessible to more readers.

All issues of *Unasylyva* are available online free of charge at www.fao.org/forestry/unasylyva. Comments and queries are welcome: unasylyva@fao.org.

FAO encourages the use, reproduction and dissemination of material in this information product. Except where otherwise indicated, material may be copied, downloaded and printed for private study, research and teaching purposes, or for use in non-commercial products or services, provided that appropriate acknowledgement of FAO as the source and copyright holder is given and that FAO's endorsement of users' views, products or services is not implied in any way.

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The publications reviewed in *Unasylyva* are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org.

Cover: Young mangrove plant
© Wilfredo R. Rodriguez H.

Contents

Editorial	2
<i>M. Wahlström</i> The critical role of trees and forests in disaster risk reduction	3
<i>P.B. Durst</i> Trees and forests contribute to recovery from the world's most powerful typhoon in the Philippines	6
<i>J. Latham, R. Cumani and M. Bloise</i> Remote sensing and geospatial systems supporting relief efforts after Typhoon Haiyan	17
<i>G. Marquis</i> Reducing disaster risk in Pakistan through watershed management	19
<i>R. Fankap and K.A. Daphnis</i> Environmental and social reconstruction in Haiti: watershed management in Léogâne and Petit-Goâve following the 2010 earthquake	25
<i>R. Schmidt</i> Forests – the green sentinels of the Alps	27
<i>G. Morgan and M. Leonard</i> Black Saturday: Australia's deadliest bushfire	32
<i>S.V. Zibtsev, J.G. Goldammer, S. Robinson and O.A. Borsuk</i> Fires in nuclear forests: silent threats to the environment and human security	40
<i>A. Thulstrup and W.J. Henry</i> Women's access to wood energy during conflict and displacement: lessons from Yei County, South Sudan	52
<i>A. Thulstrup and W.J. Henry</i> Effects of the current crisis and war in South Sudan on access to forest foods in Greater Akobo	61
<i>A. Oshiek</i> Conflict and forest resources in Darfur	62
<i>M. Annette, J.-M. Poirson, J. Zingesser, P. Otto, K. de Balogh and H. Boulet</i> Ebola virus disease in West Africa: a public health emergency becomes a complex crisis	67
<i>D. Dague and P. Hirami</i> The United States Forest Service's Incident Command System 40 years on: from domestic wildfires to international disaster response	79
<i>D. Burgeon, T. Hofer, P. van Lierop and S. Wabbes</i> Trees and forests – lifelines for resilience	86
FAO Forestry	90
World of Forestry	93
Books	96

EDITORIAL

This double issue of *Unasylva* aims to tease out the complex interrelationship between forests, trees and disasters, and to examine the ways in which forests and trees can best be managed both to resist shocks and to protect from shocks. The issue, published to coincide with the World Conference on Disaster Risk Reduction (Sendai, 14–18 March 2015), could not be more timely. As I write, peace talks are faltering in South Sudan, and a High Level Conference on Ebola, “From Emergency to Recovery”, has just been held in Brussels, involving the United Nations, the European Union, the Economic Community of West African States, and Presidents of affected countries.

Trees and forests grow slowly, and often appear as relatively stable features of our lives and landscapes. In contrast, disasters and crises strike swiftly and unexpectedly. They may not only decimate forest areas when they hit, but also wreak long-lasting environmental damage. Not all of the crises covered in this issue are recent, but the impact of all of them continues to be felt today.

Forests and trees, however, can act as natural buffers against disasters and shocks. They have a powerful role to play in protecting against disasters and in reducing their impact. Indeed, the long-term perspective implicit in sustainable forest management is also a valuable approach to planning for disaster risk reduction.

The articles in this issue cover a range of disasters and crises. Most refer to natural disasters, although some deal with human-induced disasters and other complex crises, all of which are closely interlinked with forests and the environment.

In her opening article, Wahlström, Special Representative to the UN Secretary-General on Disaster Risk Reduction, notably provides insight into the fundamental role of forests in addressing the underlying causes of disasters, including climate change, and the importance of recognizing this in the international agenda.

Durst, in his article on recovery efforts in the Philippines after Typhoon Haiyan, which struck in 2013, looks at how forests can contribute both to short-term relief efforts, such as through the use of lumber from fallen coconut trees in rebuilding, and to long-term recovery and prevention of future disasters, through the strengthening of protective coastal vegetation. In a complementary article, Latham, Cumani and Bloise demonstrate the usefulness of remote sensing and geospatial systems for assessing the damage after the typhoon and planning accordingly. Marquis, in his article on building back better in Pakistan after the 2005 earthquake, and Fankap and Daphnis, in their account of post-earthquake reconstruction in Haiti after 2010, all showcase the watershed approach as an integrated means of ensuring long-term environmental and social resilience. Schmidt, in turn, highlights Austria’s successful use of forests as a protective measure against natural hazards such as floods and landslides.

Fires are a serious threat, both to forests themselves and beyond. Morgan and Leonard look at the devastation wrought by bush-fires in Australia, and the need for long-term planning to avoid worse disasters in the future. As shown by Zibtsev, Goldammer,

Robinson and Borsuk, fires in the Chernobyl Exclusion Zone in Ukraine are an even greater concern, where the 1986 explosion of a nuclear reactor has left a legacy that includes an inadequately managed radioactive forest with a fire risk that could easily result in a dangerous level of radioactive contamination, even beyond the immediate vicinity.

Thulstrup and Henry, writing on South Sudan, and Oshiek, writing on Darfur in the Sudan, examine a different type of human-induced crises. There is often a vicious circle in which strains on natural resources can contribute to conflict, and conflict can lead to further pressure on natural resources, as witnessed in these areas. An important measure for dealing with the depletion of trees for woodfuel, which is often linked to the displacement of large numbers of people, is the introduction of fuel-efficient stoves, as demonstrated by both of these articles.

The current public health emergency triggered by Ebola virus disease is probably the most complex example of the interlinkages between forests and crises dealt with in this issue. Annette, Poirson, Otto, de Balogh and Boulet look at how the disease is part of a complex web involving human, animal and ecosystem health.

An excellent model for dealing with disasters is that of the United States Forest Service’s Incident Command System (ICS). Dague and Hiram describe its genesis and evolution, including its relevance today for a broad range of emergency situations, well beyond the forest fires for which it was initially designed.

Burgeon, Hofer, van Lierop and Wabbes close the issue with an overview of FAO’s work on resilience, as one of the Organization’s five Strategic Objectives, and the importance of forests in this work. As they observe, forests’ crucial role in disaster prevention and sustainable development must not be overlooked. ♦



© MHOBI

The critical role of trees and forests in disaster risk reduction

M. Wahlström

Trees, forests, and the ecosystem services that they provide have a fundamental role to play in addressing the underlying causes of disasters. This needs to be clearly reflected in the global agenda.

Margareta Wahlström is the UN Special Representative of the Secretary-General for Disaster Risk Reduction.

In 2010, total annual economic loss due to disasters surpassed the US\$100 billion mark, a situation repeated every year since then. The risk of disaster, if unchecked, exposes public and private investments across the world to ever-increasing levels of loss and damage. In addition to extreme and sudden events, slow onset disasters and climate change also continue to impact the global economy. Seemingly endless record-breaking occurrences – from massive tropical storms to extreme heat, intense cold, unusual absence of rain and snow or excessive rainfall – will continue to have far-reaching economic and social repercussions over the medium and long term.

There is a confluence of risk drivers compounding disaster losses, and a need to better understand and address these drivers. A failure to adequately assess the risks stemming from environmental degradation, climate change, poverty and inequality, weak governance, rapid urbanization and other pressures is fuelling losses and exacerbating both the vulnerability and the exposure of societies to disasters. The impact of Typhoon Haiyan in the Philippines in 2013 illustrates the need to address these underlying drivers of risk while also strengthening disaster preparedness and response capacity.

Above: Valley of Tinghir, Morocco

The Intergovernmental Panel on Climate Change's recent report, *Climate Change 2014: Impacts, Adaptation, and Vulnerability* (IPCC, 2014), provides a further wake-up call for the international community. While no single disaster event can be attributed to climate change, there is increased evidence that climate change is affecting many natural and human systems and is posing significant risks to human health, ecosystems, infrastructure, and agricultural, forestry and fisheries production. The report's predictions are sobering, given the immense difficulty governments and communities face today in managing existing levels of disaster risk.

However, some countries have made considerable progress across the five priorities set out in the current international framework for action on disaster risk reduction, the *Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters*, coordinated by the United

Nations Office for Disaster Risk Reduction (UNISDR, 2007). Institutional and legislative arrangements have been strengthened and at-risk communities are now better prepared and have better access to early warnings. However, exposure to disasters continues to rise, due to the underlying risk factors.

It is in this context that the important role of forests needs to be recognized. Forests sustain water supplies, protect the soils of watersheds and minimize the effects of natural hazards such as floods and landslides. More broadly, it is now well established that the ecosystem services derived from trees and forests provide a range of benefits to people, society and the economy at large. When effectively managed, ecosystem services can help to address the underlying causes of disasters.

However, forests themselves are increasingly exposed to the risk and impact of disasters, such as wind storms and wildfires. A total of 350 million ha of land was

estimated to be affected by fires in 2000 (Grégoire, Tansey and Silva, 2003) and, whereas some fires are ecologically benign, others lead to destruction or degradation of vegetation cover and secondary disasters such as erosion, landslides and floods. The consequences of wildfires for human health and security, as well as for biodiversity, are numerous. Countries still do not account systematically for the economic and social damage caused by wildfires, and global estimates are therefore seldom representative of the real scale of their impact on society. It is estimated, however, that overall forest loss and degradation could be costing the global economy between US\$2 trillion and US\$4.5 trillion a year in lost revenues (Sukhdev, 2010).

The United Nations is promoting approaches that recognize the value of healthy forests in addressing disaster risk

Himachal Pradesh, India.
Trees help to attenuate landslides
in areas with steep terrain



and the role, in this regard, of national and local authorities, forest managers and communities living in the vicinity of forests as well as relevant business and industry actors. The forthcoming World Conference on Disaster Risk Reduction (WCDRR), to be held from 14 to 18 March 2015, in Sendai, Japan, on the Post-2015 Framework for Disaster Risk Reduction, represents an opportunity to do more. The preparatory consultations and post-conference follow-up are particularly important.

Efforts to implement the above framework will require a comprehensive set of policies and actions. I see this issue of *Unasylva* as a useful contribution to these efforts. The articles included here demonstrate the need for better science and the dissemination of information on the role of forests and other ecosystems in reducing the risk of natural disasters, including floods, droughts, landslides and other extreme events. Good practices in managing forests and trees will need to be promoted. Initiatives that increase protection through the management of forests and biodiversity will need to be scaled up. Financial aid and payments for ecosystem services will be required to help protect forests while also promoting education, awareness-raising and capacity-building. The risk of wildfires needs to be included in the analysis of economic and social disaster losses and projected risk assessment. Prevention approaches and early warning systems to address such risks will need to be strengthened.

It is particularly encouraging that organizations such as FAO are assisting countries in developing land-use and forest management programmes that reflect integrated approaches to risk management and resilience. I also welcome FAO's initiative to scale up its own programmes, with the resilience of livelihoods to disasters as one of its five strategic objectives. This is contributing to the development of effective global and regional cooperation in this area.

The year 2015 provides an important opportunity to change the course of current

trends. The post-2015 framework for disaster risk reduction will have a critical influence on the ultimate success of the Sustainable Development Goals (SDGs) and the future climate change agreement under the UN Framework Convention on Climate Change (UNFCCC) and vice versa. Building coherence and mutual reinforcement among these policy frameworks will be crucial both in terms of substantive alignment of the instruments and in coordinating the implementation and monitoring mechanisms.

This is all the more important as the benefits of forests and trees in reducing disaster risk represent only one side of the coin. Globally, forests are also mitigating climate change through carbon sequestration. The loss of this potential due to forest degradation and fires can potentially reverse the positive impact of forest management measures. Strengthening forest management is a perfect opportunity to promote coherence across global agendas and to engage actively in ensuring the availability of policies, capacities and resources to reduce the risk of disasters. ♦



References

- Grégoire, J.-M., Tansey, K. & Silva, J.M.N.** 2003. The GBA2000 initiative: Developing a global burned area database from SPOT-VEGETATION imagery. *International Journal of Remote Sensing*, 24(6), 20 March: 1369–1376. DOI: 10.1080/014311602100044850.
- IPCC.** 2014. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK, and New York, USA, Cambridge University Press (available at <http://www.ipcc.ch/report/ar5/wg2/>).

Sukhdev, P. 2010. TEEB, public goods and forests. *Arborvitae*, 41: 8–9 (available at cmsdata.iucn.org/downloads/av41_english_3_.pdf).

UNISDR. 2007. *Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters*. Extract from the final report of the World Conference on Disaster Reduction (A/CONF.206/6). Geneva, UNISDR (available at http://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf). ♦

Trees and forests contribute to recovery from the world's most powerful typhoon in the Philippines

P.B. Durst

Trees and forests have an important role to play in both short-term and long-term disaster recovery efforts, as shown in the Philippines in the wake of Typhoon Haiyan.

Patrick B. Durst is Senior Forestry Officer with the FAO Regional Office for Asia and the Pacific in Bangkok, Thailand, and was a member of FAO's Typhoon Haiyan response team.

Anyone who has weathered a powerful windstorm has probably experienced fear in facing nature's fury, made worse by the eerie, unfamiliar sounds of howling, high-velocity wind. But what does 300-km/hr wind sound like? This phenomenon was the terrifying reality faced by millions of residents of the central Philippines in early November 2013, as the strongest typhoon ever to make landfall struck the country with deadly force.

"It was like a thousand jet airplanes flying directly overhead, but never passing by," said 64-year-old Gorven, a farmer from

north of Tacloban, Leyte, who lost his house and 90 percent of his farm crops to the powerful storm. "I've never experienced anything like it before." "The wind sounded like a ghost," according to another man from a fishing village on the western coast of Leyte province.

Super Typhoon Haiyan (named "Yolanda" in the Philippines) made landfall in the Eastern Visayas region of the Philippines in the early morning hours

Upland farmers slowly rebuilding following destructive Typhoon Haiyan



© P. DURST

of 8 November 2013, packing sustained winds of 315 km/hr and gusts in excess of 375 km/hr – intensities never seen before from storms making landfall anywhere in the world. The typhoon initially struck the provinces of Eastern Samar and Leyte, then cut a swathe across the northern areas of Cebu, Panay and Palawan islands before passing into the South China Sea and striking Viet Nam and China with lesser impact. A storm surge in excess of 4 m in height flooded vast coastal areas,

particularly in the Leyte Gulf area. The results were devastating.

More than 6 200 people were killed, mostly as a result of the storm surge that swept over coastal communities. Fourteen million people were directly affected by the storm. More than 1 million homes were destroyed or severely damaged, resulting in the displacement of 4.1 million people. Electricity, communications, water and other utilities were totally disrupted in most affected areas. Due to the massive

scale and expanse of the storm, 171 municipalities, in 14 provinces, across 6 regions of the country, were highly affected. The economic costs of recovery were estimated in the billions of US dollars and full recovery is expected to take several years.

Damage inflicted by Typhoon Haiyan to the agricultural sectors – including crops, fisheries, livestock and forests – was particularly severe. Philippine Department of Agriculture impact assessments conducted soon after the typhoon indicated that more than 600 000 ha of crops were destroyed; 44 million coconut (*Cocos nucifera*) trees were downed or damaged beyond recovery; and approximately 30 000 fishing boats damaged or destroyed. Financial needs for recovery and rehabilitation in the agriculture sector alone are estimated to require US\$724 million (unpublished Philippine Department of Agriculture impact assessment reports).

In upland areas, millions of forest and fruit trees were uprooted or suffered damage; roughly half of all plantation forests in the highly affected provinces were damaged with varying levels of mortality.

Coastal beach forests and mangroves also suffered varying degrees of damage and mortality. Virtually all trees in the path of the typhoon were defoliated, and while many subsequently recovered, large numbers of trees succumbed as a result of the damage and stress. Many coastal stands (particularly newly planted mangroves and immature trees) were uprooted or washed away by the powerful waves driven by the typhoon.

IMMEDIATE RELIEF EFFORTS

Initial national and international emergency response efforts were necessarily focused on the immediate survival needs of affected people, millions of whom required emergency food aid, provision of potable water, medical attention, and temporary housing or shelter. Additionally, there was the grim task of recovering the bodies of the dead.



Map of path of Typhoon Haiyan

Downed coconuts

© P. DURST

Within five days of the typhoon's devastation, the Director-General of FAO declared its first-ever Organization-wide Level 3 emergency (the Organization's highest level of emergency response) to fully mobilize FAO's resources to support relief and recovery efforts. FAO subsequently fielded more than 100 national and international technical and operational staff to support typhoon recovery efforts, working in close collaboration with other UN organizations and Philippine Government agencies. Field offices were established in the 7 locations hardest hit by the typhoon.

Typhoon Haiyan struck the central Philippines just before the start of the normal rice planting season. FAO's initial efforts therefore focused on assisting farmers to clear farm fields of debris and bring land back into production to avoid missing the immediate cropping season. With support from various donors, FAO provided 44 000 farmers with certified rice seed for the December/January planting

season and urea fertilizer and farm tools to more than 80 000 rice farmers. These inputs resulted in farmers harvesting 84 480 tons of rice in the first growing season following the typhoon – enough to feed over 740 000 people for a year.

THE RACE TO SALVAGE DOWNED COCONUTS AND TREES

While trees and forests were not the immediate focus of relief efforts following Typhoon Haiyan, various forestry-related issues rapidly emerged following the disaster. One early need was to clear downed trees and branches from roads and agricultural fields. Most notably, the typhoon destroyed over 40 million coconut trees along its path – with most uprooted and blown to the ground, resulting in matchstick jumbles of debris. While representing a daunting challenge in and of itself to clear the downed trees, this priority also presented an opportunity to satisfy another pressing need – construction

material for temporary housing and rebuilding efforts.

The damaged and downed coconuts offered the potential for salvaging more than 10 million m³ (or nearly 4 billion board feet) of low-grade lumber at relatively little cost to be used for immediate reconstruction efforts. Although the actual volume of coco lumber that could be recovered was less than the theoretical potential due to lack of equipment, inaccessibility and insufficient labour, the volume that could technically and economically be recovered nonetheless ranged in the millions of cubic metres.

Philippine Coconut Authority (PCA) and FAO experts pioneered the technology for production of coco lumber during a project based at PCA's Zamboanga Research Center in Southern Mindanao in the 1970s and 1980s and the two organizations have continued to lead in promoting coco lumber processing. FAO and PCA experts were thus well positioned to advise on

the massive salvage operations following Typhoon Haiyan.

With declining forest resources in the Philippines since the 1980s, coco lumber has become a readily accepted “poor man’s timber”, familiar to most rural Filipinos. Properly dried and treated coco lumber can remain serviceable for 10 to 20 years or longer. It is commonly used as rafters and wall studs in rural houses, and sometimes as joists and flooring, or even siding for houses and other buildings.

In contrast to typical dicotyledon hardwoods that have denser heartwood and softer sapwood, it is the outer portion of the stem of coconuts that is dense and useful as timber, while the centre core is soft and of little value. Slicing coconut stems therefore requires sharp, well-maintained equipment and considerable skill and experience.

Dead coconuts are highly vulnerable to decay (within six months for young trees,

and up to one to two years for denser, older stems). The decaying stems provide ideal breeding conditions for rhinoceros beetle (*Oryctes rhinoceros*) which, as adults, can inflict severe damage to the crowns of surviving palms and newly planted seedlings. This provided yet further motivation to remove and process dead and damaged coconuts as quickly as possible.

Early support was provided by Government agencies and international relief organizations for the purchase and importation of chainsaws and portable sawmills to process dead and damaged coconut stems. PCA alone provided more than 2000 chainsaws to farmer groups and local officials to facilitate land clearing and production of coco lumber.

Shortly after the passing of Typhoon Haiyan, dozens of national and international relief organizations pledged to provide equipment (including chainsaws),

tools and cash-for-work incentives to support the clearing of downed coconuts and other trees.

By August 2014, PCA estimated that nearly 2 million dead and downed coconuts had been processed, resulting in some 2 billion board feet of coco lumber. The widespread availability of low-cost coco lumber has spurred the construction of temporary housing for thousands of displaced individuals and the rebuilding of rural houses, buildings and schools.

While drawing less attention than the massive volume of downed coconuts, countless other trees along roads and fields, in orchards and on agroforestry farms were windblown or damaged. Common among these were planted acacia or “rain tree” (*Samanea saman*), mahogany (*Swietenia macrophylla*), gmelina (*Gmelina arborea*) and mango (*Mangifera indica*). Damage to natural



Portable sawmill used to process lumber



Chainsaw lumbering of salvaged hardwoods

FISHING BOAT CONSTRUCTION

Fish and seafood supply the main source of protein for most coastal residents of the central Philippines, and fishing is a key livelihood activity. Some 30 000 fishing boats were damaged, destroyed or lost as a result of Typhoon Haiyan.

Small-scale fishing boats in the central Philippines are traditionally 6–10 metres in length, with hardwood keels and ribs, and marine plywood sides and bamboo outriggers for stability. Boat keels are commonly shaped from red lauan (*Shorea* Spp.) or white lauan (*Shorea contorta*). Keels are also sometimes constructed from hagakhak (*Dipterocarpus warburgii*) (which is highly durable, but less commonly available than lauan), tipolo (*Artocarpus blancoi*), and other species in lesser quantities. Ribs comprising the frames for boats are also often made from lauan (or similarly durable woods), with marine plywood attached to the ribs with copper nails.

With only rare exceptions, lauan and hagakhak grow in natural forests. Therefore, under E.O. 23 restrictions on harvesting timber from natural forests, these woods traditionally used for fishing boat construction could not be legally sourced from Philippine forests following the typhoon.

Even prior to Typhoon Haiyan, some boat-makers in the Philippines were shifting towards using non-traditional timbers, including mahogany (*Swietenia macrophylla*) and gmelina (*Gmelina arborea*). These species are not native to the Philippines and thus all such trees are planted (i.e. not naturally growing) and can therefore be harvested in conformance with DENR registration and transport requirements. Other commonly planted trees grown on titled lands include acacia (*Samanea saman*), mango (*Mangifera indica*), jackfruit (*Artocarpus heterophyllus*) and a variety of other fruit and timber species that offer potential for boat construction.

forests was also severe in many locations, although thorough surveys have still not been conducted in most areas to determine the full extent of damage.

Regulations governing the cutting and use of timber trees in the Philippines are complex. Executive Order No. 23 (E.O. 23), series of 2011,¹ placed a moratorium on the cutting of all timber in the country's "natural and residual forests". Responding to the need for timber for immediate

reconstruction following Typhoon Haiyan, however, the Philippine Department of Environment and Natural Resources (DENR) issued directives to local officials in affected regions relaxing normally rigid regulations on harvesting and transport of timber, and allowing the utilization and transport of downed trees of all species grown on private lands. In practice, many local people salvaged downed trees from both planted and natural forests without regard to normally required permits and approvals – often with tacit or informal approval from local officials.

¹ <http://www.gov.ph/2011/02/01/executive-order-no-23-4>

Damaged boats

Following the typhoon, a large, but unknown, number of boat builders and fishers secured timber needed for boat construction from unauthorized harvests from natural forests or the salvaging of windblown hardwoods, with the tacit permission of forestry officials.

Recognizing both the immediate and long-term challenge of securing reliable materials for boat construction in the

Philippines, FAO provided the expertise of master boat builders and designers to explore options for new boat designs following Typhoon Haiyan. Various designs were considered and tested for their feasibility and acceptability among fishers, including models constructed of fibreglass, alternative timbers, and wood composites. Eventually, a new hybrid boat design comprising fibreglass keels and

commercially available marine plywood sides was identified as both acceptable to local fishers and compliant with national wood sourcing regulations. Tests by local fishers under a variety of sea conditions and fishing requirements confirmed the acceptability of the new design.

FAO-supported projects are now training more than 3 000 boat builders and carpenters on methods for building the new boats, using a training-of-trainers approach. Guidance manuals on construction techniques are being provided in English and local languages.

FOCUS ON BEACH AND MANGROVE COASTAL FORESTS

The extreme winds of Typhoon Haiyan whipped high waves and pushed a massive storm surge inland across many coastal areas in the path of the typhoon. The storm surge was particularly deadly in the Leyte Gulf, where water was funnelled inland at heights in excess of 4 metres across much of the Gulf, and estimated to have reached higher than 7 metres in some areas. The devastation was not unlike that of a major tsunami.

**Hybrid boat construction**

Uprooted *Rhizophora stylosa* plantation



© D. CABAHUG

Just as after the Indian Ocean tsunami of 2004 and the 2011 Japan tsunami, after Typhoon Haiyan a great deal of attention was focused on coastal vegetation (or lack thereof) and the potential protection it offers to residents in the face of tsunami waves and storm surges.

Following the Indian Ocean tsunami, FAO analysed data from a large number of sites and conditions and concluded that various coastal forest types, including mangroves, beach forests and plantations, have the potential to mitigate tsunami (and storm surge) energy and force, reduce flow depth and velocity, and limit inundation areas. Healthy, non-degraded natural forests offer the best protection to coastal areas, but plantations of closely spaced trees with low, widely branching canopies or significant ground vegetation can also provide good protection. Altered forests found around homesteads, resorts and other development areas, on the other hand, are generally too widely spaced, lack sufficient ground vegetation, and are comprised of introduced tree species not well adapted to coastal wind and wave forces, and so provide much less protection (Forbes and Broadhead, 2007).

Analysis indicated that greater protection against tsunami waves and storm surges can be achieved with increased width of coastal forest strips, increased density (stocking) of trees, older stands of trees with increased tree diameters, taller trees, and forest stands of mixed

species composition with dense vertical configurations of roots, boles, branches and foliage, and thick understorey development (Forbes and Broadhead, 2007). It was also found that the degree of protection coastal forests can provide depends on a number of variables in addition to those of the forests themselves, including the characteristics and nature of the tsunami or storm surge and the physical features of the site (e.g. bathymetry and coastal geomorphology) (Braatz *et al.*, 2007).

Many advocates have claimed that past removal of coastal vegetation in the central Philippines exposed coastal communities to increased risk from high winds and storm surges driven by Typhoon Haiyan, while leading to more coastal erosion than would have otherwise occurred had dense, healthy coastal vegetation been maintained. Although there is continuing debate among experts as to the overall effectiveness of coastal forests in protecting coastal residents from physical dangers – particularly from tsunamis and major storm surges – there is little doubt that healthy coastal forests do provide significant protection to coastal communities in many instances and help to reduce coastal erosion.

Unfortunately, much of the coastal vegetation most severely affected by the storm waves and surge generated by Typhoon Haiyan had been cleared or heavily degraded over the years prior to the typhoon's occurrence as a result of construction of human settlements and infrastructure, agriculture

expansion, fish/shrimp pond development and over-harvesting of wood for fuel and construction.

Following Typhoon Haiyan, DENR, the USAID-funded Biodiversity and Watersheds Improved for Stronger Economy and Ecosystem Resilience (B+WISER) Project and other organizations conducted coastal surveys in the Leyte Gulf and elsewhere to assess the damage to coastal vegetation and the potential for mangrove and beach forest rehabilitation.

Field observations indicated that damage to coastal forests from Typhoon Haiyan and the associated storm surge varied considerably from location to location. Assessments in the hardest hit areas of the Leyte Gulf indicated that 25 percent of mangrove stands were either uprooted and/or windblown; 80 percent of the branches of mangrove and associated beach forests were at least partially broken; and nearly 100 percent of all coastal trees were defoliated by the typhoon's wind.²

Mangrove species that were observed to have been most resilient to wind and storm surges were *Pongamia pinnata* (locally known as bani), *Nypa fruticans* (nipa), *Sonneratia caseolaris* (pagatpat), *Avicennia marina* (bungalon), *A. officinalis* (api-api), *A. alba* (miyapi) and *Hibiscus tiliaceus* (malubago). Bani and pagatpat recovered quickly after the typhoon, with the emergence of new leaves within one

² Unpublished B+WISER report.

month, while malubago, api-api, miyapi, bungalon and nipa were observed to have recovered moderately fast (Table 1).

Rhizophora species, which comprise the most widely planted group of mangrove species in the country, were generally heavily damaged by the typhoon. *Rhizophora stylosa* (bakawan bato) trees were heavily damaged and often uprooted, while *R. mucronata* (bakawan babae) and *R. apiculata* (bakawan lalake) were moderately damaged in many locations.

The damage to nipa palm stands, which left mature fronds dead in many areas, has serious socioeconomic implications for local people, since nipa leaves are commonly made into woven shingles and used in the rural Philippines as a low-cost roofing material. Although the nipa roots largely survived Typhoon Haiyan intact, it will take as long as one year for new fronds

TABLE 1. Mangrove species observed to be resilient and quickly recovering from the storm surge damage

Species resilient to storm surge		Species with fast recovery from the effects of storm surge	
Ranking	Species	Ranking	Species
1	<i>Pongamia pinnata</i> (bani)	1	<i>Pongamia pinnata</i> (bani)
2	<i>Nypa fruticans</i> (nipa)	2	<i>Sonneratia caseolaris</i> (pagatpat)
3	<i>Sonneratia caseolaris</i> (pagatpat)	3	<i>Hibiscus tiliaceus</i> (malubago)
4	<i>Avicennia marina</i> (bungalon)	4	<i>Avicennia officinalis</i> (api-api)
5	<i>Avicennia officinalis</i> (api-api)	5	<i>Avicennia alba</i> (miyapi)
6	<i>Avicennia alba</i> (miyapi)	6	<i>Avicennia marina</i> (bungalon)
7	<i>Hibiscus tiliaceus</i> (malubago)	7	<i>Nypa fruticans</i> (nipa)

Source: B+WISER.

to develop sufficiently to be exploited for nipa shingles. This deprives local residents of a cheap roofing material for rebuilding and a source of livelihood for those who previously collected nipa leaves and wove them into shingles for sale.

Following Typhoon Haiyan, there has been strong rhetoric about enforcing “no-build” zones (“easements”) along all shorelines, coupled with rehabilitation of mangrove and beach forests. Article 51 of Presidential Decree 1067 –



Despite legal and regulatory “no-build zones” near shorelines, local inhabitants have been quick to rebuild in many coastal areas

© P. DURST

The Water Code of the Philippines³ precludes building of structures within 20 metres of the shoreline in agricultural areas and 40 metres of the shoreline in forested areas. Efforts to restrict rebuilding in the coastal “no-build zones” are controversial, however, due to historical claims, residents’ desire to live near the coast, lack of suitable relocation areas and the high costs of relocating residents.

There are also various licences, permits and titles previously granted for fish/shrimp pond and other infrastructure development – often to influential individuals. Generally, it will require substantial political will and enforcement dedication to prevent a return to the pre-typhoon practices of clearing and degrading coastal and mangrove vegetation.

Despite the challenges, the Philippine Government has formulated and funded, from its own treasury, a 1 billion peso (US\$23 million) rehabilitation plan for typhoon-affected coastal forests (including mangroves and beach forests). Various donor organizations are also contributing support for rehabilitation of mangrove and beach forests. FAO has included coastal rehabilitation components in several of the typhoon recovery projects it is implementing and is providing technical inputs for the development of guidelines for the beach and mangrove rehabilitation activities of Government units, NGOs and local communities.

A key lesson from experience following the 2004 Indian Ocean tsunami is that many well-intentioned organizations spent vast amounts of money attempting to establish mangrove plantations in areas unsuitable for mangrove growth (due to unfavourable soils or hydrology, geomorphology or exposure to strong wave action). The importance of careful and systematic surveys to identify suitable planting sites, proper site-species matching and proper timing of planting efforts has therefore been emphasized by technical

³ <http://www.emb.gov.ph/portal/Portals/15/PD%201067.pdf>



Damaged banana plantation

experts as a prerequisite for serious coastal rehabilitation efforts. Mangrove experts are also advocating practices that promote the natural regeneration of mangroves and beach forests (e.g. protection, clearing of debris and dead material), generally at lower costs than artificial planting of seedlings.

The need to fully engage local residents and officials (including those from related affected sectors) in all coastal ecosystem rehabilitation programmes has also been stressed, to build consensus and commitment.

THE (NEARLY) FORGOTTEN UPLANDS

Approximately one-fifth of the population of the Philippines (more than 20 million people) live in the country’s upland areas (greater than 18 percent slope) and are among the poorest segments of Philippine society. Despite their tenuous existence, however, upland residents play key roles in managing and maintaining forest and watershed resources and protecting the country’s unique biodiversity.

Many upland residents – almost exclusively farmers – were severely affected by Typhoon Haiyan, but were initially largely invisible to relief organizations. Upland residents mostly live in inaccessible locations, off major highways, sometimes with no direct road access other than simple barangay (village) roads and trails. They tend to live in individual houses or small clusters of houses, widely dispersed and with limited communication links to the outside world. As a result, reports of uplanders’ typhoon damages and losses were slow in reaching central agencies and international organizations.

When teams assessing damage and losses finally reached upland areas, they found widespread but uneven impacts, including destruction and damage to homes and livelihoods, particularly in the agriculture and agroforestry sectors. Particularly hard hit were annual crops, banana and abaca plantations, coconuts, fruit trees, and timber tree plantations.

FAO has concentrated much of its typhoon recovery efforts in upland areas,

built around a broad coconut-based farming systems recovery programme. While this has provided a central focus, support efforts include far more than just rebuilding the coconut sector. Forestry- and agroforestry-related efforts have been integrated into the programme and include support for establishing and rehabilitating community tree nurseries; propagation of forage trees and grasses to support livestock development; planting of fruit and nut trees, bamboo and fuelwood trees; and promoting intensification and diversification in coconut-producing areas by introducing intercropping of root crops, vegetables and tree crops in new coconut plantations. These initiatives are particularly important in light of the fact that newly planted coconuts require five to seven years before reaching productive maturity.

A strong emphasis is being given to training and capacity development in areas related to nursery management, propagation techniques, Sloping Agricultural Land Technology (SALT), contour cropping and soil erosion control, agroforestry intercropping, value-added processing and livelihood diversification. Priority is being given to planting deep-rooting trees with greater potential to withstand future typhoons, and trees yielding fruit, leaves and nuts to contribute to food and nutrition security.

FAO'S 3Rs APPROACH IN THE PHILIPPINES: RELIEF, REHABILITATION AND DEVELOPMENT FOR RESILIENCE

Considering the high incidence of disasters in the Philippines (including an average of 20 typhoons or tropical storms making landfall each year, along with frequent floods, droughts, earthquakes and volcanic eruptions), FAO's approach following Typhoon Haiyan has been to focus on long-term disaster risk reduction and management. By combining humanitarian

and development efforts, FAO's resilience interventions focus particularly on the most vulnerable families and related institutions to prepare them to better anticipate and manage future shocks. The relief, rehabilitation and development interventions for resilience (3Rs approach) supports mutually reinforcing actions in terms of: i) risk and crisis governance; ii) early warning and information management; iii) risk and vulnerability reduction measures; and iv) preparedness and emergency response.⁴

For small-scale coconut and upland farmers, resilience-building strategies such as the diversification and enhancement of livelihoods through intercropping, livestock integration, value-added processing and capacity building are being employed to reduce vulnerabilities and avoid future risks of food and nutrition insecurity. Government and donor-supported recovery efforts are supplying affected populations with inputs, training and help in creating linkages with local and international markets, and through the rehabilitation of agroforestry systems. These efforts will not only strengthen household food and nutrition security, but will also enable families to generate additional income and increase their food stocks and savings, thus building

back better their livelihoods to increase resilience to future disasters.

Other resilience-building and disaster risk reduction efforts include hazard mapping of farms and residences in sloping areas, rehabilitation of coastal vegetation, training in integrated pest management practices, planting of deep-rooted typhoon-resistant tree species and promotion of climate-smart agriculture activities.

LESSONS LEARNED

At the World Economic Forum held in Manila in June 2014, Kyung-wha Kang, UN Assistant Secretary-General for Humanitarian Affairs and Deputy Emergency Relief Coordinator, described the Philippines as "... one of the best prepared countries in the world when it comes to natural disasters, because there are so many of them." She added that, "... the Yolanda (Haiyan) experience will be talked about for many years to come ... because there are so many good lessons."

One key lesson for FAO and other organizations is the value of existing positive relationships with relevant government agencies in facilitating post-disaster efforts. Close working relationships enabled the swift identification of areas where

Coco lumber for sale



⁴ Personal communication, José Luis Fernández Filgueiras, FAO Representative.



Temporary emergency housing constructed using coco lumber

interventions could best provide for affected people's needs.

A second lesson pertained to the importance of mobilizing staff and resources quickly following the emergency, and engaging the full capabilities of FAO. Not only did this allow for early support to affected people, but it positioned FAO favourably to influence the support of other partner organizations. By designating a Level 3 emergency, FAO ensured that all required support – whether deployed to the Philippines or providing back-up support – was readily available to assist the recovery programme.

For forestry, it was particularly beneficial to engage in early discussions on recovery strategies even though forestry-related activities were not of the highest immediate concern following the disaster. This is because funding commitments are generally made by donors very soon after emergencies occur and if forestry aspects were not considered from the outset, they would likely have remained unfunded. Linking forestry-related proposals with

wider, high-visibility recovery concerns (e.g. fisheries and coconut farming systems) helped to secure support for forestry that otherwise would have been very slow to materialize.

A final lesson relates to efforts to build resilience among typhoon-affected communities. From the outset, following Typhoon Haiyan, FAO has advocated a strategy with donors and government agencies that considers long-term rehabilitation and resilience requirements, beyond simply meeting immediate relief needs. This strategic approach has enabled FAO to secure funds for enhancing government capacities, reducing impacts of future shocks and better preparing local communities for future emergencies.

Throughout the Typhoon Haiyan recovery efforts, forests and forestry have played important roles. The long-term perspectives that are naturally part of forestry and agroforestry development served to reinforce integrated programmes for building local resilience to future shocks and disasters. ♦



References

- Braatz, S., Fortuna, S., Broadhead, J. & Leslie, R.** (eds). 2007. *Coastal protection in the aftermath of the Indian Ocean tsunami: What role for forests and trees?* Proceedings of the Regional Technical Workshop, Khao Lak, Thailand, 28–31 August 2006. RAP Publication 2007/07. Bangkok, Thailand, FAO Regional Office for Asia and the Pacific.
- Forbes, K. & Broadhead, J.** 2007. *The role of coastal forests in the mitigation of tsunami impacts.* RAP Publication 2007/01. Bangkok, Thailand, FAO Regional Office for Asia and the Pacific. ♦

Remote sensing and geospatial systems supporting relief efforts after Typhoon Haiyan

J. Latham, R. Cumani and M. Bloise

Geospatial and remote sensing technology enabled the rapid assessment of potential damage to rice paddy, coconut and sugar cane yields in the aftermath of Typhoon Haiyan in the Philippines in November 2013.

John Latham is Senior Environment Officer with the Land and Water Division of FAO. **Renato Cumani** is Environment Officer with the Land and Water Division of FAO. **Mario Bloise** is a senior consultant with the Land and Water Division of FAO.

Background

On 8 November 2013, Typhoon Haiyan made landfall in the Philippines, causing widespread devastation, loss of life and destruction of infrastructure and natural resources.

Damage to agriculture was extensive in areas heavily dependent on crop production and fisheries for food security and livelihoods. The typhoon struck shortly after harvest, as a new planting season was in course. Hundreds of thousands of hectares of rice, and other important crops, were affected.

Major disruptions in communications meant that the extent of the damage was initially largely unknown. Acting on the Level 3 Emergency Response that was declared, and the call for a needs assessment, the FAO Land and Water Division's Geospatial Unit supported the geospatial analysis of the impact of the typhoon. Datasets were collected from various sources, including:

- FAO
- World Food Programme (WFP)

- United Nations Institute for Training and Research Operational Satellite Applications Programme (UNITAR-UNOSAT)
- European Commission Joint Research Centre (EC-JRC)
- United States Department of Agriculture (USDA)
- United States Geological Survey (USGS)
- reports from national agencies
- National Disaster Risk Reduction and Management Council (Philippines).

The main objective was to conduct assessments of potentially affected areas for major crops, livestock, fisheries, food security, mangrove forest and vulnerable populations.

Rapid damage assessment was carried out using geospatial and remote sensing technology, which enables efficient mapping of affected areas. The geospatial community reacted quickly to provide relevant information using remote sensing interpretation, geolocation and crowd-sourcing services. FAO integrated this information with internal

TABLE 1. Estimated distribution of rice paddy areas potentially affected by Typhoon Haiyan in November 2013, Philippines

Province	District	Percentage affected areas for standing crops (season 1) and planted areas (season 2)
Region IV-A (Calabarzon)	Laguna	33.33
	Quezon	25.00
Region IV-B (Mimaropa)	Marinduque	2.21
	Occidental Mindoro	41.67
	Oriental Mindoro	50.00
	Palawan	13.07
Region V (Bicol region)	Camarines Norte	3.25
	Catanduanes	3.25
	Masbate	13.01
	Sorsogon	13.01
Region VI (Western Visayas)	Aklan	45.90
	Antique	40.16
	Capiz	22.95
	Guimaras	5.74
Region VII (Central Visayas)	Bohol	75.00
	Cebu	45.75
Region VIII (Eastern Visayas)	Eastern Samar	39.13
	Leyte	83.33
Region X (Northern Mindanao)	Bukidnon	10.85
Region XI (Davao Region)	Compostela Valley	8.33
	Davao Oriental	16.66
Region XIII (Caraga)	Agusan del Norte	16.67
	Dinagat Islands	9.76
	Surigao del Norte	16.26
	Surigao del Sur	16.25

Rice paddy areas potentially affected by Typhoon Haiyan in November 2013, Philippines

datasets to create the central database that was used to conduct the analysis.

Mapping of severity zones

Severity zones were mapped using data from EC-JRC updates based on the four main levels of Public Storm Warning Signals (PSWC): S1 (very high) to S4 (medium-low). The severity area mask was calibrated by combining remote sensing data with the EC-JRC data, and the severity intensity rate was classified proportionally to the affected population figures.

Data on crop production, harvested area and yield for major crops were collected from:

- FAO's Global Spatial Database of Agricultural Land-Use Statistics (AgroMaps)¹
- FAOSTAT²
- Philippines' Bureau of Agricultural Statistics.³

Data on arable land and permanent crops were derived from the FAO Global Land Cover Share database, and data on the area by district were derived from the FAO Global Administrative Units Layer (GAUL), version 2013-12.⁴

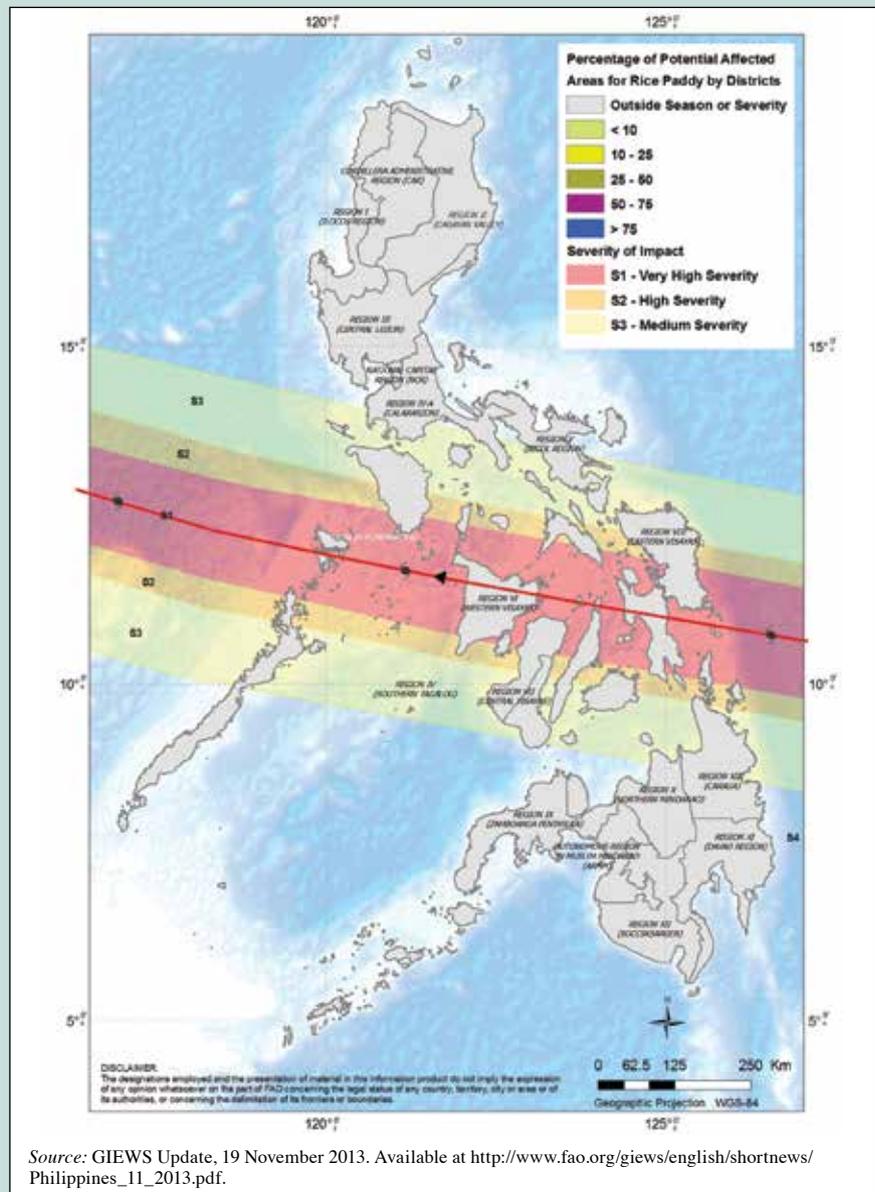
In addition, data on crop calendars to identify the crop-growing stage were collected from:

- FAO-IIASA (International Institute for Applied Systems Analysis) Global Agro-Ecological Zones portal (GAEZ)⁵
- FAO Crop Calendar from data@fao.org⁶
- FAO Agricultural Market Information System (AMIS).⁷

The Philippines rice crop calendar was provided by the Philippine Rice Research Institute (PhilRice-DA) and the International Rice Research Institute (IRRI).

Rapid damage assessment results

The assessment was undertaken by geo-referencing, harmonizing and creating a central database. The stage of crop growth was analysed according to the time of the event, with the seasonality (major and secondary season) of the rice crop considered in the analysis. The areas of standing rice at the moment of the event were mapped using the district-level crop calendars for the major season; the planted rice areas for the second season were also mapped.



The potentially affected area was calculated taking into account both of these areas, which were considered as area loss, calibrated by the severity intensity rate class.

The extent (ha) and fraction (%) of the potentially affected crop areas were calculated by intersecting the tropical cyclone severity areas with the administrative layers, arable land and permanent crops, annual harvested area, yield and production for year 2012 (which was used as a proxy to assess the planted area). Major affected crops include rice paddy, coconut and sugar cane.

The outputs of the assessment⁸ were used by FAO's emergency and early warning team and distributed via the FAO GeoNetwork⁹ to inform and plan relief and rehabilitation operations. ◆

¹ kids.fao.org/agromaps

² <http://faostat.fao.org/>

³ <http://countrystat.bas.gov.ph>

⁴ www.fao.org/geonetwork

⁵ www.fao.org/nr/gaez

⁶ <http://data.fao.org/>

⁷ <http://www.amis-outlook.org/>

⁸ <http://www.fao.org/emergencies/resources/maps/detail/en/c/238569/>

⁹ <http://www.fao.org/geonetwork>

Reducing disaster risk in Pakistan through watershed management

G. Marquis



© G. MARQUIS

Watershed management is an effective approach to reducing disaster risk, as demonstrated by the increased resilience of the communities who applied the approach in Pakistan after the 2005 earthquake.

Gerard Marquis works for FAO's Forestry Department as a consultant on resilience and watershed management.

The earthquake that struck Pakistan in 2005 measured 7.6 on the Richter scale, affecting some of the poorest regions of the country, killing more than 73 000 people and disrupting the lives and livelihoods of millions of smallholder farmers. In the aftermath, landslides and landslips ripped through 10 percent of hillside arable land, forests and rangelands (FAO, 2006). Flash floods and mudslides destroyed food and fodder crops, fruit tree plantations and livestock. Irrigation and rural infrastructure were destroyed, while roads, rivers and paths were blocked by rocks and debris. Many natural springs feeding rural water supply systems dried up.

Public health care and education services came to a complete halt. While women

often stayed behind, many men left the affected areas in search of work, which had a negative impact on the social cohesion of villages. These communities had to shoulder huge responsibilities of reconstruction, farming and care of children, orphans and the disabled.

This article is drawn from a thorough impact assessment of FAO's post-2005 earthquake rehabilitation programme in Pakistan, 18 months after project closure. The assessment of the watershed management component of the programme reveals how watershed management can help build back resilient landscapes and communities after a disaster.

Above: Batora watershed, showing a variety of land uses

DISASTERS AND LANDSCAPES

Natural hazards such as landslides and floods pose considerable risks to landscapes. They can destroy and damage forest and agricultural resources, remove topsoil and reduce land productivity, block rivers and increase downstream sedimentation (FAO, 2013a). Environmental degradation decreases the availability of goods and services to local communities, reduces economic opportunities and livelihood options and drives people towards marginal lands and fragile environments. In combination, this generates a vicious circle which can only be contained and reversed through political will and social change.

Disaster risk reduction (DRR) incorporates the three different variables that define landscapes: environment, economy and policy. It aims to reduce the vulnerability of a given setting and limit the extent of damage after a shock, as well as providing for efficient rehabilitation and reconstruction (FAO, 2013b). It promotes participatory and collaborative landscape planning and adaptive management to enhance the resilience and sustainability of both communities and ecosystems. Moreover it promotes the development of functional capacities and of legal and political platforms that facilitate a cycle of prevention, response and recovery.

In this context, the watershed management approach contributes to both environmental protection and vulnerability reduction. This is particularly true where natural resources have already been overexploited and deforestation and overgrazing may cause massive soil erosion.

WATERSHED MANAGEMENT AND THE WATER–ENERGY–FOOD NEXUS

As part of the response to the 2005 earthquake, FAO led a programme for rehabilitation through watershed management from the beginning of 2007 until mid-2011, entitled “Project to assist ERRA and its partners in restoring livelihoods in the earthquake-affected areas of Pakistan”.

The programme, funded by the Swedish International Development and

TABLE 1. Project budget

Budget	
Budget of the watershed management component	US\$1 500 000
Overall budget per watershed:	US\$90 000
Implementation of field activities	US\$50 000
Capacity development and staff time	US\$40 000
Beneficiaries	
Estimated population of the 17 watersheds	61 200 people of whom 60% women
Average population per watershed	3 600 people of whom 60% women

Cooperation Agency (SIDA), aimed to restore, in the medium term, the livelihoods of earthquake-affected people to pre-earthquake levels. It used a community-based development approach that aimed to be gender sensitive and environmentally friendly, foreseeing that the implementing partners should be able to sustain rural support services beyond the lifetime of ERRA.

In steeply sloping areas like the provinces affected by the 2005 earthquake, where livelihoods were threatened by landslides and landslips, integrated watershed management proved to be a suitable approach to ensure environmental protection and reduce vulnerability. Although human activities seem to have little influence in the occurrence – and therefore in the prevention – of deep-seated slides, much can be done to address shallow landslides, which usually occur within the zone penetrated by tree roots (FAO, 2013a).

The project used a community-based approach, in which the communities in the targeted watersheds were involved in all stages of the project and received technical assistance from government line agencies (at district level) through the coordination of FAO. The planning process included the following steps:

- delineation of watersheds;
- damage, hazard and resource mapping;
- topical Participatory Rural Appraisal (PRA), including upstream and downstream relationships;
- formation of Watershed Management Committees (WMC) and preparation of Integrated Watershed Management Plans (IWMP);

- implementation of prioritized activities;
- capacity development of beneficiary members and staff of governmental technical agencies.¹

The IWMPs developed in Pakistan built on demographic data for each watershed as well as a situational analysis of the watershed that included information on land use and natural resources, natural resource users, socioeconomic data and livelihood mapping, problem analysis and prioritization of activities. The action plan specified information on the different activities to be implemented, required inputs, costs, timeframes, roles and responsibilities, sources of community contributions and required partnerships. Thanks to the establishment of the WMCs, monitoring and evaluation were also participatory.

The WMCs are community-based organizations that bring together all stakeholders to identify, prioritize, implement and monitor watershed management activities. They serve to facilitate dialogue between community representatives and local governments, building mutual trust between the institution and its target along with a better understanding of communities' needs. In the project area, they included local decision-makers and governmental agency representatives at the district level to ensure the inclusion of IWMPs in broader district development plans, thus enhancing governmental ownership.

¹ A full list of FAO Participatory Rural Appraisal tools is available at <http://www.fao.org/docrep/003/x5996e/x5996e06.htm>.

Social inclusion being a crucial aspect in watershed management, the WMCs were also excellent vehicles to ensure gender balance in decision-making processes.

In 17 watersheds – 9 in Khyber Pakhtunkhwa province and 8 in Pakistan-administered Kashmir – the project developed a combination of long-, medium- and short-term interventions targeting landless people and small and medium-sized landowners, in order to address the needs of all segments of the beneficiary population. Carried out by the WMCs, and benefiting from a cross-cutting capacity development programme, the project provided technical support to the following main activities set out in the IWMPs:

- landslide and landslip stabilization by levelling land through terracing, and protecting the terraces with tree-planting and cost-effective bio-engineering works such as check dams and wattling, brush layering and gully plugging;
- development of water-harvesting systems (including roof water-harvesting) to serve small kitchen gardens and

ensure water for cooking and washing and for livestock;

- improvements to kitchen gardens to provide households with a source of fresh, low-cost and diverse produce, thereby improving nutrition;
- training in participatory and gender-sensitive planning and development for livelihood managers, coordinators and officers as part of the capacity development programme for local authorities.

This approach included watershed management funds that are managed and owned by the WMCs – these aim to ensure economic sustainability and increase the resilience of communities to sudden shocks. The funds allowed for the development of social protection and financial risk transfer measures such as sustainable microloan schemes. They also paved the way for the establishment of payments for ecosystem services (PES), based on upstream/downstream linkages through partnerships with the private sector.

The approach played a key role in mobilizing the targeted communities. It also strengthened the community–government

relationship, boosting governmental ownership and encouraging technical agencies to better address the communities' needs when implementing prevention and mitigation activities. The involvement of the community represented a secure investment both economically and in term of sustainability, with beneficiaries committed to maximizing benefits from their assets in order to be prepared for future hazards. This interaction between communities and local authorities is a milestone in the transition towards a future in which communities could themselves monitor and replicate environmental protection activities.

LAND RESTORATION THROUGH SUSTAINABLE FORESTRY

The project area lies in a temperate zone with pine forests. Tree species include kail (*Pinus wallichiana*), fir (*Abies pindrow*), *Robinia*, oak and *Ailanthus*. Poplar is also present on agricultural land. In addition to the damage caused by the earthquake, the area is also affected by degradation caused by various factors, including



Successfully reforested area, Khyber Pakhtunkhwa

frequent forest fires, illicit cutting of trees, overgrazing and shifts in land use, all of which hinder natural regeneration.

In response to the needs identified through consultations, the watershed management plans included the creation of well-managed, small-scale, community-based tree nurseries to produce the seedlings required for re-establishing home gardens and trees to supply household food needs. In each watershed, two nurseries were established, each with 40 000 plants. Nurseries were also used to produce high-quality seedlings for planting in diverse mixed-cropping agroforestry systems, including perennial tree crops, fast-growing fuelwood species and high-value timber-producing trees intercropped with vegetable/kitchen gardens.

The afforestation initiated by the nurseries thereby catered to people's needs while contributing to environmental restoration, with planted areas demarcated to avoid grazing. This was supported by training organized for community members and governmental agencies on cost-effective

bioengineering activities for landslip stabilization.

The plantations directly contributed to increasing tree cover, and the distribution of trees to farmers increased their number in agroforestry. The cultivation of fodder trees increased canopy cover, thereby protecting the soil against erosion.

Capacity development played a key role, as shown by the 80–100 percent success rate of these land restoration activities. The skills that were developed enabled effective rehabilitation after fresh landslips or gullies caused by floods, thereby protecting communities from new shocks and

ensuring both sustainability and upscaling.

Table 2 lists the activities carried out to improve the productivity of soil. Their impact has become increasingly visible after project closure. Retaining walls have prevented slippage while terracing has decreased runoff so that water can be used by crops and trees. Wattling, palisades, brush layering as well as check dams have fixed the slips and have been controlling the speed of water in streams after rainfalls, thus reducing erosion.

Sharing knowledge on orchard management with community members

TABLE 2. Implementation of management plans: forestry and soil conservation

	Total
Forest nurseries	10
Plantations	462 ha
Distribution of samplings	64 450
Regeneration by protection	344 ha
Direct dibbling of seeds	16 ha
Retaining walls	2 576 m ³
Terracing	17 ha
Wattling	3 971 m
Brush layering	5 364 m
Stream embankments	180 m
Check dams	24 305 m ³
Gabion walls	309 m ³
Diversion channels	600 m
Trails improvement	20.5 km
Palisades	235

Source: Marjan, 2010.



© G. MARJAN



© T. HOFER

Watershed Management Committee meeting, Pakistan-administered Kashmir

FOOD AND WATER

Kitchen gardens have improved nutrition and increased food security by introducing vegetables in local diets. The project targeted 30 percent of households in each watershed to establish some 288 kitchen gardens in the project area. Through training comprised in the IWMP, kitchen gardens have tripled in the targeted areas after project closure, with 90–100 percent of the households having established a garden.

Demonstration plots for line sowing also doubled annual yields, and smallholders are now less dependent on markets for the household's wheat needs.

Orchards have provided communities with a reliable source of income. An average of 12 orchards per watershed (guava, plum, apricot, peach and pear) were introduced. Through the skills acquired during the workshops in the field, community members have replicated this beyond the beneficiary areas.

Water ponds, roof water-harvesting systems, water channels and pipelines were developed to provide water for irrigation, washing and cooking to the most vulnerable villages as well as for livestock. In most watersheds, a 275-metre irrigation channel can serve 6 ha of new farmland. Roof water-harvesting systems have been replicated by the most vulnerable communities through grants from local NGOs. In some of the watersheds, watermills were built through funds coming from the WMC savings accounts as a result of the expertise developed during the project. Bringing water to the communities has significantly improved the lives of women, who are now able to save time that they can devote to attending vocational groups and developing new skills to generate some additional income.

LIVELIHOOD DIVERSIFICATION

A number of income-generating activities were introduced in the project area to

diversify livelihoods and foster access to the market for small local producers. In many watersheds, floriculture has rapidly become a significant business. The cut flowers grown in the project area have reached a viable market niche in the province by targeting local markets, and even reaching the capital. Vocational groups targeting women include food processing and basket knitting. The latter has expanded considerably and can be considered one of the best success stories in boosting socioeconomic development in the local communities. An average woman can knit as many as five or six baskets a month that are sold in the local market for 600 rupees each, an income managed by the woman herself.

The establishment of poultry sheds brought swift improvements to the livelihoods of the owners (eggs are sold for 7 rupees in the summer and 10 in winter,

with an average of 15–20 eggs a day in winter and 30–40 in summer). This has also had a broader effect in terms of nutrition: with two poultry sheds developed in each of the selected watersheds, the whole community has increased its consumption of eggs. This activity was also integrated with the launch of vaccination campaigns delivered in collaboration with livestock departments, which have helped to raise awareness on animal diseases and generalize vaccination.

GENDER MAINSTREAMING AND SOCIAL INCLUSION

Gender mainstreaming and social inclusion were central to the implementation of the project (FAO, 2013c). Women were empowered by their involvement in all phases of the project cycle. Because many of the project activities were directed at women, it was hugely advantageous to have gender-balanced WMCs. Women now constitute at least one-third of the membership of local WMCs, in which they play a clear role. The skills that women were able to acquire during the project have enabled them to earn an income and better manage their households. Although the region is generally highly conservative, and women are mostly excluded from decision-making, people in the communities targeted by the watershed management project quickly recognized the benefits – both for women and for the community as a whole – of involving women in planning as well as in the other phases of the community development initiatives.

CONCLUSION

In this project, the participatory landscape approach has clearly increased the resilience of both the landscapes and the communities in the face of natural disasters, as evidenced during the floods that occurred in 2010–2012. When the floods struck, the communities were far better prepared to deal with disaster, and the effects were minor compared to the aftermath of the earthquake. Little physical damage – such as landslides – was caused

thanks to the protection provided by the restored landscapes.

Watershed Management Committees established by the FAO project are still meeting on a regular basis to assess and validate any new activities to be carried out within the watershed area. And both women and other vulnerable groups now play a stronger and clearer role in the WMCs.

Eighteen months after project closure, the beneficiary groups have continued their prevention and mitigation activities beyond the project's initial scope, ensuring sustainability through their own means. The 17 watersheds thus have clear potential as learning sites to share knowledge and information, as well as to deliver on-the-job training in order to continue to expand the integrated watershed management approach to build resilient landscapes. ♦



References

- FAO.** 2005. *The new generation of watershed management projects and programmes*. FAO Forestry Paper 150. Rome.
- FAO.** 2006. *Project to assist ERRA and its partners in restoring livelihoods in the earthquake-affected areas of Pakistan*. OSRO/PAK/701/SWE. Project document. Rome.
- FAO.** 2009 (February). *Evaluation of the FAO response to the Pakistan earthquake. May–July 2008*. Final report (available at http://www.fao.org/fileadmin/user_upload/oed/docs/Pakistan_Earthquake_Response_2009_ER.pdf).
- FAO.** 2013a. *Forests and landslides. The role of trees and forests in the prevention of landslides and rehabilitation of landslide-affected areas in Asia*. Bangkok, FAO Regional Office for Asia and the Pacific.
- FAO.** 2013b. *Resilient livelihoods. Disaster risk reduction for food and nutrition security*. 2nd edition. Rome.
- FAO.** 2013c. *Watershed management: resilience and gender. Case study: Project to assist the Earthquake Reconstruction and Rehabilitation Authority (ERRA) and its partners in restoring livelihoods in the earthquake-affected areas of Pakistan*. OSRO/PAK/701/SWE. Project document. Rome.
- Marjan, G.** 2010. *Analysis of processes, interventions and lessons learnt in the watershed management component of OSRO/PAK/701/SWE*. Project document. Rome.
- Marquis, G.** 2013. *OSRO/PAK/701/SWE impact assessment report*. Project document. Rome.
- UNEP.** 2005. *Millennium Ecosystem Assessment 2005* (available at <http://www.maweb.org/en/index.aspx>). ♦

Environmental and social reconstruction in Haiti: watershed management in Léogâne and Petit-Goâve following the 2010 earthquake

R. Fankap and K.A. Daphnis

Reforestation projects have not only contributed to restoration of the environment and better resilience following the 2010 earthquake in Haiti, but have also created employment.

Reforestation in the Ladigue watershed: a two-year-old *Anacardium occidentale* in bloom, 2014



Roger Fankap is an expert in forestry and agroforestry at the Office of the FAO Representation in Haiti.

Karl Arthur Daphnis is an agronomist, working as a consultant with the Office of the FAO Representation in Haiti.

After the earthquake of 12 January 2010, FAO implemented three projects in the Republic of Haiti,¹ which aimed at improving the food security of rural families through support to agricultural production and the creation of income-generating activities. These projects focused on watershed management in the areas of the Cormier and Canot Rivers (Léogâne) and the Cayman and Ladigue Rivers at (Petit-Goave), as well as on the prevention of risks and natural disasters. In this type of situation, planted trees can perform multiple functions, ensuring production, protection and environmental services. The projects therefore concentrated on the production and planting of seedlings in targeted watersheds.

¹ OSRO/HAI/013/NOR; 018/FIN and 021/BEL.

The implementation strategy for the activities was organized along two axes: on the one hand, a participatory approach with capacity-building of community-based organizations (CBOs) for the production of seedlings; and “cash for work” for community gully modification works on the other. On this basis, 44 CBOs were assisted, including the setting up of a permanent nursery for each.

These projects were conceived in the context of an influx of people from Port-au-Prince into the areas concerned, which was accelerating the degradation of natural resources. In addition, upstream management of the watersheds was necessary to reduce the risk of flooding in the Léogâne and Petit-Goâve plains. FAO and the Ministry of Agriculture, Natural Resources and Rural Development of Haiti (MARNDR) carried out a series of

1
**Map of the Léogâne and
 Petit-Goâve intervention areas**

agroforestry and gully treatment activities, the results of which are presented below.

Establishment of nurseries and seedling production for reforestation and the development of agroforestry systems: 44 nurseries were established, for a total production capacity estimated at 3 million seedlings per year. During the implementation of these projects, 2.5 million forest and fruit tree seedlings were produced and used to populate an area of 2893 ha; of the trees planted, over 40 per cent were cashew (*Anacardium occidentale*), a high-value species. The success rate of around 90 per cent demonstrates the commitment of the farmers to the trees planted on their plots. The cost of the planting operation was estimated at US\$ 45/ha. This low cost for reforestation and agroforestry activities is a potential advantage that could encourage considerable investments from donors and the Haitian Government, with a view to restoring the land cover of the country. In addition, in order to facilitate the setting up of the plots and encourage farmers to integrate trees among their crops, the projects provided beneficiaries with 1.8 million units of plant material including:

- 700 000 sweet potato cuttings,
- 460 000 cassava cuttings,
- 256 000 yam minisets,
- 248 000 banana suckers,



- 99 000 pineapple suckers, and
 - 135 000 sugarcane cuttings,
- thus increasing agricultural production and contributing to household food security.

In the four targeted watersheds, soil conservation and erosion control activities helped to build 3 200 m³ of dry-stone sills, 5 250 m³ of sandbag sills and 13 200 (linear) m of contour channels. These erosion control

structures were strengthened by the planting of 146 600 (linear) m of strips of forage crops and the planting of fruit and forest trees. To consolidate achievements by organizing the communities living in the watershed areas and to ensure the sustainability of the activities, 12 Watershed Management Committees were formed in order to monitor the work and maintain social dialogue on the issue of land degradation in their respective communities.

The impact of the activities, which were carried out over a relatively short period of time (2010-2013), was felt in the cities of Léogâne and Petit-Goâve. The reforestation of the watersheds and construction work created temporary jobs for 7 400 households and reduced flood damage caused by bad weather downstream. Thanks to these activities, the plant cover of the project area has returned to acceptable levels. Indisputably, the structural work, reinforced by the planting of trees and forage plants, has enabled restoration of the environment in a country that is seriously affected by land degradation. ◆



**Construction of contour channels
 in the Canot watershed, 2012**

Forests – the green sentinels of the Alps

R. Schmidt



© R. SCHMIDT

In Austria, using forests for their protective functions is not only environmentally sound but also makes sense economically.

Rudolf Schmidt is Deputy Area Construction Manager in Salzburg of the Austrian Service for Torrent and Avalanche Control.

Forests as protection

Forests play an important role in the management of natural hazards in Austria, a country particularly exposed to floods, landslides, rockfalls, avalanches, hail and storms. Some 47 percent of land area is wooded, and about 31 percent of all forests in Austria provide a protective function, notably through preventing avalanches, rockfalls and landslides by adding to the stability of slopes and their groundwater management.

The “Protection through Forests Initiative” (Initiative Schutz durch Wald – ISDW), which

came into effect nationwide in 2007, serves to safeguard the protective function of forests. This protection against natural hazards is achieved predominantly through predefined silvicultural measures, supplemented by accompanying technical measures as necessary.

The initiative was developed in close cooperation by the Ministry of Agriculture, Forestry, Environment and Water

Afforestation within steel barriers at the starting area of the Böckfeld avalanche, Bad Gastein, Salzburg



© R. SCHMIDT

Sattelbach torrent after the June 2013 debris flow event, Hütttau, Salzburg

Management (Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft – BMLFUW) and experts from the provincial and district forest inspection services, the Austrian Service for Torrent

and Avalanche Control (WLV), and with scientific support from the Federal Research and Training Centre for Forest, Natural Hazards and Landscape (BFW). Within the scope of the national rural development programme, implementation of the programme will be supported with about EUR5.7 million per year.¹

Integrated forest and water management

Austria has approximately 100 000 km of rivers and creeks, and up to 9 000 lakes. Over

67 percent of its total area is part of a torrent or avalanche catchment (about 13 000 torrent catchments and nearly 6 000 snow avalanche paths).

The protective forest above the town Halstatt, Salzkammergut region, has always played a key role in the life of the inhabitants. Left: Old Town of Halstatt (peninsula to the right) with protective forests. Right: The Hallstätter Mühlbach torrent floods the town, June 2013

¹ More information on the initiative is available at <http://www.isdw.at>.



© R. SCHMIDT



© R. SCHMIDT

Section of the hazard zone map for the town of Werfen, Province of Salzburg. The blue marking indicates protective forests



The country's relatively low level of both human and economic losses is a result of heavy investments in protective measures. The Austrian Service for Torrent and Avalanche Control (WLV) was founded in 1884 as a department of the K.k. (imperial) Ministry of Agriculture and is responsible for the protection of people, their habitat and settlement areas against the natural hazards of torrents, avalanches and erosion (caused by rockfall, landslides, debris flow and fine-sediment erosion). It has its headquarters in Vienna, 7 provincial sub-headquarters and 21 branch offices throughout the country, and 3 technical offices that provide special expertise on geological questions, simulation of avalanches and IT and GIS matters. The technical service provides information on natural hazards and advice and expertise to the public, as well as ensuring the planning and realization of protective measures and linked subsidy management.

Sustainable management of protective forests

The 1975 Forestry Act sets out the legal framework for the management of Austrian forests. To ensure sustainability, it provides for numerous management restrictions and stipulations, such as the requirement for certain measures to be authorized by the forest authority. Even more stringent regulations apply to protective forests. Forest land-use planning as set out in the Forestry Act foresees three planning instruments in the presentation and forecasting of forest conditions: the forest development plan, hazard zone maps, and the forestry plan.

For areas near settlements, protective forests can be included in a hazard zone map, available for almost the whole of the country. They are either part of a blue area (blauer Vorbehaltsbereich) which implies specific management requirements, or are highlighted within a brown area (brauner

Hinweisbereich), indicating areas exposed to rockfall or landslides but with no specific requirements.

Table 1 shows clearly that having protective forests and taking care of them is a good economic decision.

The most significant issues affecting protective forests are ageing and lack of regeneration. Since most sites are steep, exposed to rockfall and/or snow-gliding and cannot be reached easily, managing the forests can be time-consuming and expensive. However a simple calculation can show the value of doing so. The costs for one hectare (10000 m²) of steel snow barriers in the starting zone of avalanches are around EUR300 000. With an assumed life span of 100 years, this gives annual costs of EUR3 000/year, without taking into account interest. If a protective forest assumes the role of the steel barriers, the amount saved could be considered as "earnings" of the forest, which could cover the costs for maintaining the forest and potentially even generate some profit for the owner.

The role of forests in protecting against natural hazards has always been important in Austria, but climate change and shrinking public budgets will undoubtedly lead forests to play an even more prominent role in the future. ♦

TABLE 1. Protective forest versus technical measures

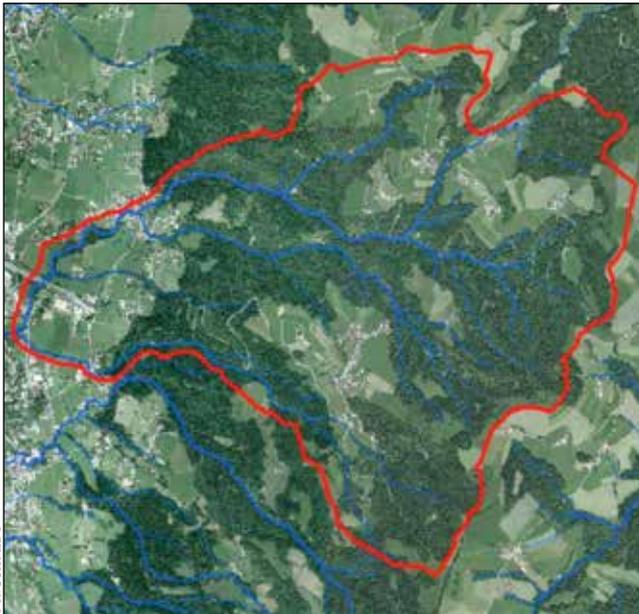
	Protective forest	Steel barriers
Life span	Sustainable	<100 years
Starting costs	None	Approx. EUR300 000/ha
Maintenance costs	Cost covering at best	None
Earnings	Hunting licences, tourism uses, protective function	None: annual costs approx. EUR3 000/year



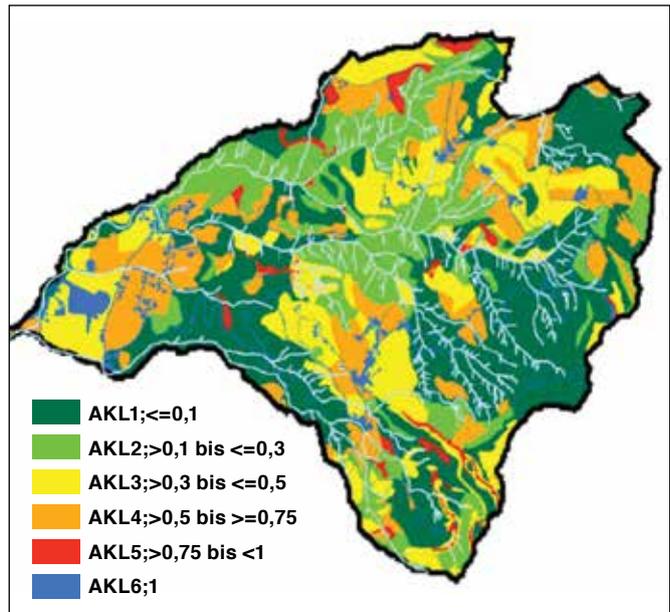
The main protective functions of forests

For torrents

Positive effect on the discharge coefficient



© R. SCHMIDT



© R. SCHMIDT

Coefficient classes derived from an aerial picture

Negative effect on the hazard of driftwood jam



© R. SCHMIDT



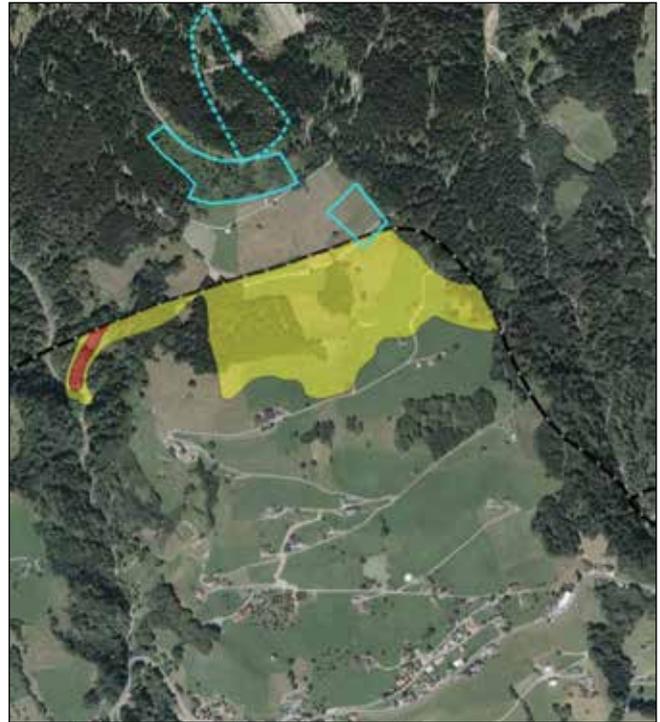
© R. SCHMIDT

Fallen forests and resulting driftwood jam

The main protective functions of forests

For avalanches

Positive stabilizing effect at the starting zone on snow cover, depending on factors including tree species, tree height, stocking level, crown cover and gap size, and positive braking effect in the avalanche track, although this is very low and only taken into account for the simulation of powder avalanches.



Avalanche hazard map for St. Gerold, province of Vorarlberg. Left: 1980. Right: 2013

For rockfall

Positive braking effect, depending on factors including tree species, trunk diameter, number of trees, stocking level, crown cover and gap size. Forests are taken into account for simulations via rock size if forested area covers the track over more than 100 m in altitude.



Deciduous forest as rockfall protection above the Arlberg Railway



Area of unprotected rockfall, Austria

Black Saturday: Australia's deadliest bushfire

G. Morgan and M. Leonard

The devastation wrought by the 2009 fires in south-eastern Australia is a powerful demonstration of the need to fully integrate fire risk considerations into land-use planning and management.

Gary Morgan is a consultant at Global Wildland Fire Management Services and former Chief Executive Officer of the Bushfire Cooperative Research Centre, Australia. **Mike Leonard** was, for several years, Strategic Adviser to the Bushfire Cooperative Research Centre. He retired in July 2014.

In south-eastern Australia, the topography, vegetation and climate combine to produce one of the most fire-prone areas on Earth.

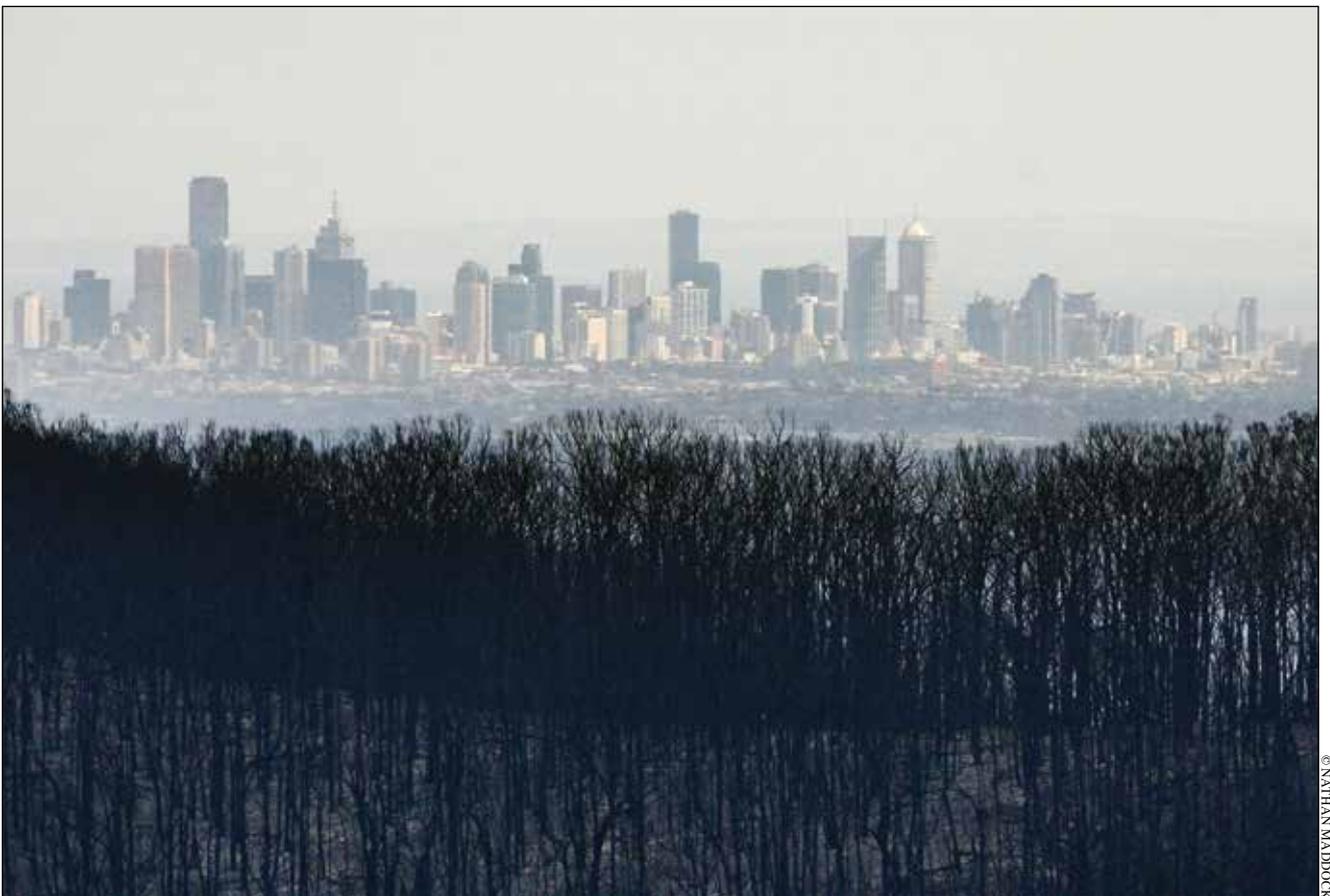
On Saturday 7 February 2009, after 13 years of drought and on a day of extreme fire conditions, 173 people perished in a matter of hours during the most deadly bushfires in Australia's history. About 430 000 ha of farmland and eucalypt-dominated forest were burnt, and 2000 properties and 61 businesses were damaged or destroyed. Several small towns were obliterated and some 78 communities affected. Coming in the wake of several

other fires that had hit the same area in previous years, the fires, and their consequences, stunned the nation.

Thousands of volunteers and professional firefighters turned out to help extinguish the fast-moving fires. A major recovery process commenced the following day, 8 February, to assist the devastated communities.

A week after the fires, and as the battle to contain some of the remaining blazes continued, the state government established a Bushfires Royal Commission.

View of the city of Melbourne behind the burnt trees of Kinglake Range



© NATHAN MADDOCK

The Commission was given broad terms of reference and was tasked with investigating the causes of, preparation for, responses to and impact on infrastructure of the fires that occurred in early 2009. The Commission reported to the State Governor at the end of July 2010.

While the circumstances were far from ideal, this national tragedy provided an opportunity for Australia, and indeed the wider wildland fire community, to bring valuable results from post-fire scientific and social research to bear on attempts to mitigate and manage the impact of bushfire and associated community trauma.

THE DRIEST INHABITED CONTINENT ON EARTH

Geographically diverse, with landscapes ranging from the deserts and semi-deserts of the inland to lush tropical rainforests in parts of the north-east, Australia also has mountain forests in the east, cool temperate rainforests in the far south-east and open eucalypt forests in the south-west.

Despite being the world's sixth-largest nation in land area, the country has a relatively small population (about 23.5 million). The only nation to govern an entire continent and its outlying islands, Australia is the driest inhabited continent on Earth. Its interior has one of the lowest rainfalls in the world, and about three-quarters of the land is arid or semi-arid. Australia's fertile areas are generally well watered, however, and agricultural production in these areas is the basis for significant trade and export.

Formed in 1901, the Australian federation consists of six states and two territories. Most inland borders follow lines of longitude and latitude. The largest state, Western Australia, is about the same size as Western Europe. Australia is one of the world's most urbanized countries, with about 70 percent of the population living in the 10 largest cities. Most of the population is concentrated along the eastern seaboard and in the south-western corner of the continent.

Forests and woodlands, particularly in southern Australia, are dominated by the



Many species of *Eucalyptus* are particularly prone to fire

genus *Eucalyptus*,¹ a diverse group of flowering trees and shrubs belonging to the Myrtaceae family. More than 900 species of eucalypts have been described, most being native to Australia. A very small number are found in adjacent areas of New Guinea and Indonesia.

Species of *Eucalyptus* are planted widely in tropical and temperate regions of the world, including Africa, the Americas, China, Europe, the Indian subcontinent, the Mediterranean basin and the Middle East.

FIRE IN AUSTRALIA

Fire has been a feature of the Australian landscape for tens of thousands of years, pre-dating human habitation. Since the arrival of the ancestors of today's Aboriginal people at least 40 000 years ago, deliberate burning of the vegetation – or “firestick” farming as it is sometimes referred to (Jones, 1969; Pyne, 2006) – coupled with periodic lightning-ignited “natural” fires, has shaped the evolution of much of Australia's landscape and its ecosystems.

Many of Australia's native plants and animals possess characteristics that constitute

effective survival strategies when exposed to natural stresses such as fire and drought. A number of species require fire or similar disturbances to regenerate or renew their habitats, and many temporarily flourish in a post-fire environment.

Most eucalypt species exhibit fire-related characteristics, such as the presence of volatile oils, particularly in the leaves, buds and flowers; and a characteristic known as “spotting”, whereby burning firebrands are transported by convection and wind to ignite new fires ahead of the source fire. Spotting behaviour recorded in Australia is the worst in the world in terms of spot-fire distance and concentration, and this has been attributed to features of eucalypt bark types.

¹ In 1995, a milestone in *Eucalyptus* taxonomy, two botanists proposed splitting the genus with their description of a new, additional genus, *Corymbia*. This split into two different genera remains contentious, with the Australian National Herbarium, among others, taking a more conservative approach.

TABLE 1. Fire-associated characteristics found in many species of *Eucalyptus*

Extensive root systems.	Assist survival in nutrient-poor soils and/or assist recovery after fire.
Presence of lignotubers and epicormics.	Many species store nutrients in swellings along the stem (epicormics) that are rich in dormant buds – lignotubers normally develop at the seedling stage at ground level or just below the surface. Both assist trees to recover from trauma such as fire and drought by enabling the development of new shoots.
Nutrients often stored also in the heartwood, below thickened bark.	Assist recovery following fire or drought.
Leaves contain oils and waxes.	Can encourage burning, even when leaves seem green.
Litter build-up: while eucalypts are evergreen, they can shed up to one third of their leaves every year. Many also regularly drop parts of their bark and branches.	Fallen material dries out, decomposes slowly and becomes fuel.
Bark types often determine the impact of fire.	Some bark types, e.g. <i>Eucalyptus</i> species with fibrous, stringy bark, appear to heighten the risk of spot-fires.

Some species, particularly those with few of the characteristics listed above, rely on seed dispersal following a fire to re-establish themselves. Forests of two higher-altitude species, alpine ash (*Eucalyptus delegatensis*) and mountain ash (*E. regnans*), which on better sites are capable of sustaining Australia's most productive timber industry, suffered extensive and severe fires in the 2003, 2006–2007 and 2009 bushfires in south-eastern Australia. Both the 2003 and 2006–2007 fires lasted for approximately two months, with each burning over 1 million ha. However, the 2009 fires burnt mainly on one extreme fire danger day and had a greater impact on life and built assets than the other two fire seasons.

These forests tend to have an open canopy and streamers of bark hanging from the tree trunks. They can exhibit up to twice the leaf litter fall of other eucalypt species, and burn ferociously under the right conditions. However, the woody, seed-bearing capsules high up in the canopy are generally only lightly burnt due to the high speed of the fires. Following heating, the capsule valves open and disgorge seed on to the ash bed below. Subsequent

rain and full sunlight, combined with the concentrated nutrients in the ash bed, can see over 1 million seedlings per hectare develop and form the basis of the next generation of even-aged forest. The newly established forests take about 20 years to reach seedling maturity, and successive fires in a shorter period will therefore eliminate the species from a site.

In southern Australia, large fires often have a significant negative economic and

social impact. The 2002–2003, 2006–2007 and, notably, 2008–2009 fire seasons in south-eastern Australia were characterized by significant areas of forest being burnt during the summers, major asset losses, high suppression costs and a need for complex incident management arrangements.

During bushfires in the mountain forests of southern Australia, maximum fire intensities² can reach up to 100 000 kW/m (Tolhurst, 2004).

VICTORIA'S BLACK SATURDAY FIRES

Fringing the southern tip of Australia's east coast, Victoria is the second-smallest of the country's six states, covering 227 600 km² – an area roughly the size of the British Isles. Its capital, Melbourne, is Australia's second-largest city, with about 4 million inhabitants (some 80 percent of the state's total population).

About one third of Victoria is made up of publicly owned land. This includes significant areas of forest and woodland that are dominated by species of the genus *Eucalyptus*. These lands include a diverse range of parks and forests, some of which

² For details of fire intensity measurement, see Tolhurst and Cheney, 1999: 21.



Aerial view of the Black Saturday fires

comprise the most rugged and remote parts of the state. Victoria's public lands contain many nationally and internationally significant ecosystems, more than 90 percent of the state's native timber resources, virtually all of its most significant natural tourist attractions and the majority of its water-supply catchment areas.

By February 2009, much of south-eastern Australia was experiencing a severe and protracted drought, which in some places had lasted more than 12 years. During January 2009, many places in Victoria had no rain at all, and most other areas were at near record lows.

In late January 2009, an exceptional heat-wave was experienced across Victoria, the most severe and prolonged in the recorded history of south-eastern Australia. On Saturday 7 February, many all-time temperature records were set. In Melbourne, the temperature reached 46.4 °C (the previous record being 45.6 °C, set on 13 January 1939 – named Black Friday in the state's bushfire history).

Melbourne set a new record for the highest number of consecutive days (three days) above 43 °C; the countryside was parched, the heat and drought had desiccated the vegetation on the forest floor, and for several reasons fuel loads in many locations were extremely high.

In the days that preceded 7 February, the extreme conditions were recognized by the relevant agencies and the community was warned that the forecast weather could lead to extreme fire risk. In the late morning of 7 February a fire, which started from a faulty electricity supply line, was reported on farmland about 60 km north of Melbourne (near the town of Kilmore). At the time, the temperature was over 35 °C and climbing towards 40 °C, northerly

winds were gusting up to 90 km/hr and humidity was approaching single figures. The fire spread quickly, soon entering forested country on its way to the northern edge of the state capital. As afternoon approached, many fires were reported across the state.³

Early that afternoon, a fire was reported in open country to the east of Melbourne

in the rural region of Gippsland, again being driven, under strong north winds, towards forested hills. At around 3 p.m., another fire was reported to the north-east of Melbourne (near a small settlement called Murrindindi), again in farmland but close to forest. Initially, arriving crews reported severe fire behaviour, with flames 20 m high and an estimated rate of spread

TABLE 2. Overview of Black Saturday

Location	South-east Australia (Victoria): north and east of the state capital, Melbourne.
Cause	The subsequent inquiry examined what it termed 26 "significant fires" that occurred on the day. Of the fires that caused fatalities, the causes were determined as follows: <ul style="list-style-type: none"> • Kilmore East (119 fatalities) – electrical failure • Churchill (11 fatalities) – arson • Murrindindi (40 fatalities) – electrical failure • Bendigo (1 fatality) – probable arson • Beechworth–Mudgegonga (2 fatalities) – electrical failure
Impact summary	Deaths: 173; homes damaged or destroyed: more than 2000. An estimated 10000 km of fencing was destroyed; 11 800 head of stock were killed; the peak animal welfare body estimates that more than 1 million animals died; 10 000 ha of prime native timber and 16 684 ha of plantation forests were burnt; an estimated 11 million tonnes of carbon dioxide was released. Direct rehabilitation costs were estimated to be in the region of A\$1 billion (US\$ 926 million), while the overall cost estimate was A\$4 billion+. Following court action, A\$800 million was paid in compensation to victims, primarily by the electrical distributor. The psychological impacts of the fires on the inhabitants were, as with many bushfires, another highly significant matter.
Fire regimes/ fire history	Fire regimes vary over the fire area. There is a history of both wildfire and the use of prescribed fire for both fuel management and, more recently, for biodiversity reasons, as the relationship between ecosystem health and fire regimes has become better understood in forest vegetation that is fire-dependent or fire-adapted. South-eastern Australia is one of the most fire-prone environments in the world. Over the past 100 years, large and damaging fires have occurred every five years on average. Many of these fires have resulted in extensive property and environmental damage and loss of human life. Fires burning on days of extreme weather conditions on 13 January 1939 and 16 February 1983 resulted in the loss of 71 and 75 lives, respectively. In total, 2.24 million ha of the same general part of south-eastern Australia has been burnt since 2003, with more than 1 million ha of fires occurring in 2003 and 2006. Fire regimes prior to the arrival of Europeans in the area (1840s) are not well understood. Active fire suppression has been practised over the past 80 years, while the use of prescribed burning, which peaked in the period 1970–1985, has been in decline over the past 25 years.
Fire protection strategies	All aspects of fire management on publicly owned land are subject to a legislated code of practice (State of Victoria, 2006) – the Code is consistent with the FAO <i>Fire Management: Voluntary Guidelines</i> (FAO, 2006). Fire management in about 60 percent of the fire area (i.e. publicly owned parks and forests) was the responsibility of the conservation agencies that use a combination of seasonal and longer-term employees. Response to fires on rural, privately owned lands is primarily provided by (unpaid) volunteer-based organizations; mutual support by both organizations also occurs. During long-duration campaign fires, interstate and international support is also sometimes provided.

³ Rural fire authorities advised the subsequent inquiry that on 7 February 2009, 592 grass and bushfires were reported on privately owned land that day, 47 of which were identified as potentially "very serious". A number of fires that started on public land that day developed into large fires but did not threaten life or property. Fourteen of the 47 private land fires became "major fires".

of 8 km/hr. Spotting was estimated at 5 km, but post-fire analysis indicated that this was an underestimate – the likely spread of the fire was about 12 km/hr, with spotting to 22 km (Bushfire Cooperative Research Centre [CRC], 2009).

A little after midday, a strong, gusty, south-westerly wind entered the state, bringing temperatures down and increasing relative humidity. No rain-shower activity was associated with the change. Many locations had by now reported their hottest day for February, if not on record. Wind gusts to 115 km/hr were reported in the wake of the change.

By the time the fires that broke out on 7 February had been contained, 173 people had been killed, about 78 communities had felt their direct impact, and several entire towns been irrevocably affected – more than 2000 homes and 61 business premises had been destroyed, and 430 000 ha of land (almost 60 percent of it forested) had been burnt. The first day of the fires made the strongest impact, but the fires took almost two weeks to fully contain.

In the weeks following the tragedy, the state government established the Bushfires Royal Commission, which was tasked with producing an interim report by mid-August 2009 and a final report by August 2010. During the inquiry, the Commission received more than 1 700 written submissions and heard some 434 witnesses and

a range of international specialists over 155 days. The final report included some 67 recommendations and covered around 1 000 pages (see Parliament of Victoria, 2010, or <http://www.royalcommission.vic.gov.au/>).

In both 1926 and 1939, extensive bushfires burnt across the mountainous region of the State of Victoria. The fires together killed some 85 percent of the region's mountain ash forest, thereby converting huge areas of old forest to regrowth. Later, the 1983 Ash Wednesday bushfires destroyed an additional 14 000 ha, or 6 percent, of the state's mountain ash, and converted it to regrowth.

After a few decades of predominately urban-based environmental campaigns, most Victorian forests are not available for harvesting. In the Eastern Highlands of Victoria, sustainable timber harvesting is limited to within a third of the region's mountain ash and related forest. This portion is overwhelmingly comprised of 1939-origin regrowth forest. Any larger pre-1900-origin trees found among the regrowth are excluded from harvesting.

The comparative impact of bushfire and harvesting on creating regrowth was exemplified by the 2009 Black Saturday bushfires which, in just a few days, killed approximately 33 000 ha of the State of Victoria's mountain ash forest. This is an area equivalent to 50–60 years of harvesting at the current rate.

The 2009 Black Saturday bushfires in Victoria burnt about 254 160 ha of forest. In the Eastern Highlands, 189 000 ha of ash forest was killed or severely damaged by the three bushfires that occurred in the area over the past decade. These burnt a land area totalling more than 2.6 million ha. Silvicultural recovery work included aerial sowing of about 7 100 ha of fire-killed areas in state forests, for which about 6 400 kg of eucalypt seed was used.

MANAGING FIRE RISK

Historically, the area of Australia subject to fire has declined somewhat over the past few decades as a consequence of changed land-use patterns, fire suppression practices and, in many areas, particularly in the north, the cessation of traditional burning by Aboriginal populations.

Negative urban attitudes towards the use of prescribed fire have also been a factor in the decline in its use in a number of areas. During this same period, land-management agencies and, to a certain extent, rural fire services have struggled to maintain the appropriate balance between prevention, preparedness, suppression and recovery. The problem is not unique to southern Australia – Goldammer (2013) and Williams (2014), for example, detail similar quandaries confronting land managers in Eurasia and North America.

In south-eastern Australia, human settlement now typically dominates the plains and the lower foothills. Above the settlements, “mixed species” eucalypt forests can be found that exhibit most of the characteristics set out in Table 1. These forests are quite fire-tolerant, at lower fire intensities, and lend themselves to the use of prescribed fire.

At higher altitudes, “ash”-type forests are often found. The trees in these forests have thin bark, the forests build up high fuel loads and they only dry out during prolonged droughts. When they do, however, they burn with high intensity and the fires are difficult to suppress. These forests are not generally conducive to the use of prescribed fire.

TABLE 3. Area burnt in Victoria's mountains in three major fire events

Fire event	Total land area burnt (ha) ^a	Area of state forest burnt (ha)	Area of other public land burnt (ha)	Total area (approx.) of ash eucalypt forest species killed or severely damaged (ha) ^b
Alpine fire (2003)	1 100 000	444 000	560 000	81 000 ^c
Great Divide fire (2006/07)	1 190 000	725 000	360 000	65 000 ^c
Black Saturday fires (2009)	406 000	170 000	117 000	43 000 ^d

a Covers privately owned, state forest and other public land.

b Covers both state forest and other public land.

c Predominantly alpine ash.

d Predominantly mountain ash.

Source: Fagg et al., 2013.

Over the past few decades, the political climate in Australia has moved against logging of native forests and the removal of trees within the urban environment. At the same time, many people who work in a built-up environment are choosing to establish their homes in forested environments as a preferred lifestyle choice. Unfortunately, these people often fail to realize the forest-fire risk they face and the inevitability of wildfires occurring in the fire-dependent ecosystem. Fire managers are increasingly challenged as they are called upon to protect growing numbers of dwellings that are being constructed among forests close to urban areas.

The use of prescribed fire along or near the rural/bushland interface is increasingly difficult, with higher operational risks. The density and value of human assets, residents' lifestyle concerns, increasingly litigious citizens and nervous governments make politicians and land managers reticent. Other fuel treatment options, such as slashing ground vegetation, are, by comparison, expensive and generally apply only in limited areas.

Clearly, in fire-prone environments, a passive management or inactive approach becomes a fool's paradise, with an inferno the invariable consequence. Prescribed burning to reduce fuels, where possible in the landscape, provides for healthier forests and less damage when the inevitable wildfires do occur.

In late 2007, a joint report prepared by the Commonwealth Scientific and Industrial Research Organisation (Hennessy *et al.*, 2006), Australia's national research organization, the Australian Bureau of Meteorology and the Bushfire Cooperative Research Centre concluded that the number of very high and extreme fire weather days could, as a consequence of global warming, increase by 4–25 percent by 2020 and by 15–70 percent by 2050 across parts of south-eastern Australia.

It is already likely that a combination of increased fire frequency, poorly resourced public agencies and confused land-management policies has consigned a

significant area of "ash" forests (which on the best sites contain the tallest flowering plants on Earth) to oblivion.

In August 2010, the Australian Senate carried out a national inquiry, which it described in its final report as "the nineteenth major bushfire-related inquiry to be conducted in Australia since 1939 and the third to be conducted federally since 2003".

In evidence to that inquiry, Professor Peter Kanowski (co-author of the 2004 national inquiry, the first such inquiry in the nation's history; see Ellis, Kanowski and Whelan, 2004) said that his 2004 inquiry had identified:

Burnt alpine ash



© BUSHFIRE CRC

...a repeated cycle of response by [state] governments and the community to major fire events: first, suppression and recovery processes are always accompanied by assertions, accusations and allocations of blame, even while the fires are still burning; second, inquiries are established and reported; third, recommendations are acted upon, to varying degrees; fourth, the passage of time sees growing complacency and reduced levels of preparedness ... and the cycle begins again with the next major bushfire event....

Wareing and Flinn (2003), in their unprecedented (in Australia) analysis of the 2003 Victorian Alpine fires (which burnt over 1 million ha and took 59 days to contain), clearly demonstrated the widespread negative environmental, economic, cultural and social impact that can result from the failure to control wildfires, noting that some environmental impacts, such as soil erosion, can be long-lasting. They concluded that similar bushfire conditions could occur in the following year due to the ongoing drought, and that with global warming there was likely to be an increased risk of frequent and severe bushfires. They also considered that the trend towards urbanization of forest areas was accelerating without adequate attention to fire risk. Further, they suggested that the contraction of the native forest-based timber industry, and its associated skilled operators and machinery, was adversely affecting the ability to contain fire outbreaks in forests and woodlands.

These 2003 fires, which burnt about 1.7 million ha of land in Victoria and adjacent jurisdictions, reportedly:

- killed an estimated 370 million reptiles, birds and mammals (Franklin, cited in *Canberra Times*, 2007);⁴
- ravaged substantial areas of forest, some of which may not regenerate to their pre-fire condition (Wareing and Flinn, 2003); and
- initiated post-fire forest regeneration of killed alpine ash forest areas in the

most severely affected half of the burnt area, which will reportedly reduce inflows to Australia's major inland river (the Murray) by an estimated 430 billion litres per year until 2050 (regenerating ash-type forests use significantly more water in their early years than mature ash forest).⁵

Across much of Australia, fire presents somewhat of a paradox. In many locations, natural fires are essential to maintain ecosystem dynamics, biodiversity and productivity. Fire is also widely used as a land-management tool. Each year, however, fires can cause widespread loss of life, ecosystem damage and adverse economic and social impact. They also contribute increasingly to global warming.

CONCLUSION

An award-winning essay by Australian National University historian Professor Tom Griffiths (2009), written within days of the Black Saturday fires, recalls how Judge Leonard Stretton's seminal inquiry on fires in Victoria in 1939 had sought to adequately describe how "rampant flame had scourged a country that considered itself civilised", and how Stretton had gone on to define "an active, half-conscious denial of the danger of fire, and a kind of community complicity in the deferral of responsibility".

Griffiths observed:

In the seventy years since 1939, we have lived through a revolution in scientific research and environmental understanding and we have come to a clearer understanding of the peculiar history and fire ecology of these forests. We have fewer excuses for innocence. We knew this terrible day would come. Why, then, was there such an appalling loss of life?

As Australia becomes more urbanized, it has been suggested that the occurrence and impact of devastating mega-fires, with their increasing cost to humans and the environment, can be reduced through:

- sound end-user-inspired independent research, such as conducted by the Bushfire CRC;⁶
- strong land-use planning provisions that are cognizant of the wildfire risk and operational practicalities, enabling the reduction of wildfire risk;
- year-round landscape management strategies for forested areas;
- improved land- and fire-management agency resourcing; and
- an associated, unwavering all-party political will. ♦



References

- Bushfire CRC.** 2009. *Victorian 2009 Bushfire Research Response*. Final report. Melbourne, Australia, Bushfire Cooperative Research Centre (available at www.bushfirecrc.com/sites/default/files/managed/resource/bushfire-crc-victorian-fires-research-taskforce-final-report.pdf).
- Canberra Times.** 2007. Bushfires wipe out wildlife by millions a year (28 January).
- Commonwealth of Australia.** 2010. *The incidence and severity of bushfires across Australia*. Report of the Select Committee on Agricultural and Related Industries. Canberra, Australia, Commonwealth of Australia.
- Ellis, S., Kanowski, P. & Whelan, R.** 2004. *National inquiry on bushfire mitigation and*

⁴ No human lives were lost as a direct result of the fires, although one firefighter drowned tragically in a river that had flooded following a severe thunderstorm at the end of the fires.

⁵ See Collaborative Research Centre for Catchment Hydrology, 2003, cited in National Association of Forest Industries and Timber Communities Australia, 2004.

⁶ In September 2014, as part of a renewed Australian government funding contribution, and after 11 years of operation, the Bushfire CRC closed. Its successor is the Bushfires and Natural Hazards CRC.

- management. Canberra, Commonwealth of Australia.
- Fagg, P., Lutze, M., Slijkerman, C., Ryan, M. & Bassett, O.** 2013. Silvicultural recovery in ash forests following three recent large bushfires in Victoria. *Australian Forestry*, 76(3–4), 140–155.
- FAO.** 2006. *Fire management: voluntary guidelines. Principles and strategic actions.* Fire Management Working Paper 17. Rome.
- Goldammer, J.G. (ed.)** 2013. Prescribed burning in Russia and neighbouring temperate-boreal Eurasia. Global Fire Monitoring Center (GFMC), Kessel Publishing House.
- Griffiths, T.** 2009. *We have still not lived long enough.* Online document (available at <http://inside.org.au/we-have-still-not-lived-long-enough/>).
- Hennessy, K., Lucas, C., Nicholls, N., Bathols, J., Suppiah, R. & Ricketts, J.** 2006. *Climate change impacts on fire-weather in south-east Australia.* Aspendale, Victoria, CSIRO Marine and Atmospheric Research, Bushfire CRC and Australian Bureau of Meteorology.
- Jones, R.** 1969. Fire-stick farming. *Australian Natural History*, 16, 224–228.
- National Association of Forest Industries & Timber Communities Australia.** 2004. *Joint submission to the [Australian] National Water Initiative.* presented to the Fifth International Wildland Fire Conference, 9–13 May, Sun City, South Africa (available at www.wildfire2011.org/presentations.php?lnk=5).
- Parliament of Victoria.** 2010. *2009 Victorian Bushfires Royal Commission.* Final report. Volumes 1–3. Melbourne, Parliament of Victoria.
- Poynter, M.** 2012. *Logging and bushfires.* Online opinion (available at www.onlineopinion.com.au/view.asp?article=13164&page=1).
- Pyne, S.** 2006. *The still-burning bush.* Melbourne, Australia, Scribe Short Books.
- State of Victoria.** 2006. *Code of practice for fire management on public land.* Revision No. 1. Melbourne, Australia, Department of Sustainability and Environment.
- Tolhurst, K.G.** 2004. *Changing our perception of fire in the environment.* Paper presented to the National Conference of Parliamentary Environment and Public Works Committees, 11–14 July 2004, Melbourne and Lorne, Australia.
- Tolhurst, K.G. & Cheney, N.P.** 1999. *Synopsis of the knowledge used in prescribed burning in Victoria.* Melbourne, Australia, Department of Natural Resources and Environment.
- Wareing, K. & Flinn, D.** 2003. *The Victorian Alpine fires January–March 2003.* Melbourne, Australia, Department of Sustainability and Environment.
- Williams, J.T.** 2011. *Findings and implications from a coarse-scale global assessment of recent selected mega-fires.* Plenary paper presented to the Fifth International Wildland Fire Conference, 9–13 May, Sun City, South Africa (available at www.wildfire2011.org/presentations.php?lnk=5).
- Williams, J.T.** 2013. Exploring the onset of high-impact mega-fires through a forest land management prism. *Forest Ecology and Management*, 294, 4–10.
- Williams, J.T.** 2014. *Between a rock and a hard place: growing wildfire threats and the urgency to adapt protection strategies.* Paper presented to the Large Wildland Fires: Social, Political and Ecological Effects Conference, 19–23 May, Missoula, Montana, USA.
- Wrigley, J. & Fagg, M.** 2010. *Eucalypts: A celebration.* Crows Nest, New South Wales, Allen & Unwin. ♦

Fires in nuclear forests: silent threats to the environment and human security

S.V. Zibtsev, J.G. Goldammer, S. Robinson and O.A. Borsuk



© MATT SHALVATIS

In the Chernobyl Exclusion Zone, forest and fire management need to be strengthened to reduce the risk of wildfire and corresponding radiation exposure.

Sergiy V. Zibtsev is Head of the Regional Eastern European Fire Monitoring Center (REEFMC), National University of Life and Environmental Sciences of Ukraine (NULESU), Kiev, Ukraine.

Johann Georg Goldammer is Head of the Global Fire Monitoring Center (GFMC), Freiburg, Germany.

Stephan Robinson is Unit Manager (Water, Legacy) with the Green Cross Switzerland, Zurich, Switzerland.

Olexandr A. Borsuk is Junior Researcher with the Regional Eastern European Fire Monitoring Center (REEFMC), National University of Life and Environmental Sciences of Ukraine (NULESU), Kiev, Ukraine.

Over recent decades, a number of nuclear accidents resulting in radioactive contamination of large areas of forest land have occurred in different parts of the world. The growing number of new nuclear power plants implies an increasing risk of similar events in the future. This article analyses wildfire risks and hazards for firefighters and persons working in the Chernobyl Exclusion Zone (CEZ), and for the environment, as well as the specificities of current fire management in the best documented case – which is the CEZ. In the CEZ, insufficient forest and fire management during the past 28 years, along with dead wood due to insects and diseases, has resulted in a high wildfire hazard in the 260 000 ha of forests and grasslands of

the Ukrainian part, an area that is highly contaminated with long-living radionuclides of plutonium (^{238}Pu , $^{239+240}\text{Pu}$, ^{241}Pu), ^{241}Am , ^{137}Cs and ^{90}Sr . Up to 9000 ha of pine forests are completely dead and are in the highest wildfire risk category. In most of the middle-aged pine plantations, 9–20 percent of trees have already died, and another 31 percent are expected to die during the next decade. Combined with the fact that nuclear radiation leads to a decreased speed of decomposition of dead organic material, this development will increase available fuel and the corresponding wildfire hazard. The numerous wildfires that have already occurred in the

Above: View of the Chernobyl reactor, 2012

CEZ, including the catastrophic fires of 1992 (17 000 ha), have revealed the existence of ignition sources across the whole CEZ, including in the most contaminated areas. Fire prevention and suppression activities pose serious risks for firefighters, who may reach their annual radiation dose limit over a relatively small number of days. In addition, the current management infrastructure is inadequate to mitigate existing and future wildfire risks. Recommendations for urgent steps to improve fire management in the CEZ are therefore proposed.

HISTORY OF NUCLEAR ACCIDENTS

Since the 1950s, three major nuclear incidents have led to wide-scale radioactive contamination of the environment: releases from the Mayak Production Association in the Chelyabinsk region (Southern Ural Mountains), Russia (Trabalka, Eyman and Auerbach, 1980); the Chernobyl Nuclear Power Plant (NPP), USSR (1986); and the Fukushima NPP (2011) (Steinhauser, Brandl and Johnson, 2014). In the last two cases, exclusion zones were established for the most contaminated areas around the damaged reactors.

In addition, a number of minor nuclear incidents have occurred, including the Three Mile Island NPP accident in 1979, where major environmental contamination was averted. However, the rapid growth in new nuclear energy facilities, particularly in the Asia–Pacific area is leading to an increasing probability of accidents in the future and therefore calls for better documentation of available experience on the management of existing radioactive contaminated territories. The Chernobyl NPP disaster is the best studied of all the disasters mentioned above and will therefore be discussed in the following in more detail.

THE CHERNOBYL ACCIDENT AND ENVIRONMENTAL CONTAMINATION

An explosion in reactor No. 4 of the Chernobyl Nuclear Power Plant in northern

Ukraine on 26 April 1986 resulted in the release of up to 12 000 PBq¹ of radioactive material into the environment (IAEA, 1996). Twenty-eight years after the disaster, radioactive contamination continues to be an important environmental issue in Ukraine, Belarus and Russia. Shortly after the explosion, residents were permanently evacuated from the most contaminated 30-km radius zone around the plant, a zone that in 1996 was extended along the western contamination path. This area has been designated as the Chernobyl Exclusion Zone (CEZ). The radioactive elements ¹³⁷Cs and ⁹⁰Sr, with a half-life period of 30 and 29 years respectively, are amongst the most widely spread. Because of their physical-chemical properties, they are the most likely to affect human health. The 10-km zone surrounding the Chernobyl NPP is in addition highly contaminated by plutonium,² with half-life times ranging from around one hundred to thousands of years. The radioactive decay of ²⁴¹Pu will generate contamination by another radionuclide of significance to human health, ²⁴¹Am, which is expected to increase over the next 100 years (IAEA, 2006).

ESTABLISHMENT OF THE CEZ

The main reasons for establishing the CEZ in 1986 were to restrict exposure of the population to contaminated areas and to enforce a special protection regime to minimize propagation of radionuclides outside the zone. An automated system (ASKRO), using 39 sensors, was established to monitor aerial radioactivity. The system covers the core of the CEZ. An additional environmental monitoring system was established to monitor the level of radioactive contamination of soils, underground and open water, vegetation and wildlife.

Spring floods of the Prypiat River³ and vegetation fires are the two most important factors that contribute to the migration of radionuclides outside the CEZ.

To prevent the washing out of radionuclides during spring floods, artificial dams

were built along the most contaminated locations of the Prypiat River. It has been observed that radionuclides still migrate with floodwater during spring time, although this poses a relatively low threat to the population due to a high level of dilution with clean water.

The significance of wildfires as a threat was fully realized only six years after the accident, when large and numerous wildfires in August 1992 burned up to 17 000 ha of contaminated forests and grasslands. Some of the fires crossed the border into Belarus and spread into the Belarusian part of the CEZ. Following these catastrophic wildfires, the specialized Chernobyl Forestry Enterprise, with a total staff of 400, was established to carry out forest and fire management in the CEZ and prevent the migration of radionuclides out of the zone.

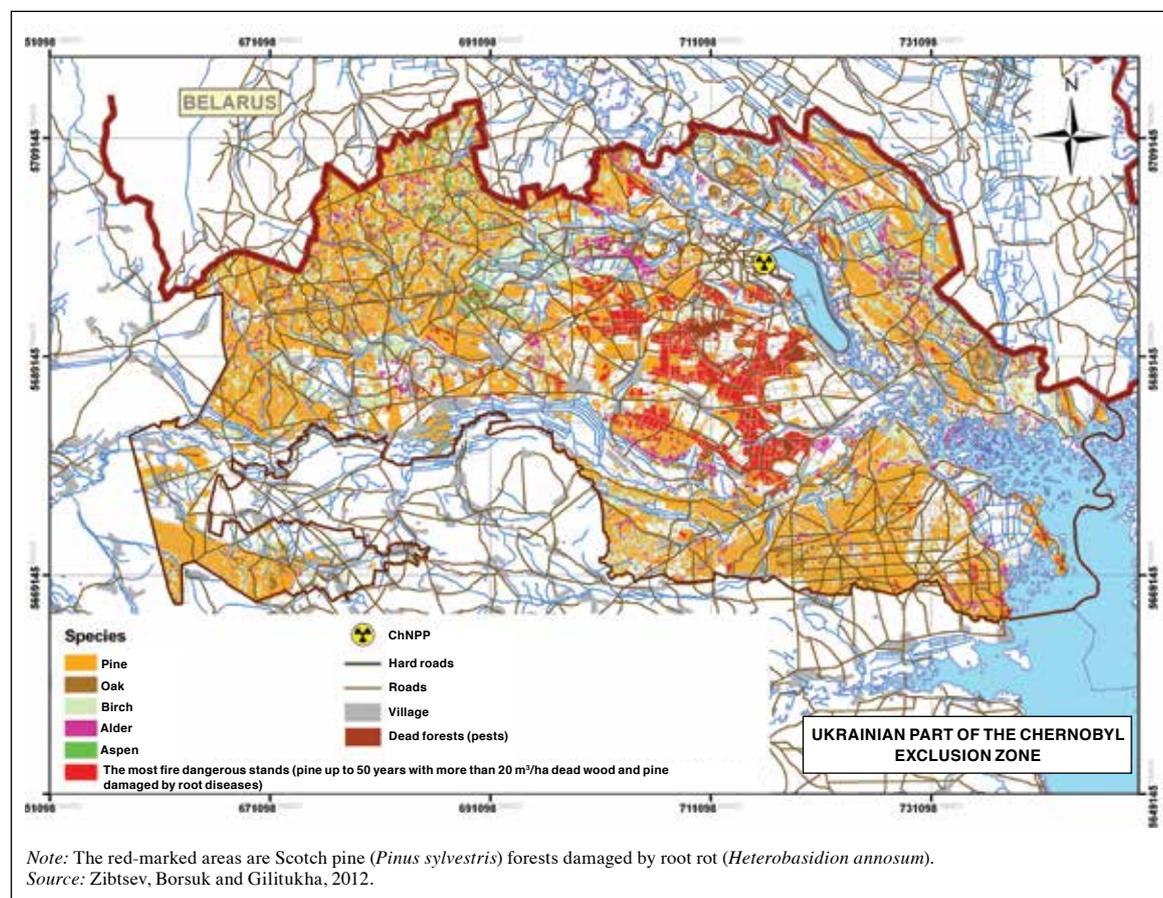
NATURAL CONDITIONS, FORESTS AND LAND USE IN THE CEZ

Before the Chernobyl NPP accident, land use in the current territory of the CEZ was equally divided between agriculture and forestry. Now, all of the CEZ lands outside of the villages, the towns of Chernobyl and Prypiat, and the former NPP, have been categorized as “forest lands” and cover a total area of 240 000 ha. Of this, 150 000 ha (57 percent) is made up of forest, while some consists of grasslands. However, due to the natural regeneration of forests on former agricultural fields, especially in locations where disturbances of the grass layer have occurred, forest area is increasing, primarily in areas adjacent to forests. The CEZ is largely characterized by dry sandy soils (glacial outwash), and Scotch pine (*Pinus sylvestris*) forests therefore prevail, currently representing 89 000 ha, while other forest

¹ PBq = Peta-Becquerel = 10¹⁵ Becquerel.

² ²³⁸Pu, ²³⁹⁺²⁴⁰Pu, and ²⁴¹Pu will be referred to below as “plutonium”.

³ The Prypiat river flows past the Chernobyl NPP and its water has been used for cooling the nuclear reactors.



1
 Distribution
 of main forest
 species in the
 CEZ

lands are covered by deciduous softwoods (mostly *Betula pendula*, *Populus tremula* and *Alnus glutinosa* – 50 800 ha) and oak (*Quercus robur* – 7 500 ha) (Figure 1).

THINNING

Historically, more than 50 percent of the pine forests in the CEZ were monoculture plantations created in the 1950s and 1960s by a very dense scheme of planting (7 000 to 10 000 seedlings per ha). Since 1986, thinning operations have been dramatically reduced or completely abandoned in the majority of pine stands because of the present level of radiation.

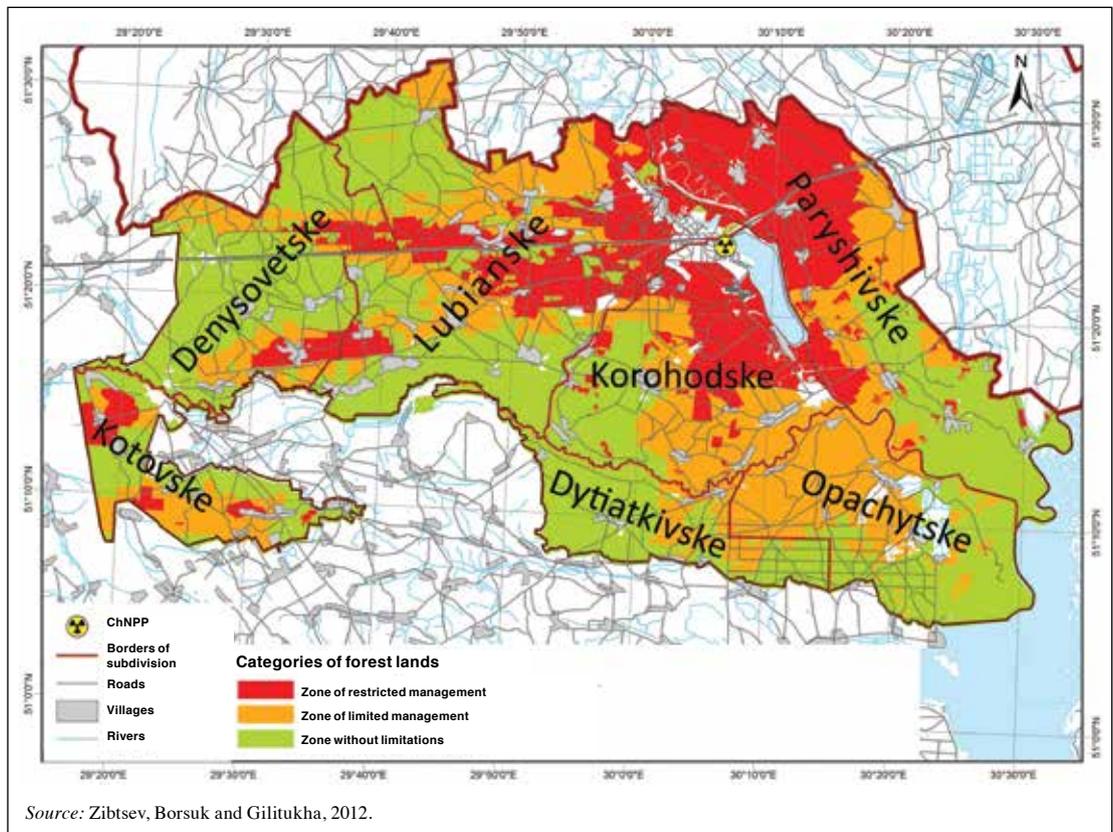
The latter has significant consequences for wildfire hazard. The magnitude of a wildfire depends on the amount of available fuel, which is essentially determined by the intensity of thinning and removal of debris. With reference to the 2006 Forest Management Plan for the CEZ,

a significant portion of planned silvicultural measures were not implemented due to a lack of funding and personnel. For example, between 2004 and 2006 only 50 percent of planned early thinning in young stands (up to 20 years old) was undertaken, in middle-aged stands only 20 percent, and in premature stands 20 percent. Timber from the last-mentioned type of thinning is of commercial use, primarily as pillars for coal mining. It needs to be underlined that silvicultural measures are only executed on sites approved by the Radiological Control Service of the CEZ (“Ecocenter”) if the contamination of the timber (roundwood without bark) is lower than the allowable threshold of 1 000 Bq/kg (Ukraine Ministry of Health Protection, 2005). Failure to carry out minimum silvicultural interventions in forests increases fuel loads and negatively impacts upon forest health.

FOREST HEALTH, INSECTS AND DISEASES

Massive outbreaks of the pine lappet moth (*Dendrolimus pini*) took place in the CEZ in 1997 and 2006, of the nun moth (*Lymantria monacha*) in 1995, and of the common pine sawfly (*Diprion pini*) in 2003. Due to a lack of effective protection measures, up to 8 500 ha in the most contaminated central part of the CEZ was damaged heavily by these insects. Another 12 300 ha were damaged by root rot (*Heterobasidion annosum* (Fr.) Bref.) (Figure 1). Forest inventory data show that 15 300 ha of forests in the CEZ have been damaged by different agents, including 5 300 ha by pests (Ukrderglisproekt, 2007). As a result, fire hazard in large areas of forest has increased substantially. Remote sensing data have confirmed that 9 000 ha of forest are completely dead due to fires and pests (Zibtsev and Gilitukha, 2012).

2
Locations of forest
ranger districts and
the different CEZ
contamination zones



DISTRIBUTION OF RADIONUCLIDES IN FORESTS

Threats to forest personnel, the population and the environment from radioactive vegetation fires in the CEZ depend on the distribution of contamination in fuel, contaminated volumes available, and types of fire. During the first month after the accident in late April 1986, radioactive fallout was deposited on the plant surfaces, especially on Scotch pine stands, since deciduous plants had not yet produced spring foliage. Within 4 to 6 months, most of the radionuclides had migrated into the ground, accumulating in mosses and soils. The vegetation root systems then gradually absorbed those radionuclides characterized by a higher chemical availability and mobility in the environment. Within three to four years, a stable state of radionuclide distribution in soil and vegetation cover was reached. Today, the concentration of each radioactive element

varies considerably between different components of the vegetation. Depending on site-specific characteristics and soil humidity, 70–85 percent of radionuclides are currently concentrated in the top soil layers of forests and grasslands, forest litter and mosses, and 15–30 percent are deposited in trees (bark, needles, timber and branches) or grasses (Zibtsev, 2004; Yoschenko *et al.*, 2006).

RADIOLOGICAL ZONING OF THE CEZ

For the purposes of forest and fire management, all CEZ forest lands were divided into seven forest ranger districts and into three zones of intensity of forest management and protection:

1. Zone of restricted management (no forest management activities): the most contaminated, core part of the CEZ (23.45 percent of forest lands; defined as the density of soil contamination by ^{137}Cs exceeding 3700 kBq/m², or

by ^{90}Sr exceeding 370 kBq/m², or by ^{239}Pu exceeding 11.1 kBq/m²);

2. Zone of limited management (31.20 percent of forest lands, thresholds for ^{137}Cs , ^{90}Sr and ^{239}Pu are 1480, 111, and 3.7 kBq/m², respectively);
3. Zone of normal management (45.35 percent of forest lands).

In every forest ranger district there are lands from all three zones ranging from high-contamination to low-contamination sites (Figure 2). Consequently, all forestry personnel of the Chernobyl Forest Enterprise are required to work in contaminated forest areas. If forest ranger districts were instead delineated on the basis of radiological contamination criteria, it would allow at least a third of current forest personnel to work in relatively clean and safe forests. Furthermore, staff working in contaminated areas need to be trained more specifically on radiation protection, receive special equipment and be part of a special medical surveillance programme.



© SERGIY ZIBTSEV

© SERGIY ZIBTSEV

FUEL ACCUMULATION

An estimated 1.4 million m³ of dead, radioactively contaminated wood that could fuel wildfires has accumulated in the CEZ. Forecasts predict that the quantity of contaminated dead wood will increase to 2.4 million m³ by 2020 (Zibtsev, 2013). Overcrowding of forests is weakening trees and increasing wildfire hazard (cf. next section on fire hazard). As of 2014, 6–20 percent of trees are dead but still standing in middle-aged stands. The dieback of another 8–31 percent is expected over the next 5–10 years. Most of the pine plantations are at a stage of minimum increment due to the competition for space, light and nutrition between trees in stands. The amount of downed and standing deadwood in the CEZ is estimated at 9–26 m³/ha. The total stock of forest combustible materials in pine stands ranges from 110 t/ha in 22-year old stands to 220–280 t/ha in 44–64-year old stands. Of these, 13–16 percent is ground fuel and 84–87 percent is above ground. Ground fuel is made up of forest litter (89–92 percent), woody debris (8–10 percent), and living forest vegetation (up to 1 percent).

FIRE HAZARD

The level of fire hazard of forest lands in the CEZ is assessed according to the official “Scale for assessment of natural fire hazard of forest lands”, approved by the State Agency of Forest Resources of Ukraine (Rating scale, 2005). The Scale

includes five classes (Hazard Class I – maximum; Hazard Class V – minimum) and takes radioactive contamination into account. In particular, Class I fire hazards include all conifer forests less than 40 years old, all conifers on dry and sandy soils, sites affected previously by fires, clearcuts, and grasslands (Figure 3).

According to official data, 66 percent of the forests belong to Fire Hazard Class I, of which 38 percent are lands contaminated with levels above 555 kBq/m² ¹³⁷Cs, and 13 percent of the forests belong to Class II. Forests with the highest natural fire hazard levels are concentrated in the central and southern parts of the CEZ, including the most contaminated territories west and northeast of the Chernobyl NPP (Figure 4).

WEATHER-BASED FIRE DANGER

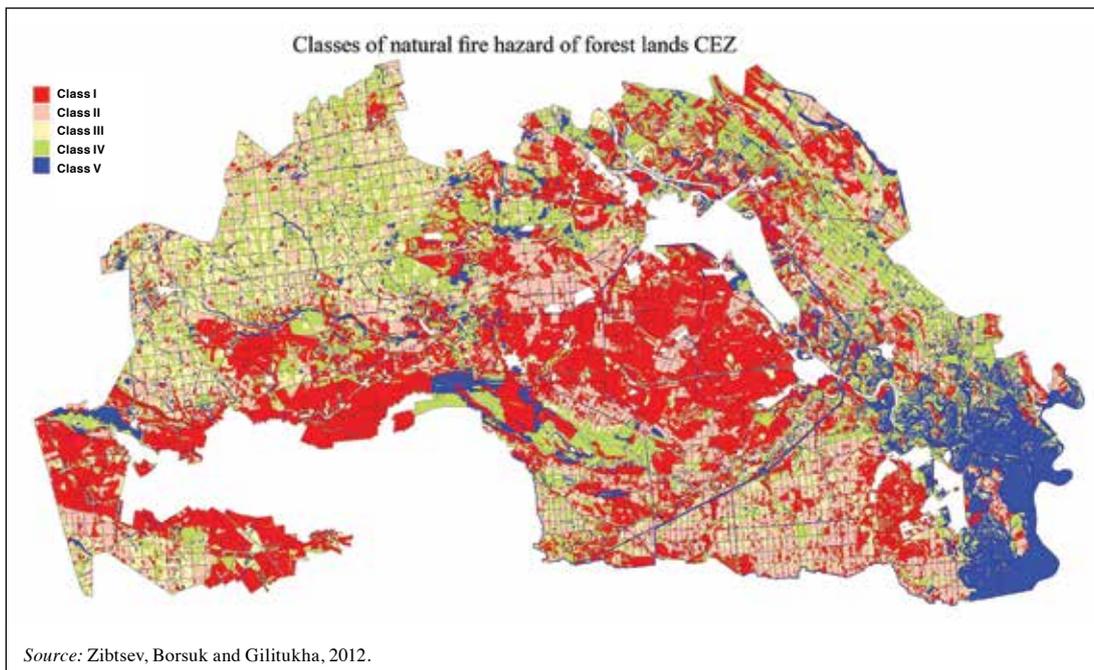
For the assessment of weather-based (meteorological) fire danger, a five-grade scale is

3
Example of a 35-year old Jack Pine (Pinus banksiana Lamb.) stand in the CEZ (Korogod forest ranger district) (left) and a 40-year old Scotch Pine (Pinus sylvestris L.) plantation (right) documented in August 2014, both classified as Fire Hazard Class I

used in Ukraine with Fire Danger Class V being the highest. The Fire Danger Class determines the level of preparedness of fire brigades and of the intensity of ground/air patrols for forests. However, a comparative analysis of fire history and official Fire Danger Classes based on a modified Nesterov Index reveals that the current early warning system does not reflect a realistic value of the fire-weather danger. A local fire danger scale based on the methodology by Kurbatsky (1963) was therefore developed for the CEZ (Zibtsev and Gilitukha, 2012) (Table 1). It includes a seasonal variation by introducing indices

TABLE 1. Comparative analysis of scales used in the current early warning system and the local scales proposed for the Chernobyl Exclusion Zone (CEZ)

Fire-weather Danger Class	Value of Ukrainian fire-weather indices (modified Nesterov Index)		
	Local scale of fire-weather danger proposed for the CEZ		Current early warning system used in Ukraine
	Spring–summer (10 March–10 June)	Summer–autumn (11 June–30 October)	
I	<250	<1400	<400
II	251–1000	1401–3550	401–1000
III	1001–2100	3551–5400	1001–3000
IV	2101–2800	5401–6400	3001–5000
V	>2800	>6400	>5000



4
Natural Fire Hazard Classes of forest lands in the Ukrainian part of the Chernobyl Exclusion Zone (Status: January 2013)

for a spring–summer and a summer–autumn period.

As can be seen from Table 1, the early warning system currently used makes a lower assessment of weather-determined fire danger, particularly for Fire Danger Classes IV and V (highest risk classes) during the summer-autumn period, whereas the official scale indicates a fire danger one class lower than that demonstrated by real fire occurrences. The reason is that during the development of the current system in 2011, no data was included from the large forest fires of 1992. Such data, however, will need to be taken into account in developing a new, local early warning system for the CEZ.

FIRE HISTORY

Forest and grass fires are regular occurrences in the CEZ despite the special territorial management regime which restricts access and land use. In 1986, the 10-km and 30-km zones around the Chernobyl NPP were fenced off and checkpoints controlled by police were established on the main access roads around the CEZ. Since then, however, fences have collapsed in some places

due to deterioration, wildlife or damage caused by people entering the CEZ illegally. According to the current rules, only professional staff of the CEZ (ca. 300 local managers and researchers) and officially guided tourists are allowed to enter the CEZ).

An analysis of fire history based on statistics available from the Chernobyl Forest Enterprise shows that over 1 147 forest and grasslands fires occurred in the CEZ between 1993 and 2013 (Figure 5).

The time and spatial distribution of the fires shows that they occur more or less regularly over the whole territory of the CEZ, including the most contaminated areas in the 10-km zone with the highest levels of ^{137}Cs , ^{90}Sr , plutonium, and ^{241}Am contamination. It is also clear that in the northern and north-eastern parts, fires have regularly crossed the borders between Ukraine and Belarus. Wildfires have been recorded in grasslands (55 percent), forests (33 percent), former villages and even in swamps during periods of drought. The highest fire occurrence is in spring, between March and May, but the risk of catastrophic fires is highest in the second part of the fire season (July and August), as in 1992. In that year,

crown fires burned up to 5 000 ha of forests, particularly in the south-eastern part of the CEZ in the Opachichi forest ranger district. Fires burning in Russia during the extreme heat wave of summer 2010 are another example of such a situation.

FIRE BREAKS

The forestry administration in the CEZ pays higher attention to the establishment of fire breaks than to other standard tools of fire prevention. According to recommendations by the Fire Management Plan (1994), a total of 111.9 km of fire breaks were established during the late 1990s, including 1.6 km of 10 m-wide breaks, 22.5 km of 11–20 m-wide breaks, 44.8 km of 21–30 m-wide breaks, and 43 km of breaks wider than 30 m. Fire breaks were placed mostly along the external perimeter of the CEZ and along main roads. It should be mentioned that since the 1990s, natural fire hazards in the CEZ have changed due to different types of disturbances (fires, wildlife, floods, natural succession, etc.). Most of the above-mentioned fire breaks are no longer maintained by regular removal of fuel and are therefore not able to stop fires. During the past decade,

mostly 1.6 m wide fire breaks were built with a total length of 1 750 km. These fire breaks are maintained 2–3 times per year by removing accumulated fuel.

However there is no digital map reflecting the current locations of fire breaks and the main criteria of their establishment is unknown. A special analysis is required to define the effectiveness of the current fire-breaks system to mitigate existing fire risks. This will enable the system to be optimized and reduce the risks of large wildfires.

THREATS TO FIREFIGHTERS AND FIRE MANAGEMENT PERSONNEL FROM RADIONUCLIDES CONTAINED IN SMOKE AND DUST

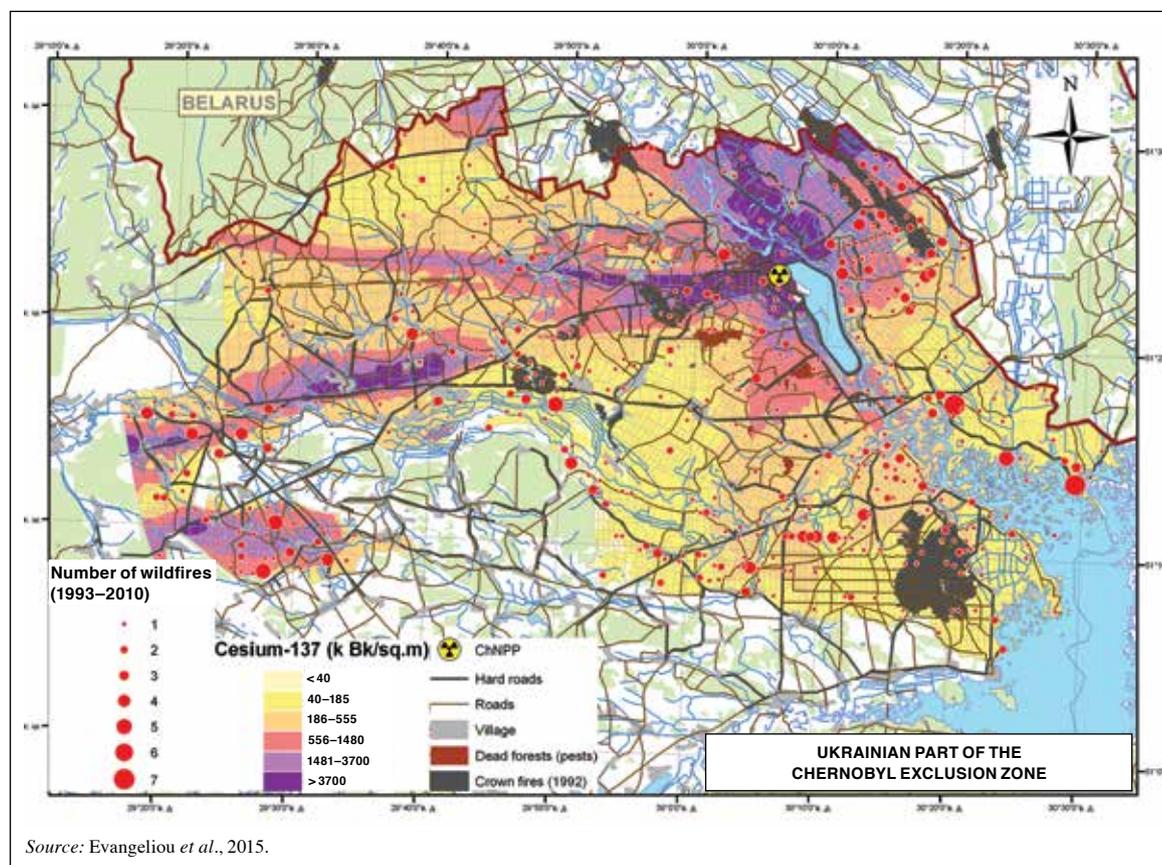
During forest fires in the exclusion zone, radionuclides deposited in forest fuel in 1986 are released into the atmosphere with smoke. Resuspension of ^{90}Sr , ^{137}Cs , and plutonium is occurring in two forms:

smoke particles and mineral dust. Dust particles are usually large (range: 2–100 μm in diameter; mean: $\sim 10 \mu\text{m}$) (Brasseur, Orlando and Tyndall, 1999) and redeposited close to the source. In contrast, forest and grassland fires emit fine particles with a bimodal size distribution of 0.04–0.07 μm and 0.1–0.3 μm (Chakrabarty *et al.*, 2006). While large particles are usually repelled by the respiratory system, fine particles are inhaled into the lungs. Over time, fine particles in smoke plumes often form large particles through coagulation and are deposited with cloud droplets downwind from the fires.

Data from the Automatic Radiation Monitoring System managed by the Ecological Center state enterprise show a clear increase in the concentration of radionuclides in the air in the CEZ during large wildfires. In particular, during the massive CEZ forest fires in the summer of 1992, an increase in the concentration of

airborne radionuclides from 0.017 Bq/m^3 to 1.5 Bq/m^3 was recorded in the town of Chernobyl, not far from the fire. The analysis of available information on the 1992 fire and inventories of radionuclides in the biomass burned showed that the ^{137}Cs -activity released into the air in this period was in the range of 28–130 TBq.⁴ Hence, wildfires with areas of up to 1 km^2 in forests with a level of soil contamination higher than 40 MBq/m^2 create a potential threat of air release and long-distance transport of up to 40 TBq of ^{137}Cs . Radioactivity levels in the air of ^{90}Sr , ^{137}Cs , and plutonium near an experimental forest fire and two grassland fires in the CEZ were found to be several orders of magnitude higher than normal levels (Yoschenko *et al.*, 2006). The radionuclides emitted, especially plutonium, were concentrated in fine particles, which would increase the inhalation risk

⁴ TBq = Tera-Becquerel = 10^{12} Becquerel



Source: Evangelidou *et al.*, 2015.

5 Distribution of wildfires (1993–2013) in different zones of radioactive contamination in the CEZ and location of forests killed by fires and pests

for firefighters. The worst case scenario (i.e. a catastrophic forest fire burning all fuel in the CEZ) shows a direct threat to the population and environment across a larger region. Radionuclides could migrate over a distance greater than 100 km, exposing the population to doses in excess of established limits (Hohl *et al.*, 2012; Evangeliou *et al.*, 2014). The risk of such catastrophic fires increases with climate change and appropriate measures should therefore be considered in emergency planning.

In 2013, an experimental assessment of doses from the resuspension of radionuclides for personnel involved in the establishment of fire breaks was undertaken (Yoschenko *et al.*, 2013). The research showed that the effective resuspension coefficient for all radionuclides, calculated for the air inside the cabin of the tractor, is of the order of 10^{-8} m^{-1} . This means that the air-conditioning system reduces the concentration of radionuclides by two orders of magnitude compared to the air outside the cabin. Internal doses to personnel in the cabin of a tractor during the establishment

of fire breaks (Figure 6) in the exclusion zone due to inhalation of radionuclides (calculated for a 50-year-old male person, effective dose equivalent) is more than twice as high as the external dose to the body. The inhalation dose is almost entirely due to the intake of transuranic elements. Inhalation doses for personnel located in the plume of dust or in a tractor cabin without an air-conditioning system will be up to two orders of magnitude higher than for staff protected by an air-conditioning system and can reach significant values. All these assessments show the importance and health benefit of cabin air filtering, as the dose contribution through inhalation is the most important pathway.

In the CEZ, the annual dose limit (5 mSv) for personnel involved in the establishment of fire breaks in areas with high contamination levels can be reached within a few weeks. At the moment, not all tractors in the CEZ are equipped with working air-conditioning systems, and air-conditioning systems are not always regularly maintained or new filters provided. In

conclusion, doses from inhalation should be taken into account during the planning of fire prevention measures in order to avoid personnel exceeding dose limits. Staying in the plume of dust and using tractors without air-conditioning should be avoided.

FIRE DETECTION

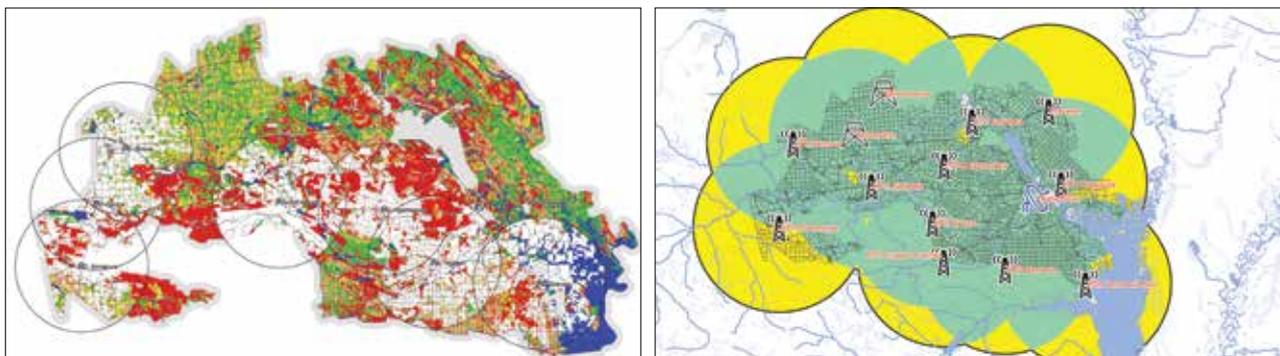
Fire detection on CEZ forest lands before 2009 was based on daily helicopter patrols at midday, detection from fire lookout towers and ground patrols during periods of high fire danger. During the past years, helicopters have no longer been available. Only seven lookout towers ($H = 35 \text{ m}$), all established before the failure of the Chernobyl reactor, are now used for fire detection across 260 000 ha of forest lands. However, most of them need repair or replacement. Spatial analysis shows that only 26.8 percent of the CEZ is covered by ground fire detection (Figure 7).

The left map reveals that large areas in the central, northern and eastern parts of the CEZ, which include highly contaminated



6
Establishment of fire breaks generates radioactive dust that can lead to an increase of inhalation doses for tractor drivers

© VASYL YOSCHENKO



Note: On the top map only the white-coloured territory is covered by fire detection (26.8 percent of the CEZ territory).
Source: Zibtsev, 2013.

lands with the highest levels of fire hazard, cannot be monitored from the existing towers. An improved monitoring system for early detection of fires in the CEZ must also include buffer zones to prevent the spread of grass and forest fires from outside the CEZ. In order to reduce the exposure of ground personnel to radiation, the lookout system should be based on automatic detection cameras and one receiving station connected to the dispatch center in the town of Chernobyl. However, a lack of funding, secure equipment and adequate power are the most important obstacles to implementing the proposed fire detection system.

ROADS

In general, the main paved roads in the CEZ connecting the town of Chernobyl with checkpoints and with the Chernobyl NPP are constantly maintained. These roads are used to transport local and international personnel and local villagers who live permanently in the CEZ; to deliver construction materials for Confinement II (new sarcophagus); and for overall nuclear infrastructure and territorial management (power lines, pipelines, etc.). Many of the roads to remote, abandoned villages (Cherevach, Rozsoha, Denisovich and others), however, are gradually deteriorating and may soon be unusable for wildfire

suppression purposes. Most of the abandoned forest roads are now blocked by downed trees and natural tree regeneration (Figure 8).

FIRE SUPPRESSION CAPACITY

The Chernobyl Forest state enterprise is responsible for prevention, patrolling, fire infrastructure maintenance and initial fire suppression in the CEZ. In the case of a fire larger than 5 ha, professional fire-fighters from the Chernobyl Fire Station

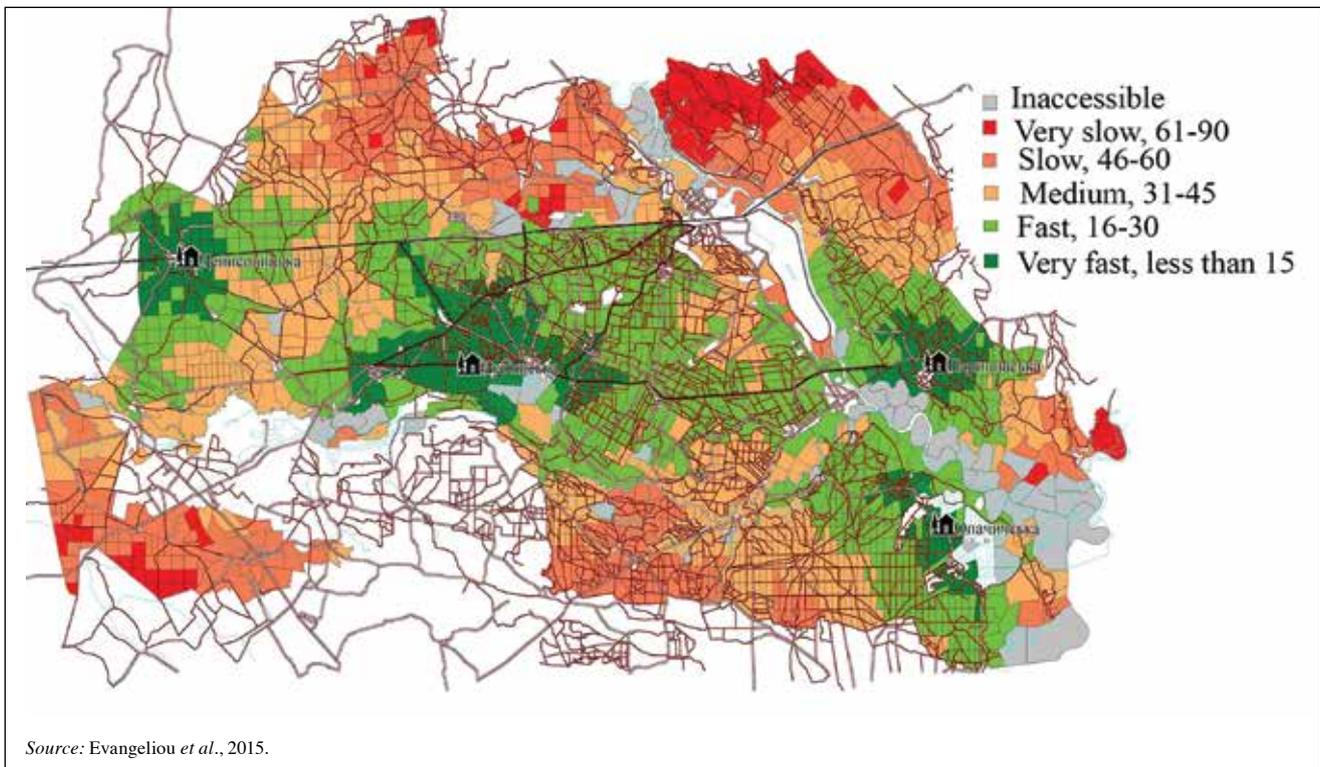
could also be involved. Common hand tools, water and the construction of fire lines around the fire are usually used for ground fire suppression. The total capacity for vegetation fire suppression

7
Current fire-detection coverage of the CEZ using the existing seven fire outlook towers (left). The proposed fire detection coverage (right) is based on 13 observation towers with a coverage range of a radius of 15 km each, and one receiving station



8
Downed trees and natural tree regeneration make forest roads inaccessible for fire suppression forces

© SHERIDY ZIBTSEV



includes four forest fire stations located in the central and southern parts of the CEZ (villages Denisovichi, Lubjanske, Paryshem, Opachichi) and seven points for hand tool storage which, however, do not coincide with the highest fire hazard areas. In total, only 33 permanent staff (firefighters and drivers), with 15 fire trucks (ZIL 131 with a capacity of four tonnes of water), 19 backpack pumps and hand tools (shovels and fire swatters) are available. The equipment does not even correspond to official Ukrainian minimum requirements for fire stations responsible for regular, non-contaminated forests. Water supply is provided by 16 fire ponds and points for replenishing water tanks.

To assess the effectiveness of the current placing of fire stations in the CEZ in terms of firefighter response time and water supply, a map was drawn up of the road networks reported officially in 2006, which could be used for fire suppression (Figure 9).

On the basis of a statistical analysis of response time from current fire stations,

the CEZ can be divided into six main zones (Table 2).

The interpretation of the efficiency assessment needs to take into account that the response time analysis was based on the road network as reported by the Forest Management Plan in 1996. Based on this road network analysis, only 40.9 percent of forest lands in the CEZ could be reached by fire brigades within 30 minutes, whereas to reach other sites, where 60 percent of

9
Zones with firefighter and fire truck response times (minutes) to potential fires from currently operating forest fire stations

the fires have occurred during the past decades, it would take up to 90 minutes. In addition, 6.9 percent of forest lands in the CEZ are completely inaccessible to ground transportation. Heavily contaminated lands in the central and northern parts of the zone are also in the category of lands with

TABLE 2. Response times from current fire stations to reach potential fire locations

	Efficiency of response	Time of arrival of firefighters (min)	Average time of arrival of firefighters (min)	Number of fires (1993-2012)	Area of the zone (ha)	Share of total CEZ area (%)
1	Very fast	<15	11	150	23 690	9.9
2	Fast	16–30	23	190	74 315	31.0
3	Medium	31–45	37	259	65 118	27.2
4	Slow	46–60	51	193	48 826	20.4
5	Very slow	61–90	66	28	11 112	4.6
6	Inaccessible	-	-	21	16 627	6.9
Weighted average / total			33	841	239 688	100.0

unsatisfactory response times (30 minutes and more). Furthermore, response time may now be much higher in many cases, as a number of roads from that time no longer exist.

RECOMMENDATIONS FOR URGENT STEPS TO IMPROVE FIRE MANAGEMENT

In light of the current state of wildfire risks, threats and fire management capacity in the CEZ, there is an obvious need to take proactive steps to prevent large fires and avoid overexposure of forestry and other personnel working in the CEZ, as well as secondary radioactive contamination of other territories over large distances. To achieve these goals, source risks need to be lowered, which means that fire management needs to be improved. The following plans should be developed and activities undertaken:

1. The CEZ fire management plan should be updated, taking into account current fire hazard, forest health, peculiarities of contamination, road and fire breaks network, fire history and fire response capacity. The fire management plan needs to be economically realistic and feasible.
2. An updated vegetation map of the CEZ should be drawn up, based on remote sensing data.
3. A local early warning system should be in place, as well as reliable automatic fire detection and fast response capacities for the CEZ.
4. A plan for the long-term reduction of fire hazards and fuel management is needed, based on silvicultural and forest utilization methods using harvester/forwarder machines properly equipped with filters to avoid inhalation doses for operators as well as strategically placed and regularly maintained firebreaks. In the long term, a strategy needs to be developed for the management and treatment of harvested, radioactive wood including consideration of special incineration facilities with associated nuclear waste

solidification and long-term storage capacities. Without such a long-term strategy, it will be difficult to manage forests and reduce fire risks through removal of dead wood.

5. A decision support system for fire suppression would allow the incident commander to control exposure time of firefighters on the fire line from the point of view of compliance with individual radioactive safety norms.
6. Methodologies should be established to assess fire behaviour and fire intensity, required amount of water, water delivery time and optimized routes for fire trucks.
7. Fire personnel of the Chernobyl Forest Enterprise should be properly trained and equipped to fight radioactive fires. Special fire suppression and incident management tactics aimed at reducing inhalation doses for firefighters as well as radiological health monitoring should be developed. ♦



References

- Brasseur, G.P., Orlando, J.J. & Tyndall, G.S.** 1999. *Atmospheric chemistry and global change*. New York, Oxford University Press.
- Chakrabarty, R.K., Moosmüller, H., Garro, M.A., Arnott, W.P., Walker, J., Susott, R.A., Babbitt, R.E., Wold, C.E., Lincoln, E.N. & Hao, W.M.** 2006. Emissions from the laboratory combustion of wildland fuels: particle morphology and size. *Journal of Geophysical Research*, 111(D7).
- Evangelio, N., Balkanski, Y., Cozic, A., Hao, W.M. & Möller, A.P.** 2014. Wildfires in Chernobyl-contaminated forests and risks to the population and the environment: a new nuclear disaster about to happen? *Environment International*, 73, 346–358.
- Evangelio, N., Balkanski, Y., Cozic, A., Hao, W.M., Mouillot, F., Thonicke, K., Paugam, R., Zibtsev, S., Mousseau, T.A., Wang, R., Poulter, B., Petkov, A., Yue, C., Cadule, P., Koffi, B., Kaiser, J.W. & Möller, A.P.** 2015. Fire evolution in the radioactive forests of Ukraine and Belarus: Future risks for the population and the environment. *Ecological Monographs*, 85(1), 49–72.
- Gilitukha, D., Zibtsev, S. & Borsuk, O.** 2011. Monitoring of forests damaged by fires and pests in the Chernobyl Exclusion Zone using remote sensing data. *Scientific Bulletin of the National University of Life and Environmental Sciences of Ukraine* (“Silviculture and Decorative Gardening” series), 164(3), 71–78 [Ukrainian].
- Hohl, A., Nicolai, A., Oliver, C., Melnychuk, D., Zibtsev, S., Goldammer, J.G. & Gulidov, V.** 2012. The human health effects of radioactive smoke from a catastrophic wildfire in the Chernobyl Exclusion Zone: a worst case scenario. *Earth Bioresources and Life Quality*, 1, 1–24 (available at <http://gcheraejournal.nubip.edu.ua/index.php/ebql/article/view/24>).
- IAEA.** 1996. *Ten years after Chernobyl: What do we really know?* Based on the proceedings of the IAEA/WHO/EC International Conference, Vienna, April 1996 (available at www-pub.iaea.org/MTCD/Publications/PDF/PiA51r_web.pdf).
- IAEA.** 2006. *Environmental consequences of the Chernobyl accident and their remediation: twenty years of experience*. Report of the Chernobyl forum expert group “Environment”. Vienna, Austria, International Atomic Energy Agency (available at www-pub.iaea.org/mtcd/publications/pdf/pub1239_web.pdf).
- Kurbatskiy, N.P.** 1963. *Wildfire danger in forest and its measurement at local scales. Forest fires and firefighting*. Moscow, Academy of Science of the USSR.
- Steinhauser, G., Brandl, A. & Johnson, T.** 2014. Comparison of the Chernobyl and Fukushima nuclear accidents: a review of the environmental impacts. *Science of the Total Environment*, 470–471, 800–817.
- Trabalka, J., Eyman, L. & Auerbach, S.** 1980. Analysis of the 1957–1958 Soviet nuclear accidents. *Science*, 209(4454), 345–353.
- Ukraine Ministry of Health Protection.** 2005. *Hygienic norms of specific activity*

- of radionuclides ^{137}Cs and ^{90}Sr in timber and products from timber. Decree of the Ukraine Ministry of Health Protection No. 573 (available at <http://zakon4.rada.gov.ua/laws/show/z1384-05>).
- Ukraine State Forestry Committee.** 2005. Rating scale of natural fire hazard of forest lands of Ukraine. In *Rules of fire safety in forests of Ukraine*. Order No. 278 from 27.12.2004. Ukraine State Forestry Committee.
- Ukrderglisproekt.** 2007. *Management plan for forests of the public enterprise "Chernobyl Forest" for the period 2006-2016*. Irpin city, Ukrderglisproekt.
- Yoschenko, V.I., Kashparov, V.A., Levchuk, S.E., Glukhovskiy, A.S., Khomutinin, Y.V., Protsak, V.P., Lundin, S.M. & Tschiersch, J.** 2006. Resuspension and redistribution of radionuclides during grassland and forest fires in the Chernobyl Exclusion Zone: Part II. Modeling the transport process. *Journal of Environmental Radioactivity*, 87(3), 260–278.
- Yoschenko, V., Protsak, V. & Levchuk, S.** 2013. Analysis of potential ways of irradiation of personal of CEZ involved in fire prevention measures. In S. Zibtsev, ed. *Scientific justification for the integrated fire management system in critical wildfire regions of Ukraine as the basis for biodiversity protection and maintaining of resilience of forest ecosystems*. Report on first year of research project of the Fire Laboratory of the Research Institute of Silviculture and Decorative Gardening of the National University of Life and Environmental Sciences of Ukraine, pp 98–116. Kyiv, NULESU.
- Zibtsev, S.** 2004. Comparative study of radionuclides accumulation in main tree species of central Polissia of Ukraine. *Scientific Bulletin of the National Agrarian University*, 71, 18–26.
- Zibtsev, S.** 2013. *Theoretical and methodological justification of forest monitoring in zones of radioactive contamination after disaster on Chernobyl Nuclear Station*. Autoreferat of the dissertation (summary) for the obtaining of Doctor of Sci. degree on Specialty 06.03.03. Forest Ecology and Applied Silviculture. Kyiv.
- Zibtsev S., Borsuk O. & Gilitukha D.** 2012. *Development of a scientifically based system of measures to reduce the risk of catastrophic forest fires in the zone of radioactive contamination after the Chernobyl disaster*. Report. Kyiv, NULESU.
- Zibtsev, S. & Gilitukha, D.** 2012. Development of a local scale for weather-based fire hazard for the Chernobyl Exclusion Zone. In S. Zibtsev, O. Borsuk & D. Gilitukha, *Development of a scientifically based system of measures to reduce the risk of catastrophic forest fires in the zone of radioactive contamination after the Chernobyl disaster*. Report. Kyiv, NULESU, pp 50–63. ♦

Additional information on fire management on contaminated terrain

The following web page of the Global Fire Monitoring Center (GFMC): http://www.fire.uni-freiburg.de/GlobalNetworks/SEEurope/SEEurope_1_radio.html includes an in-depth analysis of wildland fires and human security and a forthcoming (2015) report by the Organization for Security and Cooperation in Europe (OSCE) on firefighting safety on contaminated terrain:

Goldammer, J.G. 2013. Beyond climate change: Wildland fires and human security in cultural landscapes in transition – examples from temperate-boreal Eurasia. In J.G. Goldammer, ed. *Vegetation fires and global change: Challenges for concerted international action. A White Paper directed to the United Nations and international organizations*, pp. 285-311. Remagen, Global Fire Monitoring Center (GFMC) and Kessel Publishing.

Goldammer, J.G., Kashparov, V., Zibtsev, S. & Robinson, S. 2015. *State-of-the-art assessment of best practices on fire suppression in contaminated areas, including recommendations on radioactive and chemical safety of firefighters*. Organization for Security and Cooperation in Europe (OSCE) (in preparation).



Women's access to wood energy during conflict and displacement: lessons from Yei County, South Sudan

A. Thulstrup and W.J. Henry

The example of South Sudan, with its millions of displaced people, exposes the pressing need for sustainable supplies of woodfuel and efficient cooking technologies in the wake of emergencies, to ensure not only food security, health and safety but also environmental sustainability.

Andreas Thulstrup is Natural Resources Management Officer with FAO's Climate, Energy and Tenure Division.

Wani James Henry is National Natural Resources Officer with the FAO Representation in South Sudan.

Sub-Saharan Africa is particularly affected by acute emergencies and protracted crises, including both natural disasters and violent conflict. The region is also highly dependent on biomass as a source of domestic energy. In 2011, 81 percent of the population in the entire continent of Africa used woodfuel to boil and sterilize water (FAO, 2014a). According to the International Energy Agency (IEA, 2014), 79 percent of the population in sub-Saharan Africa rely on traditional biomass to cover their cooking needs (IEA, 2014). FAO (2014a) estimates that 63.1 percent of the population rely on woodfuel to cover

their cooking needs. Traditional biomass use refers to the use of fuelwood, charcoal, manure and crop residues for cooking (UNEP, 2014a). Biomass is a source of energy for many poor and rural populations, who often use these types of fuels inefficiently in open hearths or simple stoves and in poorly ventilated spaces for the purpose of cooking (UNEP, 2014a). Since women are in most cases responsible for cooking and procuring cooking fuel, they are by

Above: On the road between Nimule and the camp for Internally Displaced Persons (IDPs), women walk long distances for firewood

far the most affected by the detrimental impacts of inefficient fuel use on well-being.

Food is often provided by humanitarian actors as an immediate response to emergencies, but the importance of ensuring affected populations' access both to fuel for cooking and to efficient cooking technologies is often overlooked. Crisis-affected populations will in most cases – unless the food provided is ready to eat – require a source of energy to cook it. The need for cooking energy is especially urgent in emergencies for a number of reasons. When people are displaced and forced to settle in areas that already support host communities or are environmentally fragile, there is a risk of conflict over resources and of environmental degradation. Women and children are often forced to venture out of refugee/Internally Displaced Persons (IDP) camps in search of fuelwood. As a result, they may be exposed to harassment, violence and sexual assault perpetrated by men. The scarcer biomass resources are, the further women will have to walk

to collect fuelwood, thus increasing the likelihood of being attacked. When access to cooking fuel is constrained, there is also a higher risk of women undercooking food (WFP, 2012). In urban areas affected by emergencies, lack of access to fuel has even led some women to resort to the trading of sexual favours in exchange for fuelwood or charcoal (FAO, 2013). The high demand for fuelwood in emergency contexts can lead to environmental degradation in areas that host IDPs when supplies of dead wood are progressively exhausted and live trees are cut in an uncontrolled manner (ProAct, 2012). The environmental impact is often the most visible and lasting impact of informal and formal camps for displaced people (ProAct, 2012).

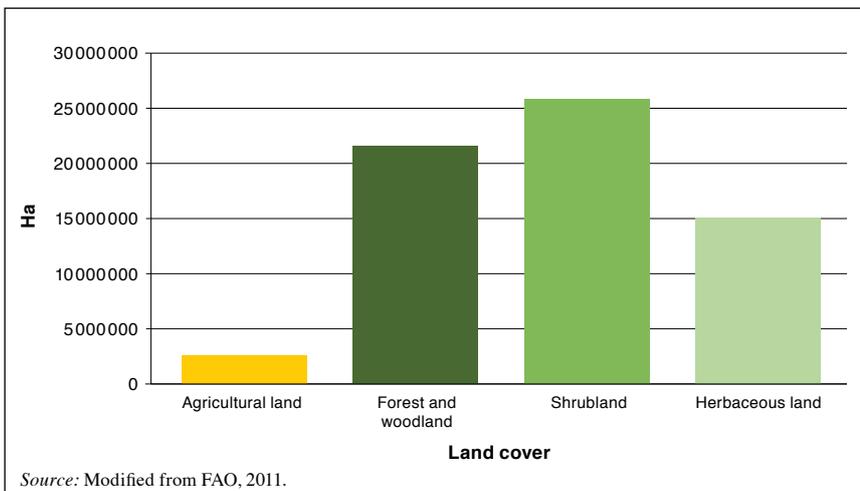
As part of efforts to reduce the environmental impact of an emergency, the provision of a stable and sustainable supply of fuel for cooking can help ensure that forests are not overexploited as a result of the concentration of displaced people and host communities. However, sustainable supplies of fuel are rarely available in conflict settings and would have to be provided by humanitarian actors from zones outside degraded forest areas. Rather

than focusing on fuel supply in acute emergencies characterized by violent conflict, environmental impacts can be addressed by changing the demand for woodfuel. The provision or local production of fuel-efficient stoves (FES) helps reduce the amount of wood and the time needed for cooking, which can allow women more time to engage in productive activities. The use of FES also reduces exposure to indoor air pollution, which constitutes a major health concern in many developing countries. Over 4 million premature deaths every year are attributed to indoor air pollution caused by the inefficient use of solid fuels (WHO, 2014). Finally, both the provision of cooking fuel and efficient cooking technologies help ensure that women do not venture out into unsafe areas in order to collect fuelwood.

The multisectoral challenges outlined above encompass environmental impacts, health, protection issues and livelihoods. Taking all of these into account, a United Nations Inter-Agency Standing Committee Task Force on Safe Access to Firewood and alternative Energy (SAFE TF) was established in 2007: it included UN agency members such as the Office of the United Nations High Commissioner for Refugees (UNHCR), World Food Programme (WFP), United Nations Children's Fund (UNICEF) and FAO. During its existence from 2007 to 2009, SAFE TF produced two guidance tools for field-based actors, including a decision-tree diagram for choosing an appropriate fuel strategy in acute emergencies and protracted crises, and a matrix on the roles and responsibilities of various agencies to ensure successful implementation of the strategy (WFP, 2012; FAO, 2013). Since 2010, the implementation of SAFE projects and activities has gained momentum. WFP – which originally co-chaired SAFE TF with UNHCR, InterAction and the Women's Refugee Commission (WRC) – has implemented SAFE projects in Ethiopia, Haiti, Kenya, Sri Lanka, the Sudan (Darfur) and Uganda (WFP, 2012). UNHCR is currently launching a SAFE global strategy which

Water supply is one of the many challenges for IDP camps. Here, people line up for clean drinking water provided by Oxfam



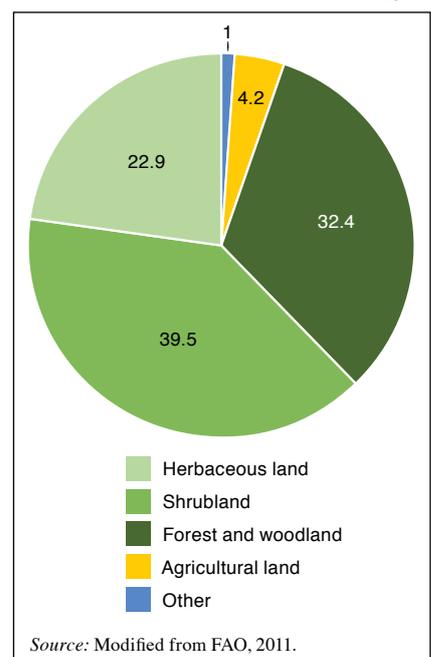


1
Land cover in South Sudan

South Sudan also has extensive and diverse forest and woodland resources that provide food, oils, medicines, timber and fuelwood (USAID, 2007). A study by FAO (2011) has provided an extensive overview of the annual and perennial vegetation found in South Sudan. The study involved a mapping of the country which divided South Sudan into land cover classes. The major classes and the size of the total land area are based on FAO (2005) and are shown in Figure 1.

The percentage of the total land area of South Sudan for each type of land cover is shown in Figure 2. Agricultural land encompasses agriculture in terrestrial and aquatic/regularly flooded land while forest and woodland refers to closed-to-sparse trees in terrestrial and aquatic/regularly flooded land. Shrubland and herbaceous land comprises closed-to-sparse shrubs and closed-to-sparse herbaceous land in terrestrial and aquatic/regularly flooded land, respectively.

2
Percentage of various land cover types



will be rolled out in selected countries from 2014 to 2018, many in sub-Saharan Africa (UNHCR, 2014).

This article examines some of the challenges outlined above in one of the world's youngest nations, the Republic of South Sudan. Having achieved independence and a short-lived peace after being embroiled in two civil wars, South Sudan is now on the brink of an emergency as a result of recent violence, in which the issue of access to energy is emerging as an important driver of both protection risks and environmental impacts. More than ever, there is a strong need to address the environmental and gender implications of the unfolding emergency in the country. The following sections of this paper examine the current linkages between energy needs and forest resources and present a case study of FAO's response.

NATURAL RESOURCES AND THE ENVIRONMENT IN SOUTH SUDAN

The independence of South Sudan, declared on 9 July 2011, was the culmination of a long peace process that started with the signing of the Comprehensive Peace Agreement (CPA) in 2005, bringing an end to the second civil war in Sudan which lasted 22 years (OECD, 2011). More than 2 million people were killed and over 4 million displaced due to the conflict, from the start of fighting in the early 1970s to the signing of the CPA

in 2005 (Haynes, 2007). South Sudan is now one of the youngest and poorest nations in the world. It also differs markedly from the Republic of the Sudan in terms of religion, ethnicity, infrastructure, financial resources, topography and natural resources.

South Sudan covers an area of 640 000 km² and is situated in the Nile catchment area, receiving water from highland areas of the Central African Republic, the Democratic Republic of the Congo (DRC), Ethiopia and Uganda (UNDP, 2012). The elevation of land in the country ranges from 600 to 3000 m above sea level (AfDB, 2013). While the Sudan consists mainly of deserts, semi-deserts and low-rainfall woodland savannah, most parts of South Sudan have a sub-humid climate (FAO, 2000; AfDB, 2013). The state of Western Equatoria and the highland parts of Eastern Equatoria receive the greatest amount of rainfall, which ranges from 1 200 to 2 200 mm annually, while the lowland areas of Eastern Equatoria, Jonglei, Upper Nile and Bahr el Ghazal receive 700–1 300 mm annually (AfDB, 2013). The south-eastern tip of Eastern Equatoria receives the least rainfall: about 200 mm per year (AfDB, 2013).

South Sudan has vast areas of wetlands and floodplains, such as the Sudd and the Machar Marshes, which constitute significant wildlife havens, especially for migratory waterfowl (UNEP, 2007).

Traditional charcoal making



© ANDREAS THULSTRUP

As shown in Figure 2, agricultural land constitutes only a little over 4 percent while forest and woodland take up 32.4 percent of the total land area. When adding shrubland, the total area with perennial vegetation cover constitutes an area of over 47 million ha and over 70 percent of the total land area. Earlier studies have estimated that only a small part of this area, 640 211 ha, consists of gazetted forests (USAID, 2007). The figures above indicate that a significant amount of wood-based resources exist that can potentially be used for domestic energy purposes. Over the course of a year, from 2011 to 2012, South Sudan produced 4 383 000 m³ of woodfuel, of which 244 000 m³ was charcoal (FAO, 2014b). While most of this was for domestic consumption, increasing amounts of charcoal are being exported to the Sudan and Uganda, and even reaching markets in the Middle East. According to the United Nations Environment Programme (UNEP, 2014b), other potential uses of forest resources have been considered.

The timber industry has been suggested as an important development opportunity for South Sudan, if managed sustainably and under stable and peaceful conditions. UNEP has estimated that teak plantations (*Tectona grandis*) alone could generate up to US\$50 million per year in export revenue (UNEP, 2014b).

Local communities play an important role in forest management and land use decision-making in South Sudan and almost all forests in the country are community forests (UNEP, 2014b). However, a significant amount of forest cover has been lost throughout the country (UNEP, 2014b). This development is recent. Over the course of both the first and second civil wars in Sudan, the pressure on natural resources was low due to depopulation in many areas and inaccessibility of certain zones due to mines in areas of what is now South Sudan (UNDP, 2012). USAID (2007) reported that there was an increase in vegetation density in Southern Sudan (now South Sudan) over the period of the war from 1982 to 1999.

THE IMPACTS OF VIOLENT CONFLICT AND FAO'S RESPONSE IN SOUTH SUDAN

The situation changed, at least partly, due to the signing of the CPA, after which millions of refugees returned to South Sudan from camps in Ethiopia, Kenya and Uganda (UNDP, 2012). Along with these returnees came an influx of Sudanese refugees. Fighting in the Blue Nile and South Kordofan states in the Sudan led to the flight of about 190 000 people to the Upper Nile and Unity states in South Sudan, where refugee populations far outnumber host populations (UNHCR, 2013). The annual deforestation rate has been estimated at 277 630 ha (UNDP, 2012). The main causes of loss of forest cover have been the clearing of land for cultivation or for roads and settlements and the production of charcoal (UNDP, 2012). Other sources also cite fuelwood extraction, brick production and collection of construction materials as major drivers of forest degradation (UNEP, 2014b). Competition over forest resources has also

led to conflict. Over the last two years, conflict over increasingly sparse forest resources has broken out in Maban County in Upper Nile state, where four refugee camps house 110 895 refugees from the Sudan (DDG, 2013). Women from these refugee camps are particularly vulnerable to assault when collecting fuelwood, and competition for forest resources has resulted in significant deforestation around the camps (DDG, 2013).

In addition to the impact of returnees and refugees, struggles along ethnic lines in South Sudan have recently evolved into a national humanitarian emergency. On the evening of 15 December 2013, fighting erupted in the South Sudan capital of Juba, initially among members of the Presidential Guard (UNMISS, 2014). The Sudan People's Liberation Army (SPLA) was subsequently divided into two factions, the forces in one faction being loyal to the government and President Salva Kiir Mayardit, from the Dinka ethnic group, and rebel forces in the other faction being loyal to former Vice-President Riek Machar, from the Nuer ethnic group. As a result of this split, fighting moved rapidly to various military installations and then into civilian neighbourhoods (UNMISS, 2014). The violence soon took on an ethnic dimension. Both sides have since been accused of human rights violations, including "extra-judicial killings, enforced disappearances, rape and other acts of sexual violence, arbitrary arrests and detention, targeted attacks against civilians not taking part in hostilities, violence aimed at spreading terror among the civilian population, and attacks on hospitals as well as personnel and objects involved in a peacekeeping mission" (UNMISS, 2014).

Fighting has been concentrated in the Jonglei, Unity and Upper Nile states, where state capitals have changed hands several times, in both urban and rural areas (UNMISS, 2014). However, all states are affected to some degree by the violence

and disruption to livelihoods. Overall in the country, about 1 million people are currently internally displaced and 4 million are in need of humanitarian assistance (OCHA, 2014a). Furthermore, in the most conflict-affected states, such as Jonglei, Upper Nile and Unity, the planting season has been disrupted. In addition, in many areas, people are still recovering from the effects of floods in 2013, making them particularly susceptible to food insecurity and malnutrition (OCHA, 2014b).

In response to the violence and subsequent humanitarian emergency, FAO began implementing its Emergency Livelihoods Response Programme (ELRP). This programme supports food security and livelihood responses by distributing emergency livelihood kits, protecting food production and availability in less affected areas, implementing emergency livestock response mechanisms, including the procurement of veterinary drugs and rehabilitation of cold chains, and reducing the environmental impact of improvised settlements for IDPs, including the provision of support for energy needs (FAO, 2014c). Many of FAO's development-oriented projects had been temporarily halted as a result of the violence, but some of these were subsequently incorporated

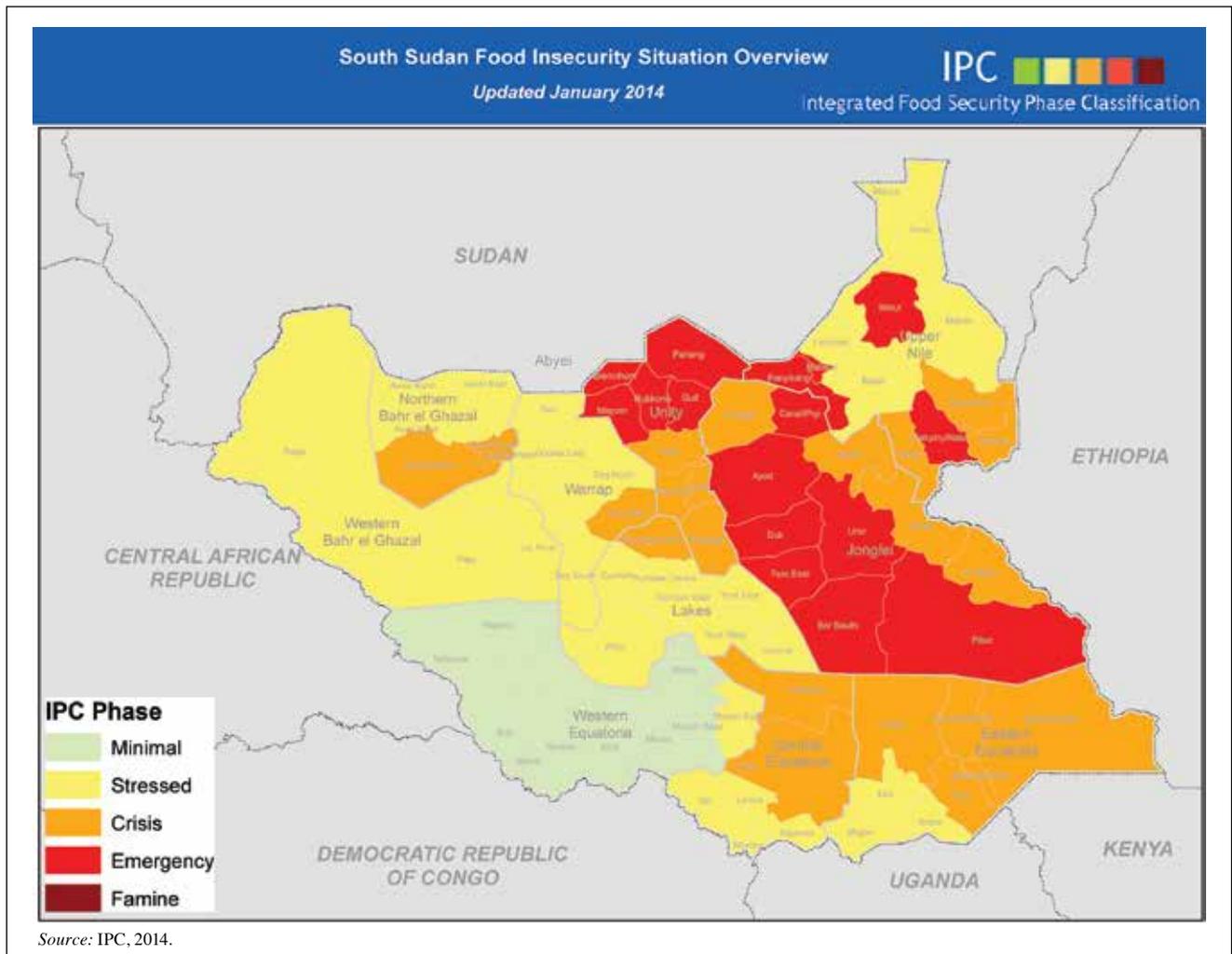
in the ELRP while a few were able to continue. One of the latter, entitled "Integrated Food Security Assistance to Returnees and their Host Communities in South Sudan", addresses the cooking energy needs of vulnerable people, women in particular, in Yei County near the capital, Juba.

Yei County is one of six counties in Central Equatoria. The capital, Yei, is located near the border with the DRC, 156 km southwest of Juba. Around 35 percent of the area of Central Equatoria state consists of forest and woodlands and the total area of perennial vegetation, including shrubland, covers 77 percent of the land area of the state. Agricultural land covers 8.6 percent of the land area, which is over twice the national average (FAO, 2011). Yei is the third largest county in Central Equatoria and covers an area of 669 909 ha of which 14 percent is used for agricultural production, much higher than the national average or the average for the state. Forests and woodlands alone cover 46 percent of the county area, which is much higher than the national average. Total forest area, including shrubland, covers 70 percent of the total area of the county, which is lower than the state average and similar to the national average (FAO, 2011).



Three-stone fire traditionally used in Yei County

© WANI JAMES HENRY



As of January 2014, Yei County was classified as a “stressed” county, according to the Integrated Food Security Phase Classification (IPC), unlike the majority of counties in Jonglei, Unity and Upper Nile which are classified as being in a state of “crisis” and “emergency” (IPC, 2014; see Figure 3 above).¹ Population groups, including IDPs, returnees and host communities in Yei County remain in a precarious situation but are less exposed to violence and food insecurity than the aforementioned states.

¹ The IPC classifies counties in South Sudan according to the severity and magnitude of food insecurity experienced. The categories for food insecurity are “minimal”, “stressed”, “crisis”, “emergency” and “famine”.

More than 94 percent of the communities in the county are dependent on woodfuel as a source of domestic energy (KFTC, 2013). The majority of households in the county collect fuelwood from nearby woodlands and shrubland. However, this pattern of fuelwood collection has been disrupted by the influx of returnees and the expansion of Yei town to rural areas. The overall impact has been a dwindling of forest areas traditionally reserved for the collection of fuelwood and other non-wood forest products. Access to biomass energy is becoming an increasing concern in Yei due to the high concentration of IDPs and refugees from the DRC.

If the issue of the access of women in Yei Country to a secure and efficient source of

energy, especially for cooking purposes, is not addressed, there will be a rapid increase in the risks they face, as they will need to walk longer distances in search of fuel sources. The environmental risk is also significant, and unchecked fuelwood exploitation from nearby woodlands may lead to deforestation and desertification in the mid- to long term. The traditional open fires or three-stone fires (see photo on previous page) used by women in Yei for cooking purposes are not only inefficient in terms of energy use but also unsafe since they generate indoor air pollution and can cause burns and scalds. Hence, addressing

3
*IPC classification of South Sudan
as of January 2014*

energy and woodfuel needs is an urgent priority for the communities in Yei County, which prompted them to request FAO's support in the development of lasting solutions. The communities highlighted access to FES and the establishment of agroforestry as key areas of collaboration with FAO and the Kagelu Forestry Training Center (KFTC), a government institution, on a SAFE project with funding from Japan. The project has targeted the most vulnerable members of the Mugwo, Otogo and Yei Block communities in the county, first and foremost women, as well as elderly, sick and disabled individuals.

Based on the result of a needs assessment carried out by communities in Yei and facilitated by FAO, a total of 20 women from women's organizations have been trained in the construction of FES. Two kinds of FES were selected by the communities: a portable ceramic charcoal stove and a stationary mud/brick stove which uses both fuelwood and charcoal as energy sources (see photos below). The mudstoves are constructed using local materials such as clay soil, bricks and sticks. Working together with the KFTC, community members and FAO constructed a total of 1 500 household stoves. The FES are low-cost and have had a very positive impact

in improvised settlements, IDP camps and with host communities in Yei County. The stoves have reduced the need for fuelwood and the burden and time spent collecting it. Fuelwood collectors in Yei – frequently women and children – are therefore now much less exposed to violence and sexual assault. Beneficiaries have also witnessed nutritional and health benefits since the stoves have reduced the risk of undercooking food to save fuelwood. In addition, those households that depend on purchasing fuelwood or charcoal will reduce their energy expenditures since the stoves are more efficient and use less woodfuel. Furthermore, if the stoves continue to be produced locally, they can provide a source of income for the women's groups that produce them and the skills acquired can be transferred to other women.

The project also addressed the fuel supply side through the establishment of woodlots and agroforestry. Beneficiaries received training to establish tree nurseries and subsequently establish woodlots with multipurpose tree species, used for fuel, shade, fodder, windbreaks and to improve soil fertility. The trees are also a means of restoring the surrounding environment and minimizing the long-term negative impact of large improvised encampments in Yei.

Some of the women who have begun to use the FES have already shared their experiences on a local radio programme, Radio Miraya's Monday Moi:

What I have seen is that it takes less fuelwood and sometimes smoke is not coming directly into your eyes and it cooks faster since you put the source in one side and the food in the other. Also, children will not get burnt when using the stove.

CONCLUSION AND RECOMMENDATIONS

There is a great need to recognize the importance of fuel for cooking, heating and other immediate needs in the context of humanitarian settings. Access to cooking fuel has implications for a range of sectors that influence livelihoods, the well-being of people, environmental sustainability and the overall resilience of crisis-affected populations to shocks. Because of the strong links between energy access and food security, livelihoods, environment,

Stoves which are now used by FAO beneficiaries in Yei County. On the left, the Rocket Lorena stove which uses both charcoal and fuelwood (smoke is directed outside the kitchen wall). On the right, the shielded-fire portable stove





© ANDREAS THULSTRUP

Tree nursery in Yei County

nutrition and health, emergency fuel response activities should be considered as life-saving interventions and have a firm place in emergency response procedures. These include the Multi-cluster Initial Rapid Assessment (MIRA), Post Disaster Needs Assessments (PDNA) and the Office for the Coordination of Humanitarian Affairs (OCHA) emergency cluster system itself, either as a cluster in its own right or in a cross-cutting role.

Successful energy interventions should ideally address both fuel supply and fuel demand, as the case study from Yei County shows. It has been possible to address longer-term issues in Yei, such as the sustained supply of woodfuel, because the county is relatively calm compared

to counties in other states. These types of interventions will also be very important in post-crisis and rehabilitation phases to ensure that communities are resilient in the face of future shocks.

It should be recognized that fuel supply activities may not always be possible in acute emergency settings where more phased approaches may be needed. In acute emergencies, where the displacement of people poses a risk to food security and environmental sustainability, a relevant starting point is the provision of fuel-efficient, durable and portable cookstoves for both displaced people and host communities. These can be deployed as an integral part of emergency kits for affected populations, while fuel can even be sourced from other areas, if feasible, in anticipation of

a more comprehensive fuel strategy after initial emergency response efforts.

Given that energy needs in humanitarian settings are associated with a range of sectors, it is very important that responses are well coordinated and that they draw upon the comparative advantages of various UN agencies and organizations. Hence, it is crucial that the members of the SAFE Steering Committee establish solid lines of communication and ensure coordination on the ground. This can be achieved through joint SAFE programming.

Providing context-specific and well-coordinated support that addresses the fuel supply and fuel technology needs of crisis-affected populations can help to provide stability and progress towards rehabilitation, recovery and resilience. ♦



References

- AfDB.** 2013. *South Sudan: An Infrastructure Action Plan – A Program for Sustained Strong Economic Growth*. Tunis, African Development Bank Group.
- DDG.** 2013. *Displacement, disharmony and disillusion. Understanding host–refugee tensions in Maban County, South Sudan*. Copenhagen, Danish Demining Group.
- FAO.** 2000. Country Pasture/Forage Resource Profiles: Sudan (available at <http://www.fao.org/ag/AGP/AGPC/doc/Counprof/sudan/sudan.htm>).
- FAO.** 2005. *Land cover classification system: classification concepts and user manual*. Rome.
- FAO.** 2011. *Land cover atlas of the Republic of South Sudan*. Rome.
- FAO.** 2013. *Guidance Note on Safe Access to Firewood and Alternative Energy in Humanitarian Settings*. Rome (available at http://www.fao.org/fileadmin/user_upload/emergencies/docs/Guidance%20Note%20Safe.pdf).
- FAO.** 2014a. *State of the World's Forests 2014*. Rome (available at <http://www.fao.org/forestry/sofo/en/>).
- FAO.** 2014b. FAOSTAT (available at <http://faostat.fao.org/>).
- FAO.** 2014c. Urgent Appeal. FAO's role in the Revised South Sudan Crisis Response Plan (January–June 2014) (available at http://www.fao.org/fileadmin/user_upload/emergencies/docs/FAO%20Component%20of%20Revised%20South%20Sudan%20Response%20Plan.pdf).
- Haynes, J.** 2007. Religion, ethnicity and civil war in Africa: the cases of Uganda and Sudan. *The Round Table: The Commonwealth Journal of International Affairs*, 96(390): 305–317.
- IEA.** 2014. World Energy Outlook Energy Access database. URL: <http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/>.
- IPC (Integrated Food Security Phase Classification).** 2014. *Current Acute Food Insecurity Overview in South Sudan January 2014*. IPC (available at <http://www.ipcinfo.org/ipcinfo-detail-forms/ipcinfo-map-detail/en/c/216180/>).
- KFTC.** 2013. *Fuelwood Assessment Report*. Juba, Kagelu Forestry Training Center.
- OCHA.** 2014a. *South Sudan* (available at <http://www.unocha.org/south-sudan/>).
- OCHA.** 2014b. *South Sudan: last chance to prevent famine* (available at <http://www.unocha.org/top-stories/all-stories/south-sudan-last-chance-prevent-famine>).
- OECD.** 2011. *Report on International Engagement in Fragile States: Republic of South Sudan*. Paris, OECD Publishing.
- ProAct.** 2012. *Alternative domestic energy options for Darfur: a review*. Nairobi, UNEP.
- UNDP.** 2012. *Environmental impacts risks and opportunities assessment: natural resources management and climate change in South Sudan*. Juba.
- UNEP.** 2007. *Sudan Post-Conflict Environmental Assessment*. Nairobi, UNEP.
- UNEP.** 2014a. Traditional use of biomass (available at <http://www.unep.org/climatechange/mitigation/Bioenergy/Issues/TraditionaluseofBiomass/tabid/29473/Default.aspx>).
- UNEP.** 2014b. Community forestry (available at <http://www.unep.org/disastersandconflicts/CountryOperations/southsudan/CommunityForestry/tabid/79281/Default.aspx>).
- UNHCR.** 2013. *Towards an environmental strategy for Sudanese refugee hosting areas in Upper Nile and Unity States, South Sudan: environmental inception mission 4–22 June 2013*. Evillard, Switzerland, Adansonia-Consulting.
- UNHCR.** 2014. *Global Strategy for Safe Access to Fuel and Energy (SAFE): a UNHCR strategy 2014–2018*. Geneva.
- UNMISS (United Nations Mission in South Sudan).** 2014. *Conflict in South Sudan: a Human Rights Report*. Juba.
- USAID.** 2007. *Southern Sudan environmental threats and opportunities assessment: biodiversity and tropical forest assessment*. Washington D.C., International Resources Group.
- WFP.** 2012. *WFP Handbook on Safe Access to Firewood and Alternative Energy (SAFE)*. Rome.
- WHO.** 2014. Household air pollution and health (available at <http://www.who.int/mediacentre/factsheets/fs292/en/>). ♦

Effects of the current crisis and war in South Sudan on access to forest foods in Greater Akobo

A. Thulstrup and W.J. Henry

Balanites aegyptiaca can play a critical role in food security, but the gathering of its fruits and leaves has been disrupted by the conflict.

Fructing branches of the desert date, *Balanites aegyptiaca*



© MARCO SCHMIDT

For their food and livelihoods, the Lou Nuer people of South Sudan rely mainly on cattle-rearing and crops like sorghum, maize, pumpkins and other vegetables, which are cultivated mainly in the rainy season. These and other livelihood activities depend on people's access to land and associated natural resources such as soils, water, forests/woodlands, wetland, wildlife and fisheries. Land is not only a means of earning a livelihood but is also a source of wealth, tribal belonging and conflicts.

Traditionally, the Lou Nuer people treasure the forests/woodlands for the products they provide for both livestock and human consumption. The food gathered from these areas is mainly in the form of seeds, leaves, nuts and fruits. These forest foods are not only important in terms of their dietary value; their availability in times of food scarcity, especially during the dry season when there is inadequate rainfall to support crop production, makes them essential.

One particular tree treasured among the Lou Nuer is the *Balanites aegyptiaca*, which

is used for food both by humans and livestock and is critical in moments of scarcity. *B. aegyptiaca* is a fruit-bearing tree found in the Sudano-Sahelian region of Africa, in the Middle East and in South Asia. The Lou Nuer people call it *thou* and consume mainly the pulp of its fruits as snacks and the leaves as vegetables. The kernels are boiled and eaten directly or used for extracting oils. In addition to its value as a source of food, *B. aegyptiaca* has high medicinal value. In particular, the fruits, the kernels and the leaves have many medicinal uses. Being an evergreen tree in the dry Sudano-Sahelian region, *B. aegyptiaca* is also valued for its shade, particularly for animals in the dry season, when most other trees shed their leaves. The tree is often retained in farmers' fields as recognition of its intercropping potential. The tree also has strong spiritual value for some communities in the Sahelian region. It is considered a symbol of blessing for newly married couples or women after the birth of a baby.

The various edible parts of *B. aegyptiaca* are collected at different times of year. Leaves are usually collected from November to January while the fruit is collected from February to April. These are periods where there is no rainfall and crop production comes to a halt. However, this normal pattern of gathering wild food has been greatly affected by the eight months of conflict in South Sudan. Traditionally, collection of edible parts from the *B. aegyptiaca* starts with trees located close to the homestead, after which collection continues to nearby woodlands which are often 2–4 km away. However, this unimpeded access to extensive land territory for pastures, water and forest food has been affected by the current insecurity as a result of the ongoing war.

The people in the area are in zones controlled by the rebels and have therefore been denied access to services and markets in the capital, Juba. The limited mobility of the community has resulted in depletion of nearby tree stands of *B. aegyptiaca*. As a result, the traditional gathering of its fruits and leaves – the community's main coping mechanism – has been critically compromised. ◆

Conflict and forest resources in Darfur

A. Oshiek



© FAO/SUDAN

There is growing concern in the Sudan about the impact of the Darfur conflict on natural resources, particularly forest resources.

The conflict in Darfur has resulted in the massive loss of human lives and assets. Already in 2008, the UN estimated (UNICEF, 2008) that between 200 000 and 300 000 people had died since the start of the conflict in 2003.

The protracted conflict has disturbed livelihoods and resulted in severe food insecurity in some areas. Outbreaks of violence have forced millions of people to flee from their homes and land, thereby becoming Internally Displaced Persons (IDPs) in camps. Some 2.5 million people are currently displaced as a consequence of the conflict, out of a total population of between 7 and 8 million.

IDPs and their hosting communities face limited livelihood options and often rely on

unsustainable coping strategies, such as the unmanaged cutting of trees and shrubs for fuelwood and charcoal production.

THE INTER-RELATIONSHIP BETWEEN CONFLICT AND NATURAL RESOURCES

Natural resources in Darfur prior to the conflict were flourishing and plentiful. Central and Southern Darfur were rich in forest products and valuable timbers such as mahogany (*Khaya senegalensis*). The Jebel Marra massif area has a special climate and soil characteristics which make it suitable for the production of several soft

Aisha Oshiek is Technical Officer with the FAO office in Sudan.

Above: Trained IDP women making a mud fuel-efficient stove in Zanzam IDP camp, North Darfur

wood species, including *Cupressus* and *Pinus*. These resources have been severely affected by over-exploitation and drought, and further aggravated by the conflict.

Traditional governance in Darfur has become increasingly weak. The tribal leadership had legal authority under the Native Administration system until 1971, when the system was abolished. In 1986, it was renewed but its role remained dependent on broader political and religious dynamics. Profound changes, such as the redrawing of state boundaries and breaking up of tribal homelands, have altered the tribal-political map, and inconsistent and weak tribal administrations have undermined traditional environmental management (Bromwich, 2008).

Indeed, environmental degradation may be a contributing cause of conflict, as highlighted by the UN University for Peace Conference on “Environmental degradation as a cause of conflict in Darfur”, held in Khartoum in December 2004. The conference noted that an increase in population density intensifies cropping and grazing, which can entail a deterioration in yields and carrying capacities. In turn, larger areas are needed to support the same yields and herds, while demands and herds are increasing. Herders and farmers are therefore in competition for access to resources, which may lead to conflict.

DEFORESTATION

The United Nations Environment Programme (UNEP)'s *Sudan post-conflict environmental assessment* (UNEP, 2007) has estimated that deforestation in Darfur is in excess of 1% per annum.

Several conflict-related factors have contributed to the removal of trees in Darfur. According to the Forests National Corporation, the three states of Darfur permitted the United Nations Mission in Darfur (UNAMID) forces to clear trees, establish camps, evict forest staff and occupy premises in some forest reserves, as well as hindering legal procedures against these acts. War and displaced populations in the states of Darfur have inflicted severe

damages on 23 forest reserves and extensive areas of *Faidherbia albida* forests in the regions of Jebel Marra. The worsening security situations and tribal conflicts have also facilitated the forests' deterioration process and the unauthorized trafficking of forest products.

In particular, the conflict and subsequent human displacement have led to a high energy demand. Darfur is characterized by a high urbanization rate, and the former urban/rural ratio of 20:80 has now been reversed. This, in turn, has created a huge demand for building materials, particularly red clay bricks, which are made in inefficient wood-fired kilns, exacerbating pressure on dwindling forest resources. Other reasons for the growth in energy needs relate to the sale of fuelwood and charcoal, social preferences for certain types of fuel and a growing population.

Environmental degradation often occurs in areas that host IDPs, as supplies of dead wood are progressively exhausted and live trees cut in an uncontrolled manner. Deforestation is often the most visible, serious and lasting impact of informal and formal camps for IDPs.

Furthermore, when IDPs finally return to their original domains they could be expected to use trees to rebuild and repair homes and properties; provide energy (for houses, restaurants and schools); support industry (brick-making, tobacco curing); and fence off agricultural holdings, livestock pens and backyard gardens.

DEMAND FOR WOODY BIOMASS

FAO (2011) conducted a Woodfuel Integrated Supply/Demand Overview Mapping (WISDOM) assessment and provided detailed information on woody biomass supply and demand. The total stock of woody biomass in Darfur states was estimated at 99.8 million m³, or 58.8 million oven-dry tonnes. The estimated mean annual increment, according to the medium productivity variant, was estimated at 7.9 million m³, or 4.6 million oven-dry tonnes. The physically accessible annual production was estimated

at 7.4 million m³, or 4.3 million oven-dry tonnes.

According to the analysis, the total annual consumption of woody biomass in 2011, according to the business-as-usual (BAU) consumption variant, all uses included, was estimated at 6.3 million m³, or 3.7 million oven-dry tonnes. With 93 percent of total woody biomass use, the household sector was by far the most important demand sector. This value was higher in rural areas (98 percent) and lower in urban areas (77 percent), where industrial uses are concentrated. Eighty-six percent of household consumption went to cooking and the rest to construction, maintenance and furniture. The cooking share was lower in rural areas (83 percent) and higher in urban areas (95 percent).

The building wave subsequent to the influx of the international community, which boosted brick production to extreme levels, has also had a long-lasting impact. The WISDOM study estimated an annual fuelwood consumption of over 118 000 m³ for this purpose, which is lower than the peak but still almost five times higher than the pre-war situation.

Annual consumption by the institutional, commercial and industrial sectors (bricks included) was estimated at 453 000 m³.

FUEL-EFFICIENT STOVES

Considerable attention has focused on domestic energy in Darfur, particularly since the start of conflict when the visible impacts of deforestation became prominent around major towns such as Nyala, which have attracted large numbers of IDPs.

Household energy use in Darfur is characterized by a continuing high dependence on fuelwood, most of which is unsustainably harvested and burnt on inefficient stoves, and humanitarian assistance packages typically do not include energy sources for cooking. IDP households face considerable pressure and challenges to satisfy their cooking energy needs and women run the risk of insecurity when collecting firewood; not to mention health risks associated with smoke from open

cooking fires, which affect women and children in particular.

As displaced people spend significant amounts of time, money and labour securing sufficient fuel to meet their cooking needs, and can often not afford petroleum products, the dissemination of fuel-efficient stoves (FES) is one of the ways to reduce the consumption of fuelwood. It has had good results in IDP camps, although it remains marginal in rural and urban areas. It is estimated that a widespread and intensive stove programme in rural and urban areas ("FES" consumption variant) could reduce total consumption of firewood by up to 1.2 million m³ (from 6.3 to 5.1 million m³, or from 3.7 to 3 million oven-dry tonnes).

FAO'S ROLE IN FOREST CONSERVATION AND ENERGY SAVING IN DISASTER AREAS IN DARFUR

Since the beginning of the conflict, FAO and other UN agencies, international non-governmental organizations (INGOs) and

non-governmental organizations (NGOs) have exerted considerable efforts to support conflict-affected communities in Darfur. FAO, in partnership with UNEP, has formulated and implemented many projects to contribute to reforestation and energy-saving, including the Darfur Timber and Energy Project, which was implemented successfully from January 2009 to December 2010. This project provided the original analysis of the wood energy situation in Darfur (FAO, 2010a). The 2011 update was carried out in the framework of the Sudan Institutional Capacity Programme: Food Security Information for Action (SIFSIA N) funded by multiple donors, including the European Commission.

The Timber and Energy project also succeeded in mobilizing governmental institutions and local communities to produce and distribute 815 590 seedlings to over 150 000 IDPs, and to host community and returnees' households in the three states of Darfur, as well as 760 community forest farmers. In addition, 16 community

forests/woodlots and committees were set up in North and West Darfur. Five training of trainers (TOT) sessions were conducted for 371 committee members, extension agents and local leaders on tree seedling production, husbandry and protection, nursery management and seed broadcasting. Women represented 40 percent of those involved in training on community forests and tree planting.

Special attention was given to FES, with 342 women trained as trainers in both the manufacturing and use of the mud-type FES. These women further trained another 50 611 women and 72 900 FES were produced and distributed to households in the three states of Darfur. These stoves use 30–60 percent of the quantity of fuelwood traditionally consumed by the widely-used three-stone fire (FAO, 2014). The final report of the Timber and Energy project estimated that each household consumed 12 medium-sized trees per year, i.e. that at least four medium-sized trees are saved annually by each household that uses an improved stove.



Community leaders (women and men) and teachers following a session on the importance of FES given by the Forest National Corporation (FNC)



*IDP woman from Morni Locality
taking her stove home*

FES can attenuate the negative impact of forest removal to meet the needs of the war-affected, IDPs and other vulnerable communities. In addition to their role in energy saving, these stoves also have an important gender dimension. Women and girls have the primary responsibility of cooking and collecting fuelwood for household use, frequently in insecure conditions, and in conflict situations are particularly vulnerable to gender-based violence while carrying out this task. In addition, women can earn an income from the production of FES.

To date, FAO continues to implement a number of other projects aiming at improving environmental protection and sustainable natural resource management (NRM) in Darfur through community

awareness raising, training on FES production and tree planting.

Overall, FAO is taking an integrated multisectoral approach to peace-building through improving food security and nutrition, livelihoods, environmental protection and sustainable NRM, for example through promoting dialogue between conflicting pastoral and farming communities and enhancing livelihoods and NRM in North and West Darfur. The impact of these initiatives is complementary to that of the FES and other NRM activities. This approach is at the heart of FAO's Strategic Framework Country Plan of Action for 2015-2019, of which Pillar 3 focuses on NRM and livelihoods, food security and nutrition response, protection and recovery.

CONCLUSION

Conflict has multiple short- and long-term impacts on development, the environment and human well-being. The displacement of people is a major social and economic cost of conflict, during but also after the end of conflict. The conflict in Darfur has seriously exacerbated the processes of environmental degradation which have contributed to the destabilization of subsistence livelihoods in the area. The environmental drivers of conflict have been aggravated as a result. Resource scarcity is one of the contributing drivers, besides the wider political and economic marginalization.

A World Bank study (IRIN, 2005) has shown that it is not only humanitarian, but also far cheaper, to help returnees rebuild their lives rather than to abandon them to a situation that may result in impoverishment, instability and a renewal of conflicts. The repatriation and settlement of refugees and IDPs needs to be tackled from various angles, with a vision that aspires to sustain and consolidate peace while encompassing rehabilitation of the degraded environment.

There is a clear need for sustained collaboration between all actors at the local, national, regional and international levels in repatriation, rehabilitation and reconstruction processes. Unless there is a coordinated, genuine partnership between the Government of Sudan, local authorities and NGOs to ensure consistency across socioeconomic and environmental policies, it will be impossible to generate sustainable livelihoods for IDPs. ♦



References

- Bromwich, B.** 2008. Environmental degradation and conflict in Darfur: implications for peace and recovery. *Humanitarian Exchange Magazine*, 39(July). UNEP.
- El Deen, Fatah Al Aleem Mohie.** 2004. *Forestry sector review Sudan: revision of national forest policy, legislation and institutional reorganization project* (TCP/SUD/2903).
- FAO.** 2010a. *UNEP and partners in Sudan joint programme on environment and natural resources management. Darfur Timber and Energy Project*. Final report 2010. Rome (available at <http://www.fao.org/emergencies/fao-in-action/projects/detail/en/c/195682/>).
- FAO.** 2010b. *WISDOM Darfur: land cover mapping and wood energy analysis of Darfur's IDP regions*. Final report. Rome (available at http://www.wisdomprojects.net/pdf/?file=WISDOM_Darfur_draft_report_update2011.pdf).
- FAO.** 2011. *WISDOM Darfur: land cover mapping and wood energy analysis of Darfur's IDP regions*. Update. Rome (available at http://www.glc.n.org/activities/darfur_wisdom_en.pdf).
- FAO.** 2014. *Assessing the impact of fuel efficient stoves in Darfur*. Rome.
- Forests National Corporation.** 2011a. *Technical note for forest resource rehabilitation in Darfur*. Sudan, Forests National Corporation.
- Forests National Corporation.** 2011b. *Report on land cover mapping and WISDOM analysis for emergency and rehabilitation planning in Darfur 2011*. Sudan, Forests National Corporation.
- Hood A.H., Ahmed, A.O. & Oshiek, A.A.** 2004. *Dissemination of smoke reduction. Interventions in Sudan*. World Urban Forum Workshop, Barcelona.
- IRIN.** 2005. The long journey home: an IRIN in-depth on the challenge of refugee return, reintegration. *IRIN*, February (available at <http://www.irinnews.org/indepthmain.aspx?InDepthId=16&ReportId=62486>).
- ProAct.** 2008. *Assessing the effectiveness of fuel-efficient stove programming – a Darfur-wide review* (available at http://postconflict.unep.ch/publications/darfur_FES.pdf; see also <http://proactnetwork.org/proactwebsite/en/assessmentmonitoringevaluation/past-projects-list/61-pastprojectsame/113-fuel-efficient-stove-review>).
- ProAct.** 2011. *Alternative domestic energy options for Darfur*. A review (available at postconflict.unep.ch/publications/UNEP_Sudan_DAEP.pdf).
- UNDP.** 2012. *United Nations Development Assistance Framework for the Republic of Sudan 2012-2013* (available at http://www.ss.undp.org/content/south_sudan/en/home/library/planning-frameworks0/undaf_12-13.html).
- UNEP.** 2007. *Sudan post-conflict environmental assessment* (available at <http://postconflict.unep.ch/publications.php?prog=sudan>).
- UNICEF.** 2008. *Sudan, Darfur overview* (available at http://www.unicef.org/infobycountry/sudan_darfuroverview.html).
- University for Peace.** 2004. *Environment degradation as a cause of conflict in Darfur*. Conference proceedings. Khartoum (available at www.africa.ucepeace.org). ♦

Ebola virus disease in West Africa: a public health emergency becomes a complex crisis

M. Annette, J.-M. Poirson, J. Zingeser, P. Otto, K. de Balogh and H. Boulet

In several countries in West Africa, the initial public health emergency triggered by Ebola virus disease (EVD) has developed into a complex crisis, affecting food security, livelihoods and national economies, and even threatening geopolitical stability.

This article outlines the global scientific community's knowledge of the clinical characteristics and epidemiological features of the disease, the biology of the virus, its known and suspected ecological features, and the role of wildlife in the introduction of Ebola virus into communities.

It also summarizes the global response to the current epidemic, highlighting FAO's role in that response, and pointing out the need for a comprehensive multisectoral approach such as One Health to ensure that future outbreaks are contained.

BACKGROUND

Nineteen Ebola virus disease (EVD) outbreaks have been identified in East and Central Africa since it was first described in 1976 on the basis of two simultaneous outbreaks, one in southern Sudan and the other in northwestern Zaire (now Democratic Republic of the Congo, DRC) (WHO, 1978). Ebola virus (EBOV), the cause of EVD, is one of the most deadly infectious zoonotic pathogens, with case

Ebola graveyard in a rural community, Sierra Leone, December 2014



Myriam Annette is Food Safety Associate Professional Officer in the Food Safety and Quality Unit of FAO in Rome.

Jean-Michel Poirson is Senior Officer for EMPRES Food Safety (food safety emergency prevention) in the Food Safety and Quality Unit of FAO in Rome.

James Zingeser is a Veterinary Epidemiologist, Veterinary Public Health, in the Animal Production and Health Division of FAO in Rome.

Patrick Otto is Animal Health Officer, Veterinary Public Health, in the Animal Production and Health Division of FAO in Rome.

Katinka de Balogh is Senior Officer, Veterinary Public Health, in the Animal Production and Health Division of FAO in Rome.

Hubert Boulet is working with FAO as a consultant on wildlife and protected area management.

fatality rates ranging from 50 to 90 percent. The present EVD outbreak in West Africa has become the most devastating on record, with more than 20 000 reported cases and over 8 000 deaths as at 7 January 2015 (WHO, 2015), and Guinea, Liberia and Sierra Leone experiencing their first ever human EVD outbreak. It is, however, widely acknowledged that the available case counts are an underestimate and the

true magnitude of the epidemic is not fully known. A comparison with the largest EVD outbreak previously recorded – in Gulu, Uganda, in 2000 – with 425 reported cases and 224 deaths, puts the scale of the current epidemic into perspective.

The first confirmed cases of EVD in the current West Africa outbreak were reported in March 2014 in the Préfecture of Guéckédou in Guinea's remote Nzérékoré region, bordering Sierra Leone and Liberia. The exact origin of the current epidemic remains unknown. However, the

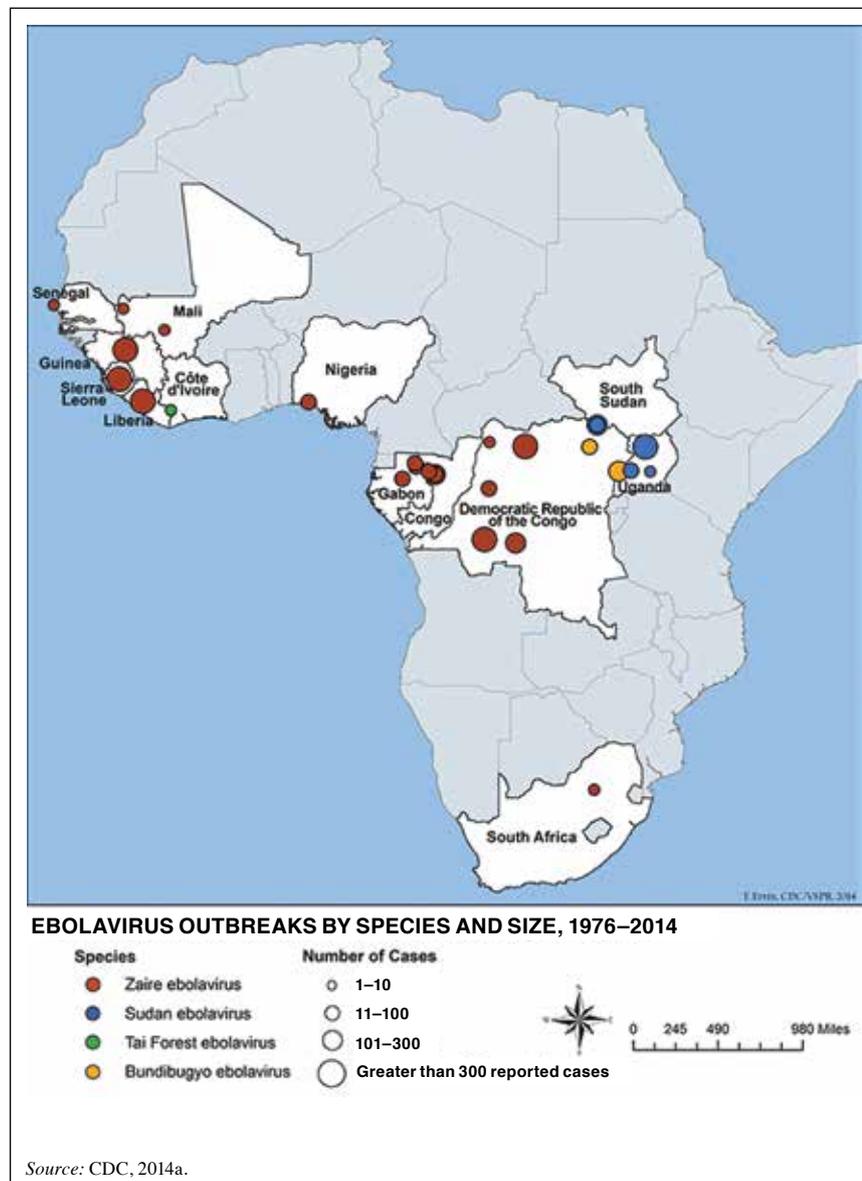
earliest reported cases have been traced back to a two-year-old child who died in December 2013, igniting a chain of human-to-human transmission, spreading EVD to other préfectures of Guinea and subsequently to Liberia and Sierra Leone (Baize *et al.*, 2014).

National public health services and other healthcare systems in the affected countries are gravely under-resourced. Even with the technical and logistical support of various agencies such as the World Health Organization (WHO), the United States' Centers for Disease Control and Prevention (CDC), Médecins Sans Frontières (MSF), the Red Cross, etc., which has led to strengthened case identification and isolation of suspect cases, contact tracing and case management, the further spread of the disease has not been contained.

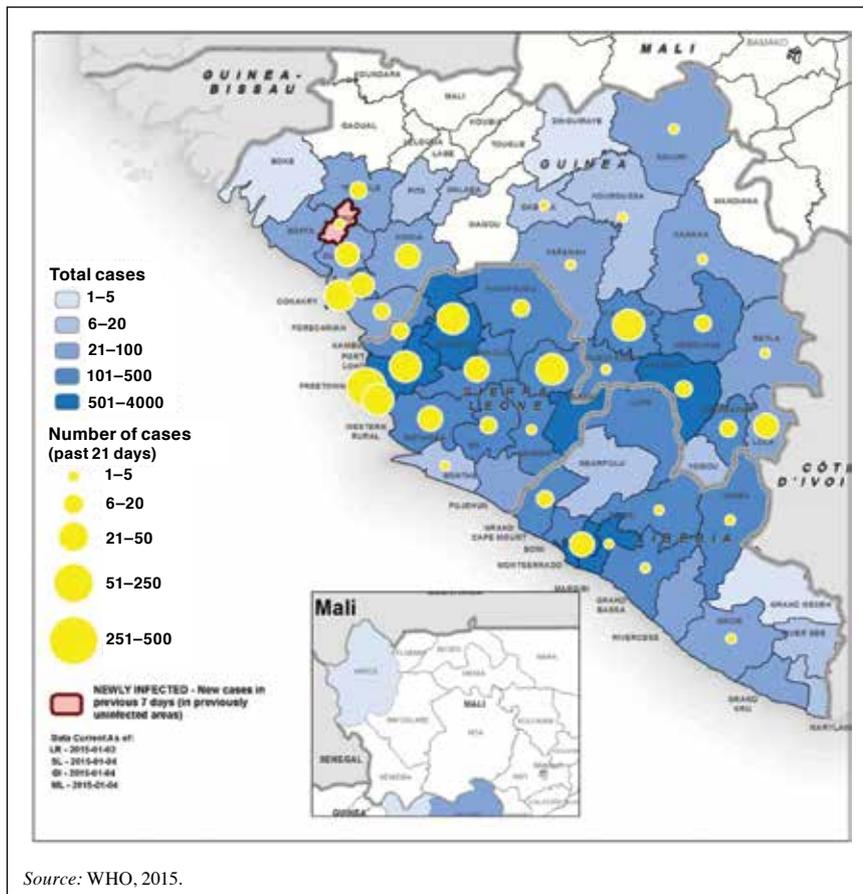
In addition to the West African outbreak, DRC also reported an outbreak of human EVD at the end of August 2014. This outbreak is unrelated to the West African crisis and was directly caused by an EBOV spillover from infected wild animals in connection with the consumption and handling of bushmeat (Maganga *et al.*, 2014).¹ Timely case identification, contact tracing, investigation and case isolation and treatment proved effective in DRC in preventing escalation into an outbreak that could have overwhelmed national public health and healthcare capacities.

Six additional countries (Mali, Nigeria, Senegal, Spain, the United Kingdom and the United States of America) have reported one or more cases originating in Guinea, Liberia or Sierra Leone. Cases in Europe and North America have highlighted the risk of spread to countries outside the immediately affected region. However, it is also apparent that cases introduced by travellers do not generate uncontrollable outbreaks in countries with well-functioning public health and healthcare systems.

1
Cases of Ebola virus disease in Africa, 1976–2014



¹ For the purpose of this article, the transmission from wildlife to humans is called a “spillover event”.



Source: WHO, 2015.

INTERNATIONAL REACTION AND RESPONSE

While the initial response to the outbreak was mainly conducted by the governments of each country in close collaboration with WHO, MSF, the Red Cross and CDC, other organizations became involved as the epidemic expanded, including the United Nations Children's Fund (UNICEF) for communication and social mobilization, the World Food Programme (WFP), providing short-term food assistance to patients and quarantined populations, and FAO, to address longer-term food security and development concerns. Within each country, the UN Country Team coordinates efforts from UN agencies along with donors and other partners.

On 8 August 2014, the Director-General of WHO declared the Ebola outbreak in West Africa a Public Health Emergency of International Concern and endorsed

the Temporary Recommendations under International Health Regulations (IHR) (2005) to reduce the spread of Ebola to other countries. On 18 September 2014, the United Nations Security Council, in its emergency meeting on the crisis, declared the Ebola outbreak in West Africa a threat to peace and security and announced deployment of the UN Mission for Ebola Emergency Response (UNMEER) to the affected region. This was only the third time that the UN had taken such action on a public health crisis. Soon thereafter, the Secretary-General appointed a Special Envoy for Ebola and a Special Representative/Head of UNMEER. The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) joined the effort to coordinate humanitarian support to the UN agencies. The setting up of UNMEER in Accra, Ghana, and the establishment of the Ebola Response

2

New, confirmed and probable cases of EVD in Guinea, Liberia, Mali and Sierra Leone, January 2015

Multi-Partner Trust Fund were intended to ensure a coherent UN system contribution to the overall response. According to the UN, nearly US\$1 billion is needed to fight the Ebola outbreak raging in West Africa and meet UNMEER's five priorities: stopping the outbreak, treating the infected, ensuring essential services, preserving stability and preventing further outbreaks.

THE CAUSATIVE AGENT OF EVD

EVD (formerly known as Ebola haemorrhagic fever) is caused by the EBOV genus *Ebolavirus* – one of the three members of the Filoviridae family (filoviruses), along with the viruses of the genera *Marburgvirus* and *Cuevavirus*. The genus *Ebolavirus* comprises five distinct species: *Zaire ebolavirus* (ZEBOV), *Bundibugyo ebolavirus* (BDBV), *Sudan ebolavirus* (SUDV), *Tai Forest ebolavirus* (TAFV) and *Reston ebolavirus* (RESTV).

Initial phylogenetic analyses of the Guinea 2014 EBOV concluded that the outbreak was caused by a divergent lineage of the Zaire EBOV (Baize *et al.*, 2014). A May 2014 re-analysis of the same dataset by Dudas and Rambaut suggested that the Guinea 2014 EBOV is a member of the Zaire lineage that has spread from Central Africa into West Africa in recent decades. This view was supported by the analysis of Calvignac-Spencer *et al.* (2014). The same conclusion was drawn in a study published in August 2014 (Gire *et al.*, 2014). In the region, serologic analyses of human blood samples collected during the three-year period 2006–2008 suggest past human exposure to an *Ebolavirus* in the region, although no outbreak had been previously observed (Schoepp *et al.*, 2014). This suggests that the virus has been circulating in the region for some time, with consequent illness and deaths attributed to other causes.

EBOVs are enclosed in a lipid envelope that renders them relatively unstable in



Handwashing at a roadside stand, Kolahun, Voinjama route, Lofa County, Liberia

the environment (Bausch *et al.*, 2007). In terms of its survival and resistance characteristics, EBOV is inactivated by heating at 60°C for 30 to 60 minutes, or boiling for five minutes, after ultraviolet (UV) and gamma irradiation (1.2×10⁶ rads to 1.27×10⁶ rads), and with 1 percent formaldehyde or β-propiolactone. EBOV is also susceptible to 3 percent acetic acid (pH 2.5), 1 percent glutaraldehyde, alcohol-based products and dilutions (1:10-1:100 for ≥ 10 minutes) of 5.25 percent household bleach (sodium hypochlorite) and calcium hypochlorite (bleach powder) (PHAC, 2014). However, studies also indicate that EBOV can survive in liquid media for many days and that survival is better at low temperature (4°C) than at room temperature. Freezing or refrigeration will preserve the infectivity of EBOV. Finally, there is no clear information on the persistence of EBOV in meat or animal products (EFSA, 2014). Leroy *et al.* (2004) stated that animal carcasses left in

African forests were not infectious after three or four days, although details were not provided. Information on the effect of salting, smoking or drying of meat on EBOV infectivity is inconclusive.

EBOLA VIRUS IN WILDLIFE AND HUMANS

Non-human primates, porcupines and antelopes (particularly duikers) are highly susceptible to EBOV and appear to be incidental hosts (Le Guenno *et al.*, 1995; Formenty *et al.*, 1999; Rouquet *et al.*, 2005; Leroy *et al.*, 2004 ; Nkoghe Mba *et al.*, 2005). Besides commercial hunting, extensive deforestation and other human economic activities, EVD is considered a major reason behind the severe decline in gorilla and chimpanzee populations in Central Africa in recent decades (Bermejo *et al.*, 2006; Walsh *et al.*, 2003; Formenty *et al.*, 1999).

Several species of fruit bats of the Pteropodidae family (fruit-eating bats)

are suspected to be the reservoir for EBOV although conclusive evidence has yet to be found (Muyembe-Tamfum *et al.*, 2012; Leroy *et al.*, 2005; Pourrut *et al.*, 2007; Pourrut *et al.*, 2009; Taniguchi *et al.*, 2011). Experimental infections of bats have shown that they can become infected without showing symptoms, and shed the virus in their faeces, which suggests that they may be reservoir species for the virus (Swanepoel *et al.*, 1996). EBOV-specific antibodies were detected in serum, and nucleotide sequences were found in tissue samples from livers and spleens of three African fruit bat species: *Hypsignathus monstrosus*, *Epomops franqueti* and *Myonycteris torquata* (Leroy *et al.*, 2005; Pourrut *et al.*, 2007). Antibodies to ZEBOV have been detected in other bat species in Africa, including *Micropteropus pusillus*, *Rousettus aegyptiacus* and *Mops condylurus* (Pourrut *et al.*, 2009).

RESTV-specific antibodies were detected in *Rousettus amplexicaudatus* in the Philippines (Taniguchi *et al.*, 2011). Despite this, no EBOV has been isolated from any free-ranging bat (Muyembe-Tamfum *et al.*, 2012; Check Hayden, 2014). The missing link remains the understanding of the transmission mode from reservoirs to susceptible wildlife species that become ill with EVD and amplify viral spread.

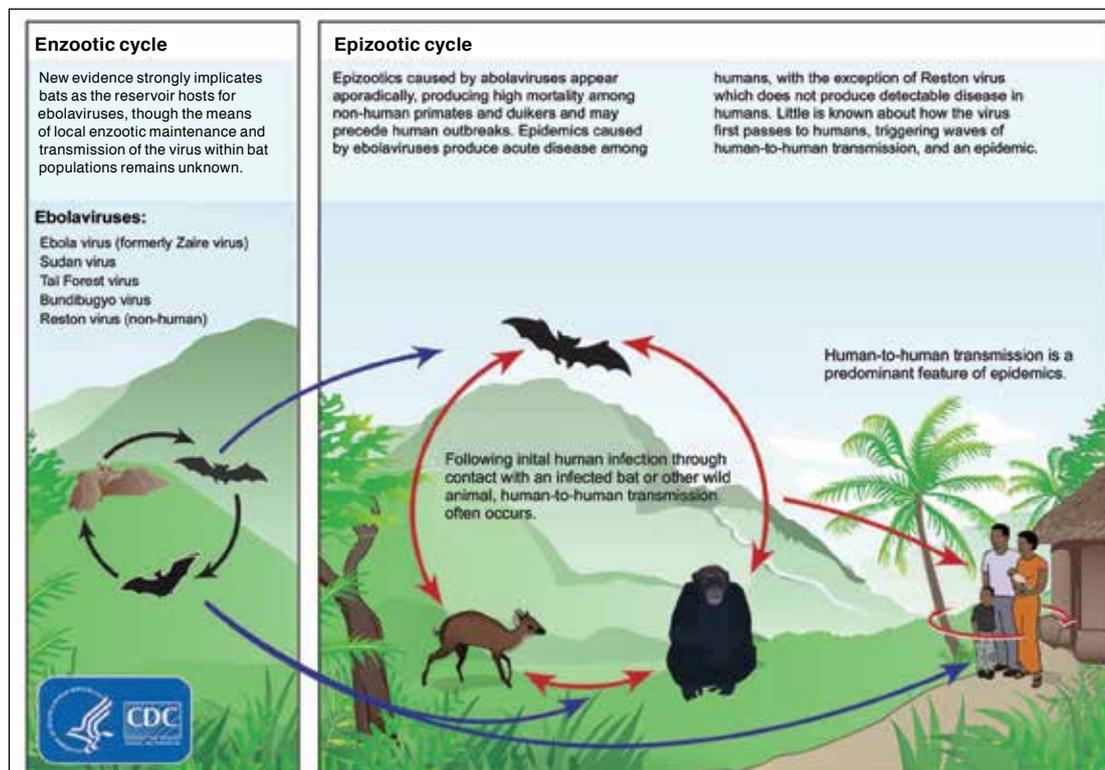
The current predominant hypothesis regarding EBOV spillover to humans is that this may occur through close contact with blood or other bodily fluids from infected animals, including animals found dead. In Africa, human contamination has been documented through the handling of infected chimpanzees, gorillas or duikers found ill or dead (Muyembe-Tamfum *et al.*, 2012; Leroy *et al.*, 2004). It is suspected that some of the previous human EVD outbreaks (e.g. Kikwit, DRC, 1995; Mweka, DRC, 2007; Gulu, Uganda, 2000; and Yambio, Sudan, 2004) may have resulted from direct exposure to fruit bats through hunting and

consumption activities (Leroy *et al.*, 2009; Muyembe-Tamfum *et al.*, 2012). Once the initial spillover from wildlife to humans has occurred, the virus spreads from person to person through direct contact with infected bodily fluids, tissues or organs of a dead or sick infected person or through contact with contaminated materials (Muyembe-Tamfum *et al.*, 2012).

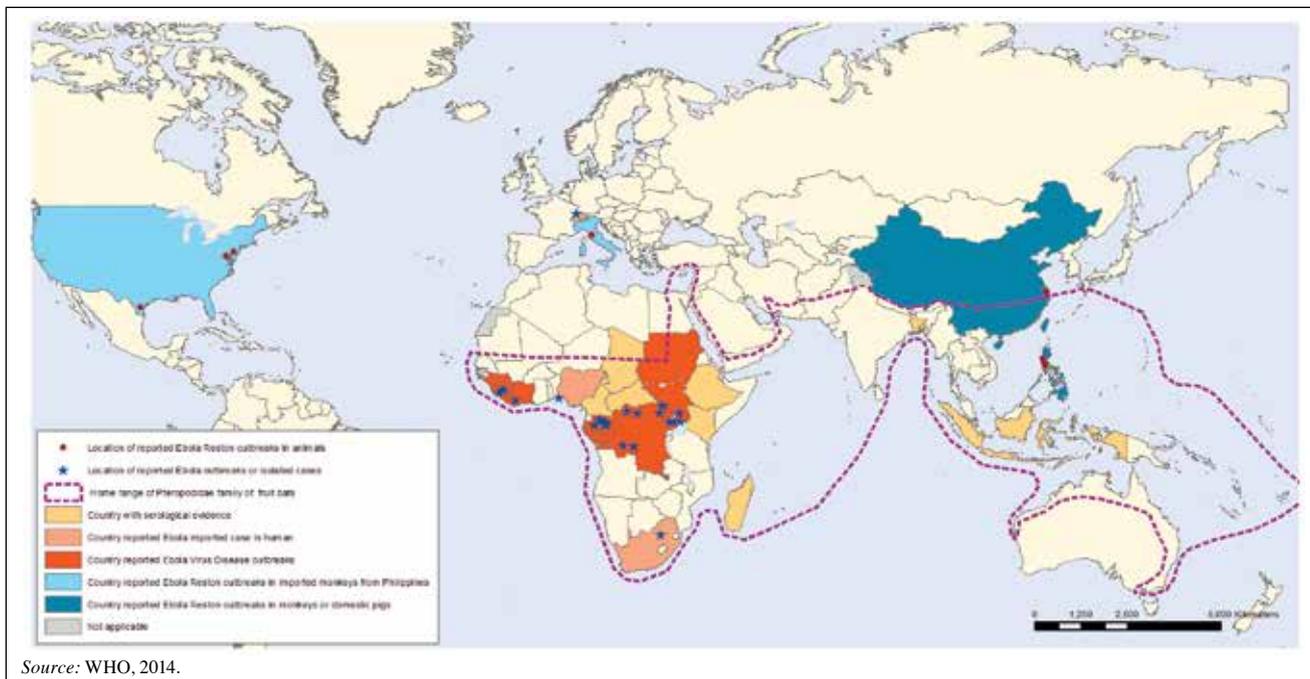
In humans, the incubation period of the disease is 2–21 days. Typical signs and symptoms include fever, malaise, myalgia, diarrhoea, vomiting and abdominal pain. Progressive multisystemic disease with haemorrhagic manifestations may follow. Currently, there is no known specific treatment or preventive vaccine, although the current outbreak has accelerated research and development on new antiviral treatments and vaccines. Some of these are promising although they have not undergone full clinical trials and some have been exceptionally authorized in certain countries and by WHO for humanitarian reasons.

RISKS FROM BUSHMEAT

Evidence from investigations into previous outbreaks suggests that a range of traditional practices and behaviours increase the risk of human exposure to infected animals or foods and may facilitate spillover events. These practices are associated with hunting and the preparation of bushmeat for sale and/or consumption. Hunting and butchering of wildlife has been identified as a potential source of infection in previous outbreaks (Pourrut *et al.*, 2005; Muyembe-Tamfum *et al.*, 2012). Indeed, the primary risk of exposure to and infection by EBOV from bushmeat practices derives from contact with infected sick animals, infected dead animals or carcasses. The virus has been isolated from the muscle of non-human primates (Rouquet *et al.*, 2005) and from their bodily fluids, including blood and any excretion or secretion. The skinning, carcass dressing, butchering and handling of infected sick or dead animals (a time at which viraemia and high virus counts in all organs,



Source: CDC, 2014b.



secretions and excretions are expected) and their raw products constitute a high risk of infection through contact. Risk mitigation would require a high level of biosecurity measures, which are not/ may not be routinely used by hunters, butchers and households to significantly reduce the risk of exposure.

Cross-contamination can be prevented through good hygiene practices and the use of surface and utensil cleaners and disinfectants. EBOVs are easily destroyed by alcohol and chlorine-based disinfectants, as well as antiseptic soaps.

Bushmeat is often consumed thoroughly cooked. Despite the absence of heat treatment monitoring, the infection risk from exposure to EBOV resulting from cooked bushmeat consumption can be considered as negligible to moderate. Epidemiological investigations of past outbreaks suggest that people who had been in contact with a dead monkey before it was cooked were affected, but not those whose only contact was cooked meat (Georges *et al.*, 1999).

Bushmeat is also often smoked to substantially extend its shelf life (Cowlshaw, Mendelson and Rowcliffe,

2004). Other methods include salting and drying (FSA, 2005). Only scant information is available on the effect of salting, smoking or drying of meat to eliminate EBOV infectivity, although these methods are expected to reduce infectivity (EFSA, 2014). The risk of infection is further reduced over time as meat and meat products are preserved at ambient temperature. So far, only a few animal species used for bushmeat are either sensitive to EBOV (non-human primates, porcupines and antelopes, in particular duikers) or are suspected to be the virus reservoir (bats). In addition, despite the routine consumption of bushmeat in Africa (EFSA, 2014), only a limited number of outbreaks (27) have been reported to date on that continent.

Despite significant risk of exposure to the virus from infected animals, their fluids and carcasses, epidemiological observations of past EBOV outbreaks suggest that virus spillover from animals to humans remains a rare event. However, the health consequences of spillover are far-reaching. They can lead to uncontrolled outbreaks among humans in countries where early cases

4 Geographic distribution of Ebola haemorrhagic fever outbreaks and Pteropodidae fruit bats

are not rapidly identified, case contacts are not traced and sick people are not adequately isolated and treated.

One of the challenges in the prevention of EBOV spillover from animals to humans is the difficulty in regulating activities related to human subsistence, such as hunting. There are strong cultural factors maintaining the demand for various types of wildlife products. Sick or dead non-human primates (e.g. gorillas and chimpanzees), or other animals found in the forest, can be used for food or other purposes. In West, Central and East Africa, wildlife hunting, including the capture of bats and non-human primates for consumption, is common in affected countries. Bushmeat is a source of animal protein and income for the inhabitants of forest areas. Throughout West Africa, governments have taken emergency measures in an attempt to control hunting and bushmeat distribution and marketing.

WHAT MAKES THIS OUTBREAK DIFFERENT FROM PREVIOUS ONES?

This is the first time that an Ebola outbreak has occurred in West Africa. Guinea, Liberia and Sierra Leone, the three principal West African countries affected by the outbreak, are among the poorest in the world. Liberia is facing its gravest crisis since the 14-year civil war ended in 2003. The country's economy and infrastructure cannot cope with the outbreak without massive external support. Sierra Leone suffers from a similar post-conflict situation due to its own recent civil war. Stagnating economies, inefficient and poorly resourced healthcare facilities, limited preparedness and response capacities, and inadequate social mobilization early on in the outbreak have undermined initial efforts to contain it.

Furthermore, while previous outbreaks of EVD in Central Africa have remained

limited to rural communities, the virus behind this outbreak has reached the densely populated capital cities of Conakry, Freetown and Monrovia, particularly affecting poor and overcrowded neighbourhoods that lack basic sanitation and health services. These conditions, in addition to misconceptions about the disease, have allowed EVD to spread in rural and urban areas at rates that are overwhelming the response capacities of national authorities and international partners. The death toll in Liberia alone is greater than the previous 20 EVD outbreaks combined. The combination of scale and duration means that the outbreak represents the biggest regional health security threat of modern times.

The social and economic impact and potential political implications are unprecedented. On 9 October 2014, World Bank Group President Jim Yong Kim remarked

at the High-Level Meeting on the Impact of the Ebola Crisis that, in Guinea, Liberia and Sierra Leone, "People are going hungry and are not able to go to work. At least 6 million children are unable to go to school, and thousands have been orphaned. Many businesses have shut down their operations; farmers are unable to harvest their crops. Airline flights are being cancelled; trade has diminished." This has significantly cut the growth projections for 2014 of the three most-affected countries, and the two-year regional financial impact could reach US\$32.6 billion dollars by the end of 2015 (World Bank, 2014).

Some of the measures taken to control the spread of the virus could have inadvertently amplified the challenges in containing the outbreak. The establishment

Bushmeat on sale, Kolahun City, Lofa County, Liberia



of quarantines, curfews, furloughing of non-essential government workers, closure of markets and schools, and the prohibition of customary burial practices have encountered various degrees of resistance by affected populations. Overall panic and social unrest have led to attacks on healthcare workers and the destruction of health facilities.

The risk of exposure to EBOV infection has increased due to hiding and home-caring of the sick, delays in presenting suspected cases for diagnosis and treatment, and under-reporting of contact with infected persons. Deaths are not reported for fear of mandatory incinerations in populations where traditional burial ceremonies are deeply rooted. Social mobilization and communication teams have, nevertheless, worked diligently to adapt their interventions by involving local communities and integrating local cultural practices into response efforts.

THE EVOLVING INTERFACE BETWEEN HUMANS, ANIMALS AND ECOSYSTEMS

As mentioned earlier, scientific evidence suggests that EBOV or a similar virus has been circulating in the region for at least eight years. When did the spillover that started the current epidemic occur? What are the animal species involved? How is the virus evolving? The answer to these important questions should help to anticipate and prepare for future outbreaks of EVD. This will require a better understanding of the complex links between ecological and socioeconomic factors in a constantly evolving interface between humans, animals and ecosystems. Human encroachment on nature (due to population growth, urbanization, deforestation through agriculture and logging, wildlife hunting and trade) alters that interface, bringing human populations and livestock into closer contact with wild animals and possible virus reservoirs. Climate change may also play a role by influencing dynamics at the forest frontier. As indicated by Leach (WHO, 2010), there

is a need to piece together these different causes and effects, some of which relate to long-term environmental and socio-ecological dynamics.

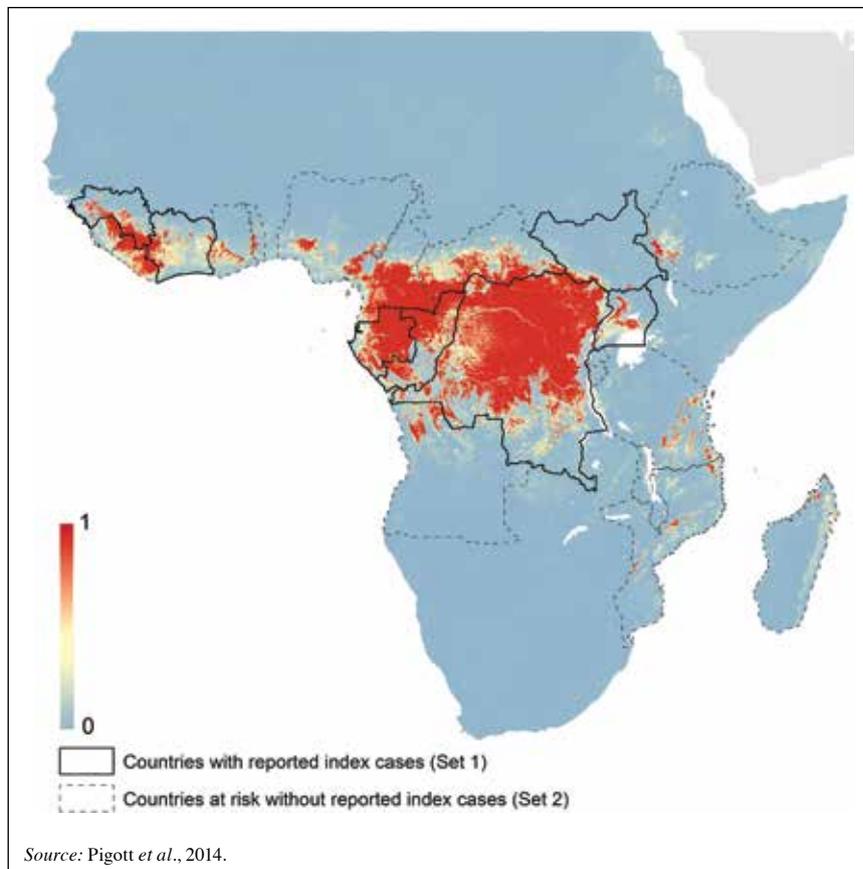
Ecoregions dominated by tropical rainforests are known to be the primary home of EBOV zoonotic cycles (Pigott *et al.*, 2014), and the type of environment in which the West African EBOV outbreaks emerged is similar to that of Central Africa. The increase in Ebola outbreaks since 1994 has been associated with drastic changes in forest ecosystems in tropical Africa, which may have promoted direct or indirect contact between humans and infected wild animals (Muyembe-Tamfum *et al.*, 2012).

Over the past 40 years, EVD outbreaks have also been accompanied by considerable changes in demographic patterns throughout Africa. Population growth and urbanization have been coupled with African populations becoming better

connected internally and internationally (Pigott *et al.*, 2014). This has increased the spread of disease from once isolated rural villages to major cities, and through air travel to world capitals.

The changing environment, driven by development and growth, has introduced both threats and potential solutions to human and animal health. It has become clear that a more robust One Health approach is needed to reduce pathogen spillover from animals to humans. This model must include socioeconomic, climatic and environmental factors. The broad interdisciplinary approach of One Health allows for a better understanding of the complex interplay of factors that can contribute to the emergence and spread of disease.

5
Predicted geographic distribution of the zoonotic niche for Ebola virus



One Health

One Health has been defined as “the collaborative effort of multiple disciplines – working locally, nationally and globally – to attain optimal health for people, animals and the environment” (AVMA, 2008). One Health represents a holistic vision for addressing the complex, interlinked challenges to human, animal and environmental health, which include food safety issues along the food chain, food insecurity and poverty.

The concept of One Health is increasingly becoming merged with that of ecohealth. Whereas the One Health concept was developed in human and veterinary medicine with the discovery of zoonoses, the origin of the ecohealth concept stems from the ecological sciences and the increasingly evident interdependence of human, animal and ecosystem health (Zinsstag, 2012). Drawing on biomedical, veterinary, food, environmental, ecological, social and behavioural sciences, the approach provides an overarching conceptual framework to understand the human, animal and environmental interactions that trigger complex health issues, such as the emergence and transmission of zoonoses (Wilcox, Aguirre and Horwitz, 2012; Kahn *et al.*, 2012; Richter *et al.*, 2015).

FAO embraces One Health across its various areas of expertise. FAO’s global partners in One Health are the World Organisation for Animal Health and WHO, as well as the United Nations Environment Programme and the International Atomic Energy Agency. At the regional and national level, FAO is expanding its partnerships with a host of additional agencies, funding partners, financial institutions, non-governmental organizations and national and local authorities (FAO, 2011).



FAO workshop with Ministry of Agriculture agents who are assisting the Ministry of Health, Sierra Leone

FAO ACTIONS AND PRIORITIES

FAO brings together technical expertise in the areas of food security, food safety, socioeconomics, livelihoods, markets/trade, forestry and wildlife management, animal production and health, and disease ecology. In addition, FAO and its partners provide assistance in data management and analysis. All of this provides a unique multidisciplinary/multisectoral perspective and approach to emergency crises, which allows the Organization to tackle complex disease problems, such as in the case of the EVD outbreaks, at their root, i.e. at the continuum of environmental–agroecological–socio-economic–animal–human interactions.

FAO’s actions are articulated around three axes:

- social mobilization to contribute to the immediate prevention of human-to-human transmission, in particular in forest-edge and farming communities;
- early warning of increased pathogen spillover risks at the interface between animals and humans to enable timely public health interventions, and longer-term prevention of spillover risks associated with hunting and bushmeat preparation; and

- monitoring and assessment of food markets and food security, to inform immediate food relief and longer-term food and agriculture production support.

FAO has been supporting Guinea, Liberia and Sierra Leone since July 2014 through its Emergency Technical Cooperation Programme (TCP), for a total of US\$1.5 million, to strengthen EVD response capacities at the human–wildlife–ecosystem interface.

FAO is working with governments, WHO, UNICEF and other partners to improve information about the virus and raise awareness of risk factors among rural communities via extension services, rural radio and other communications strategies in order to help reduce human-to-human transmission of EVD. It is critical for rural communities to understand which practices pose the highest risks for transmission.

FAO has activated its networks of local animal health clubs, community animal health workers, producer organizations, forestry and wildlife contacts, and agriculture extension services to contribute to in-country communication and sensitization efforts. Where at-risk communities

have regular contact with agricultural support services, such as farmer field schools and extension officers, agriculture officers can work with government and community partners to strengthen community health and hygiene education, building on the trust already established between the agricultural services and rural communities.

FAO and WFP are addressing the serious threat to food security created by the epidemic and the response to it. Government-imposed restrictions on movement and fear of contagion are preventing farmers from working in their fields at critical moments in the agriculture season. Movement of traders in rural communities is also very limited, which means that even if harvested, agricultural and forest products may not be marketed. Increased processing of some food commodities and loss of income due to export reduction, market disruptions and limited or non-existent transport services have increased general living expenses. High demand and low supply will lead to increasing food insecurity for the poorest sectors of society, and food shortages in the short term may lead to longer-term food insecurity in the affected areas due to lack of financial and material means to prepare for the next harvest season.

FAO, in collaboration with ministries of agriculture and regional institutions, has made rapid assessments of food security to inform the global response planning process. In collaboration with ministries of agriculture, WFP and other key partners, FAO is leading socioeconomic impact assessments in the three affected countries mentioned above. In the short term, FAO will focus on agriculture and livelihood support to farmers and livestock producers; then, appropriate action will be taken to respond to the long-term impact of the epidemic on farmers' livelihoods and rural economies in the affected areas.

FAO proposes to support community-based participative epidemiology networks to increase wildlife mortality data collection and analysis, and contribute to early warning of increased pathogen spillover

risks at the human–animal interface collaboration with local communities, frontline ministries and conservation organizations, taking stock of lessons learned and good practices from other countries. The objective is to enable effective and timely social mobilization to strengthen surveillance and public health response.

However, it is imperative that any action be underpinned by efforts to understand the drivers of zoonotic epidemics with the goal of anticipating or preventing future spillover events, drawing on the One Health approach. Once the epidemic is under control, FAO will work with governments and global experts to launch ecological investigations at the human–animal–ecosystem interface to better anticipate and reduce the likelihood of future outbreaks. At the Global Health Security Agenda (GHSA) event held at the White House in Washington, DC on 26 September 2014, FAO Director-General José Graziano da Silva stressed “the need for controls on animal health to control or minimize pathogen spillover from animals to humans, to address EVD and other infectious zoonotic diseases dangerous to humans”.

CONCLUSIONS

The current EVD epidemic in West Africa is unprecedented in size and geographic spread, leading to EBOV circulation in large urban and rural populations engaged in cross-border movement and global travel. Evidence suggests that a single virus spillover event from wildlife led to human-to-human transmission, eventually affecting at least nine countries. This tragic epidemic emphasizes the importance of developing local capacity for early case detection, laboratory confirmation and contact tracing, as well as appropriate isolation and treatment of patients. Promising research accelerated by the current crisis may lead to the development of successful antiviral treatments and vaccines, yet without strengthened animal and human health systems, many countries remain at risk for outbreaks of EVD or other emerging zoonotic diseases. Strong and

vigilant animal and public health systems are the first line of defence against disease outbreaks, but health authorities need to better understand and manage human and ecological drivers of disease.

Responding effectively to EVD outbreaks calls for innovative approaches. Current efforts in responding to the crisis, including FAO's contribution to social mobilization, food security, agriculture, forestry and wildlife management, must be complemented by strengthening the preparedness and response capacities of affected and at-risk countries in combination with increased early warning and prevention. This requires longer-term risk communication and social mobilization, prevention of high-risk behaviours, and policies to ensure safer and sustainable agriculture, forest and wildlife management. Approaches that build upon coordinated multidisciplinary and intersectoral actions are being designed to prevent future Ebola crises and strengthen One Health response efforts in our increasingly globalized world.

ACKNOWLEDGEMENTS

The authors thank Kaye Wachsmuth and Morris Potter (public health consultants), and Sarah Cahill (Food Safety Officer, FAO), for reviewing the manuscript and for their very helpful advice. ♦



References

- AVMA.** 2008. *One Health: a new professional imperative*. One Health Initiative Task Force: final report. American Veterinary Medical Association, Schaumburg, IL, United States of America (available at www.avma.org/KB/Resources/Reports/Documents/onehealth_final.pdf).
- Baize, S., Pannetier, D., Oestereich, L., Rieger, T., Koivogui, L., Magassouba, N.,**



FAO personnel practise preventive measures, Voinjama route, Lofa County, Liberia

- Soropogui, B., Sow, M.S., Keïta, S., De Clerck, H. et al.** 2014. Emergence of Zaire Ebola virus disease in Guinea. *New England Journal of Medicine*, 371(15), 1418–25.
- Bausch, D.G., Towner, J.S., Dowell, S.F., Kaducu, F., Lukwiya, M., Sanchez, A., Nichol, S.T., Ksiazek, T.G. & Rollin, P.E.** 2007. Assessment of the risk of Ebola virus transmission from bodily fluids and fomites. *Journal of Infectious Diseases*, 196(Supplement 2): S142–S147.
- Bausch, D.G. & Schwarz, L.** 2014. Outbreak of Ebola virus disease in Guinea: where ecology meets economy. *PLOS Neglected Tropical Diseases*, 8(7): e3056.
- Bermejo, M., Rodríguez-Teijeiro, J.D., Illera, G., Barroso, A., Vilà, C. & Walsh, P.D.** 2006. Ebola outbreak killed 5 000 gorillas. *Science*, 314(5805): 1564.
- Calvignac-Spencer, S., Schulze, J.M., Zickmann, F. & Renard, B.Y.** 2014. Clock rooting further demonstrates that Guinea 2014 EBOV is a member of the Zaïre lineage. *PLOS Currents: Outbreaks*, June 16, 2014. Edition 1.
- CDC.** 2014a. *Cases of Ebola Virus Disease in Africa, 1976–2014*. Ebola virus disease distribution map. Atlanta, United States of America (available at www.cdc.gov/vhf/ebola/outbreaks/history/distribution-map.html).
- CDC.** 2014b. *Ebolavirus ecology*. Virus ecology graphic. Atlanta, United States of America (available at www.cdc.gov/vhf/ebola/resources/virus-ecology.html).
- Check Hayden, E.** 2014. The Ebola questions: scientists know a lot about the virus that causes Ebola – but there are many puzzles that they have yet to solve. *Nature*, 514(7524): 554–557 (available at www.nature.com/news/the-ebola-questions-1.16243).
- Cowlishaw, G., Mendelson, S. & Rowcliffe, J.M.** 2004. *The bushmeat commodity chain: patterns of trade and sustainability in a mature urban market in West Africa*. Wildlife Policy Briefing No. 7 (available at www.eldis.org/vfile/upload/1/document/0708/DOC16497.pdf).
- Dudas, G. & Rambaut, A.** 2014. Phylogenetic analysis of Guinea 2014 EBOV Ebolavirus outbreak. *PLOS Currents: Outbreaks*. Edition 1.
- EFSA (European Food Safety Authority).** 2014. An update on the risk of transmission of Ebola virus (EBOV) via the food chain. *EFSA Journal*, 12(11): 3884 (available at www.efsa.europa.eu/efsajournal).
- FAO.** 2011. *One Health: Food and Agriculture Organization of the United Nations Strategic Action Plan* [brochure]. Rome, Italy (available at www.fao.org/docrep/014/al868e/al868e00.pdf).
- Formenty, P., Hatz, C., Le Guenno, B., Stoll, A., Rogenmoser, P. & Widmer, A.** 1999. Human infection due to Ebola virus, subtype Côte d'Ivoire: clinical and biologic presentation. *Journal of Infectious Diseases*, 179(Suppl 1): S48–S53.
- FSA (Food Standards Agency).** 2005. *Review of possible microbiological hazards that may be associated with the illegal importation of bushmeat*. Advisory Committee on the Microbiological Safety of Food, discussion paper. London.
- Georges, A.J., Leroy, E.M., Renaut, A.A., Benissan, C.T., Nabias, R.J., Ngoc, M.T., Obiang, P.I., Lepage, J.P.M., Bertherat, E.J., Benoni, D.D., Wickings, E.J., Amblard, J.P., Lansoud-Soukate, J.M., Milleliri, J.M., Baize, S. & Georges-Courbot, M.C.** 1999. Ebola hemorrhagic fever outbreaks in Gabon, 1994–1997: epidemiologic and health control issues. *Journal of Infectious Diseases*, 179: S65–S75.
- Gire, S.K., Goba, A., Andersen, K.G. et al.** 2014. Genomic surveillance elucidates Ebola virus origin and transmission during the 2014 outbreak. *Science*, 345: 1369–1372.
- Kahn, L.H., Monath, T.P., Bokma, B.H., Gibbs, E.P. & Aguirre, A.A.** 2012. One health, one medicine. In A. Alonso Aguirre, R.S. Ostfeld & P. Daszak, eds. *New directions in conservation medicine: applied cases of ecological health*, pp. 33–44. New York, NY, United States of America, Oxford University Press.
- Le Guenno, B., Formenty, P., Wyers, M., Gounon, P., Walker, F. & Boesch, C.** 1995. Isolation and partial characterisation of

- new strain of Ebola virus. *Lancet*, 345(8960): 1271–1274.
- Leroy, E.M., Rouquet, P., Formenty, P., Souquière, S., Kilbourne, A., Froment, J.M. et al.** 2004. Multiple Ebola virus transmission events and rapid decline of central African wildlife. *Science*, 303(5656): 387–390.
- Leroy, E.M., Kumulungui, B., Pourrut, X., Rouquet, P., Hassanin, A., Yaba, P. et al.** 2005. Fruit bats as reservoirs of Ebola virus. *Nature*, 438(7068): 575–576.
- Leroy, E.M., Epelboin, A., Mondonge, V., Pourrut, X., Gonzalez, J.P., Muyembe-Tamfum, J.J. & Formenty, P.** 2009. Human Ebola outbreak resulting from direct exposure to fruit bats in Luebo, Democratic Republic of Congo, 2007. *Vector-Borne and Zoonotic Diseases*, 9(6): 723–728.
- Maganga, G.D., Kapetshi, J., Berthet, N., Ilunga, B.K., Kabange, F., Kingebeni, P.M., Mondonge, V., Muyembe, J.J., Bertherat, E., Briand, S. et al.** 2014. Ebola virus disease in the Democratic Republic of Congo. *New England Journal of Medicine*, 371: 2083–2091.
- Muyembe-Tamfum, J.J., Mulangu, S., Masumu, J., Kayembe, J.M., Kemp, A. & Paweska, J.T.** 2012. Ebola virus outbreaks in Africa: past and present. *Onderstepoort Journal of Veterinary Research*, 79(2) (available at www.ojvr.org/index.php/ojvr/article/view/451).
- Nkoghe Mba, D., Formenty, L., Nnegue, C., Bachy, A.I. et al.** 2005. Plusieurs épidémies de fièvre hémorragique due au virus Ebola au Gabon, d'octobre 2001 à avril 2002. *Bulletin de la Société de Pathologie Exotique*.
- PHAC (Public Health Agency of Canada).** 2014. *Pathogen safety data sheet – infectious substances: Ebola virus* (available at www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/ebola-eng.php).
- Pigott, D.M., Golding, N., Mylne, A., Huang, Z., Henry, A.J., Weiss, D.J., Brady, O.J., Kraemer, M.U., Smith, D.L., Moyes, C.L., Bhatt, S., Gething, P.W., Horby, P.W., Bogoch, I.I., Brownstein, J.S., Mearns, S.R., Tatem, A.J., Khan, K. & Hay, S.I.** 2014. Mapping the zoonotic niche of Ebola virus disease in Africa. *eLife*, 3: e04395 (available at elifesciences.org/content/3/e04395).
- Pourrut, X., Kumulungui, B., Wittmann, T., Moussavou, G., Délicat, A., Yaba, P., Nkoghe, D., Gonzalez, J.P. & Leroy, E.M.** 2005. The natural history of Ebola virus in Africa. *Microbes and Infection*, 7(7–8): 1005–1014.
- Pourrut, X., Delicat, A., Rollin, P.E., Ksiazek, T.G., Gonzalez, J.P. & Leroy, E.M.** 2007. Spatial and temporal patterns of Zaire ebolavirus antibody prevalence in the possible reservoir bat species. *Journal of Infectious Diseases*, 196 (Suppl 2): S176–83.
- Pourrut, X., Souris, M., Towner, J.S., Rollin, P.E., Nichol, S.T., Gonzalez, J.P. & Leroy, E.** 2009. Large serological survey showing cocirculation of Ebola and Marburg viruses in Gabonese bat populations, and a high seroprevalence of both viruses in *Rousettus aegyptiacus*. *BMC Infectious Diseases*, 9: 159.
- Richter, C.H., Nguyen-Viet, H., Steele, J., Xu, J. & Wilcox, B.A.** 2015. Toward operational criteria for ecosystem approaches to health. *EcoHealth* (forthcoming).
- Rouquet, P., Froment, J.M., Bermejo, M., Kilbourn, A., Karesh, W., Reed, P. et al.** 2005. Wild animal mortality monitoring and human Ebola outbreaks, Gabon and Republic of Congo, 2001–2003. *Emerging Infectious Diseases*, 11(2): 283–290.
- Schoepp, R.J., Rossi, C.A., Khan, S.H., Goba, A. & Fair, J.N.** 2014. Undiagnosed acute viral febrile illnesses, Sierra Leone. *Emerging Infectious Diseases*, 20(7): 1176–82.
- Swanepoel, R., Leman, P.A., Burt, F.J., Zachariades, N.A., Braack, L.E., Ksiazek, T.G., Rollin, P.E., Zaki, S.R. & Peters, C.J.** 1996. Experimental inoculation of plants and animals with Ebola virus. *Emerging Infectious Diseases*, 2(4): 321–325.
- Taniguchi, S., Watanabe, S., Masangkay, J.S., Omatsu, T., Ikegami, T., Alviola, P. et al.** 2011. Reston Ebolavirus antibodies in bats, the Philippines. *Emerging Infectious Diseases*, 17(8): 1559–1560.
- Walsh, P.D., Abernethy, K.A., Bermejo, M., Beyers, R., De Wachter, P., Akou, M.E. et al.** 2003. Catastrophic ape decline in western equatorial Africa. *Nature*, 422(6932): 611–614.
- WHO.** 1978. *Ebola haemorrhagic fever in Zaire, 1976*. Report of an International Commission. *Bulletin of the World Health Organization*, 56(2): 271–293 (available at [http://whqlibdoc.who.int/bulletin/1978/Vol56-No2/bulletin_1978_56\(2\)_271-293.pdf](http://whqlibdoc.who.int/bulletin/1978/Vol56-No2/bulletin_1978_56(2)_271-293.pdf)).
- WHO.** 2010. Time to put Ebola in context. *Bulletin of the World Health Organization*, 88: 488–489 (available at www.who.int/bulletin/volumes/88/7/10-030710/en/).
- WHO.** 2014. *Ebola outbreak response: maps*. Global Alert and Response (GAR) (available at www.who.int/csr/disease/ebola/maps/en/). Geneva.
- WHO.** 2015. *Ebola situation report* [7 January 2015]. Geneva (available at apps.who.int/iris/bitstream/10665/147112/1/roadmapsitrepre_7Jan2015_eng.pdf?ua=1&ua=1).
- World Bank.** 2014. *World Bank Group President Jim Yong Kim's remarks at the High-Level Meeting on the Impact of the Ebola Crisis: a Perspective from the Countries* [transcript]. Ebola Crisis High-Level Meeting, Washington, DC.
- Wilcox, B.A., Aguirre, A.A. & Horwitz, P.** 2012. Ecohealth: connecting ecology, health and sustainability. In A. Alonso Aguirre, R.S. Ostfeld & P. Daszak, eds. *New directions in conservation medicine: applied cases of ecological health*, pp. 33–44. New York, NY, United States of America, Oxford University Press.
- Zinsstag, J.** 2012. Convergence of Ecohealth and One Health. *Ecohealth*, 9(4):371–373 (available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3627853/>). ◆

The United States Forest Service's Incident Command System 40 years on: from domestic wildfires to international disaster response

D. Dague and P. Hiram



© FIRESCOPE

A former US Forest Service Sector Boss recalls the introduction of the Incident Command System in 1975, and how it became a model for international disaster response.

Dale Dague is Acting Assistant Director, Partnerships, Fire and Aviation Management, US Forest Service, and a former Type 1 Incident Commander.

Patricia Hiram is Deputy Director, Fire and Aviation Management, US Forest Service.

Although it occurred nearly 40 years ago, he remembers the radio call vividly: it was a hot southern California summer day in 1975. He was returning from a fire assignment on an adjacent forest in southern California, where he was Sector Boss. This fireline position was very familiar to him; under the Large Fire Organization system used by the US Forest Service, a Sector Boss was responsible for an assigned section of fireline (or sector) to manage all the firefighting assets staffing that specific area of the wildfire. The assignment had lasted a few days, and he was returning to his own unit. His home Dispatch Center blasted new instructions, “You have been diverted to the Pacoima fire on the Angeles National Forest. Your assignment is

Strike Team Leader, under a new incident management system.” Although the Sector Boss was never one to turn down a fire assignment, he spent the one-hour drive to the new fire assignment wondering what a Strike Team Leader did.

Shortly after arriving at the Pacoima Incident Command Post, the seasoned firefighter learned that this fire was the first to be managed under the new Incident Command System (ICS). Upon hearing that a Strike Team Leader was similar to a Sector Boss, his concerns disappeared. Although the names of firefighting assets, the terminology used on the radio, and supervisory position titles were unfamiliar,

Above: Jesusita fire, Santa Barbara, California, 2009

the firefighter readily understood the new system. This assignment was to supervise two 20-person hand crews using axes and shovels to clear out vegetation to keep the fire from spreading. Thus began the firefighter's introduction to the ICS, as well as the US Forest Service's trial of the system. However, the ICS actually had its origins several years earlier.

THE CALIFORNIA WILDFIRE SITUATION AS CATALYST FOR THE INCIDENT COMMAND SYSTEM

During a 13-day period in the autumn of 1970, wildfires erupted in the State of California. Fuelled by dry vegetation and winds of over 80 km/hour, with gusts to 129 km/hr (Chaney, 1971), wildfires raged throughout central and southern California. Wildfire conditions and fire behaviour were extreme. Day after day, wildfires continued to burn out of control as relative humidity fell to 3 percent, and fuel moistures continued to drop, making control efforts futile. The largest fire, Laguna Mountain, burned along an 11 km front and spread over 50 km in 30 hours

(Anear, 1987). Up to 70 different firefighting agencies worked a single wildfire that crossed multiple jurisdictions. Mutual-aid and other long-standing agreements were activated to mobilize firefighting assets from local, state and federal agencies.

All wildfire agencies were operating at maximum capability. The US Forest Service and other federal agencies reached back and sent their fire suppression assets from other states. Thousands of firefighters from around the country arrived and fire managers were now able to keep the wildfire situation from becoming worse. Before the fires were controlled, however, they caused the loss of 16 lives, the destruction of over 700 homes, damage to thousands of other homes, and the devastation of 243 000 ha of timber and watershed, making them susceptible to erosion and mudslides. Suppression costs and damages together were estimated at US\$233 million at the time (or 1.4 billion in 2014 dollars). The unprecedented number of fires and communities threatened thus established 1970 as a new milestone in California.

ASSESSMENT OF THE 1970 WILDFIRE SUPPRESSION SITUATION

Responding agencies cooperated and performed well, but their efforts lacked coordination, and "confusion also existed between agencies because of non-uniformity in terminology, wildland fire suppression organization structure, and procedures" (Chase, 1980). In particular:

1. Each agency had a different organizational structure, making it difficult for firefighters to understand who was in charge.
2. The large number of employees assigned to each supervisor made it challenging for one individual to coordinate and provide oversight over activities among the firefighters.
3. Due to incompatible radio frequencies and different radio codes, communications between firefighters on the same incident were nearly impossible.
4. Agencies had different names for firefighting equipment. A tanker was an engine to one firefighter, but to another firefighter, a tanker was an aircraft; this contributed to on-scene confusion.



© US FOREST SERVICE

Helicopter making a drop on a wildfire

*US Forest Service
firefighting operations*

5. Each agency worked within its individual regulations and responsibilities, although on the same interagency incident. Not all agencies were familiar with the regulations and policies of the jurisdictional agency for a particular incident.
6. Lines of authority between agencies were unclear, causing confusion for on-scene supervision and coordination for suppression actions.

**THE GENESIS OF THE INCIDENT
COMMAND SYSTEM**

In an effort to address the suppression issues that had come to the fore during the previous year, in 1971 a US Congress subcommittee recommended funds for the US Forest Service research branch “to strengthen fire command and control systems research”. The subcommittee also recommended that the work should include development of advanced intelligence methods to detect and map fires (Chase, 1980). An analysis team was formed with members from the US Forest Service and six California city, county and state agencies (Task Force on California’s Wildland Fire Problem, 1972; California Office of Emergency Services, 2003). This group quickly recognized that increased effectiveness required not only better technology, but also depended upon interrelated systems to plan and coordinate suppression actions. The interagency group noted that the systems should apply to both simple and complex fires, as well as other emergencies.

In 1973, the first FIRESCOPE (Fire-fighting Resources of Southern California Organized for Potential Emergencies) technical team was chartered to guide the development of the Incident Command System (US Forest Service, 1973, 1974; FIRESCOPE, 1988). The charter was focused on a system design that would “make a quantum jump in the capability of southern California wildland fire



protection agencies to effectively coordinate interagency action and to allocate suppression resources in dynamic, multiple-fire situations” (Chase, 1980).

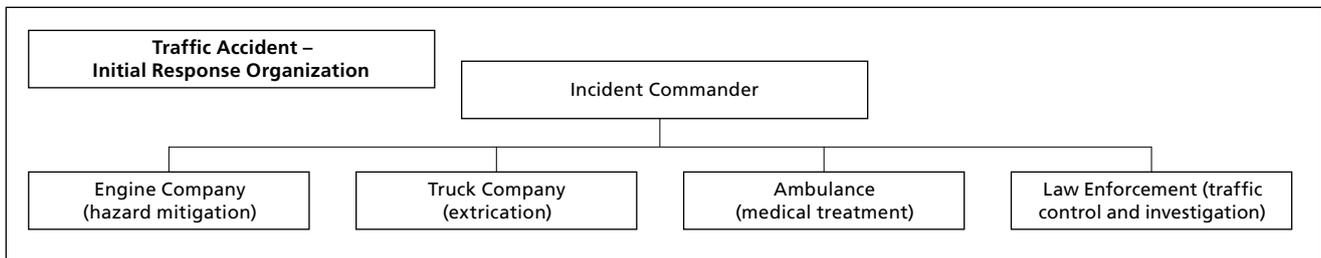
It took several years to develop and field-test a standardized emergency management system to remedy the 1970 problems. The effort was directed by four basic concepts:

1. The system must be organizationally flexible to meet the needs of incidents of varying size and complexity, whether a natural (e.g. flood, earthquake, wild-fire) or human-induced event.
2. All agencies must be able to use the system on a day-to-day basis for routine situations as well as for major emergencies.
3. The system must be sufficiently standard to allow personnel from a variety of agencies and diverse geographic locations to rapidly meld into a common management structure.
4. The system must be cost-effective.

Although full consensus throughout the chartered team was not reached, all participating agencies formally agreed to the basic concepts. In 1975, the ICS was ready for an on-scene management test on the Pacoima fire, Angeles National Forest, near Los Angeles, California. It was a

successful trial, but highlighted a need for some refinements. By 1978, adoption of the ICS began with local departments in southern California, and by the early 1980s the US Forest Service had approved the ICS implementation for the agency throughout the Pacific Southwest Region (California) (Chase, 1980). During this period, the National Wildfire Coordinating Group (NWCG)¹ was also analysing

¹ The National Wildfire Coordinating Group (NWCG) was formed in 1976. Its original membership was comprised of the US Department of Agriculture (USDA) Forest Service, four Department of the Interior agencies: Bureau of Land Management (BLM), National Park Service (NPS), Bureau of Indian Affairs (BIA) and the Fish and Wildlife Service (FWS); and state forestry agencies through the National Association of State Foresters. The purpose of NWCG is to coordinate the programmes of the participating wildfire management agencies so as to avoid wasteful duplication and to provide a means of constructively working together. Its goal is to provide more effective execution of each agency’s fire management programme. The group provides a formalized system to agree upon standards of training, equipment, qualifications and other operational functions. In subsequent years the US Fire Administration, the International Association of Fire Chiefs and the Intertribal Timber Council were included in NWCG (S. Gage, US Forest Service, Fire and Aviation Management, Assistant Director for Operations, personal communication, 2014).



1
Initial response
organization chart

FIRESCOPE ICS to determine its suitability for application nationwide.

By 1981, the ICS was in wide use throughout southern California for wildland fire incidents (California Office of Emergency Services, 2003). Because of its ease of use and adaptability, use of the ICS was extended to non-fire incidents, such as floods, earthquakes, terrorist attacks and law enforcement situations, among others. For example, traffic accidents often involve a combination of law enforcement agencies, firefighters and medical responders who work together to manage the scene and care for the victims. These first responders, although from different agencies, used the ICS to provide a common means of coordinating their efforts. During the same year, the FIRESCOPE Board of Directors supported the national adoption of the ICS by NWCG and it became a part of the National Interagency Incident Management System (NIIMS).² The US Forest Service adopted NIIMS/ICS for agency-wide use as of 1985, along with all federal, state and local wildland fire agencies (US Forest Service, 2009).

² The National Interagency Incident Management System (NIIMS) was developed by NWCG to provide a common system that wildland fire agencies could utilize at local, state and federal levels. NIIMS consists of five major subsystems that collectively provided a total systems approach to incident management. The subsystems are: the Incident Command System (ICS); training; Qualifications and Certification System; publications management; and supporting technologies. By 1982 all FIRESCOPE ICS documentation was revised to NIIMS terminology and organization, which better equipped the ICS for adaptation to an all-hazards environment (NWCG, 1983). NIIMS was the basis for the development of the National Incident Management System (NIMS) by FEMA, and in 2013 the term (NIIMS) was retired by NWCG.

In 1986, the US Federal Emergency Management Agency (FEMA) awarded an exemplary practices honour in emergency management to the FIRESCOPE programme.

OVERVIEW OF THE ICS

The ICS is a command-and-control organizational structure for on-scene management of emergency incidents, managed by the agency that has the jurisdiction responsibilities for that particular incident. The ICS incorporates common elements of planning, communications, locations, and incident objectives to unify different organizations to accomplish a common task. Organizations and individuals trained in the ICS easily transition from their day-to-day organizational structure to the ICS when an emergency response is initiated.

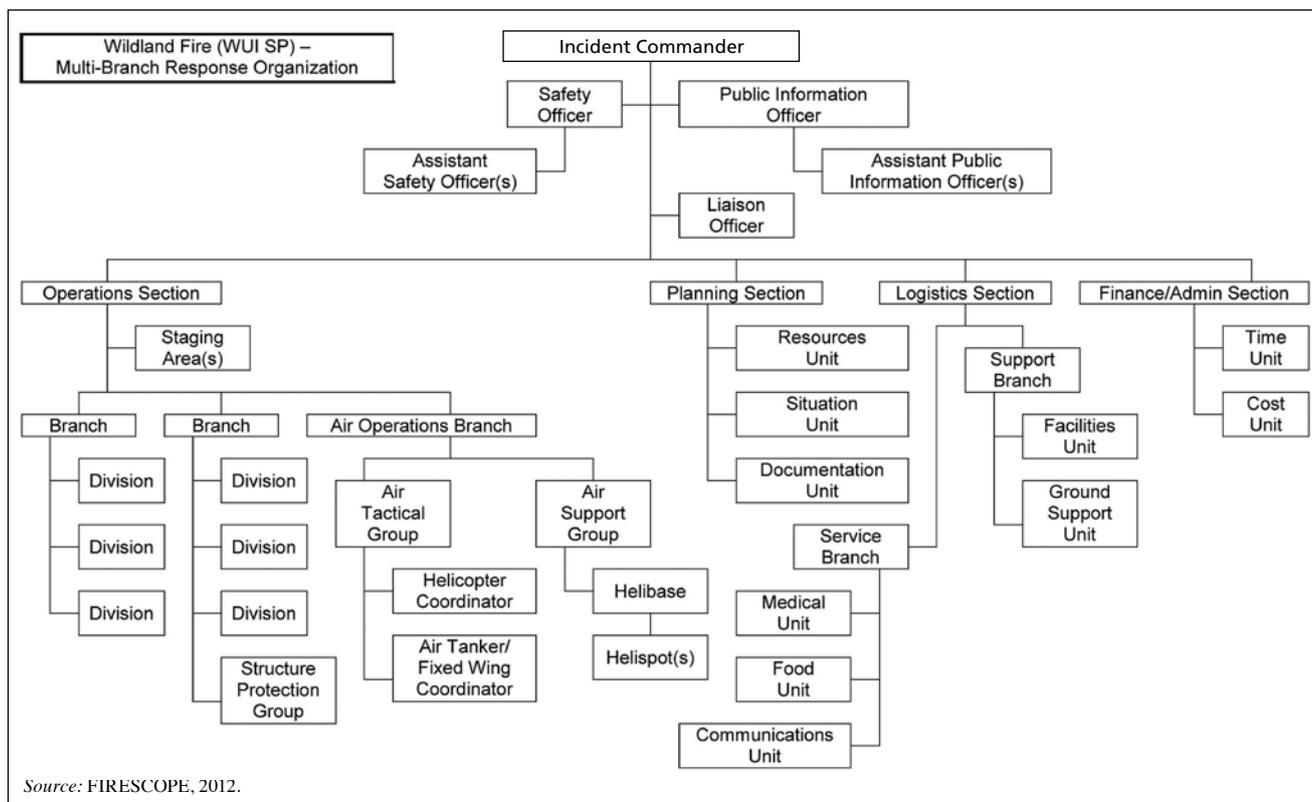
The ICS operates with the following characteristics:

- It provides a single management system for multi-jurisdictional incidents, i.e. incidents that cross ownership/jurisdictional boundaries, or that require several agencies to become involved such as law enforcement and firefighting.
- It uses a standard organizational structure consisting of five major functional areas: command, operations, finance, logistics and plans.
- It is structured to integrate any type of asset – law enforcement, military, technical experts and non-governmental organizations.
- It uses common terminology for position titles, resources and facilities.
- It allows for a manageable span of control – optimally one supervisor for five assets.

- It is not a permanent organizational structure or secretariat.
- It is used for every incident regardless of size.
- During an emergency, the ICS-qualified personnel leave their normal duties and are assigned to a specific position within the ICS organizational structure.

The ICS is organizationally flexible and scalable, allowing the number of personnel and resources to expand or contract as incident requirements increase or subside. It can be adapted to manage any incident type or complexity; only the positions or functions necessary for a particular incident are utilized. The organizational chart in Figure 1 identifies the resources required for a small incident. The organizational chart in Figure 2 identifies the needs of an emergency response that has escalated into a major incident requiring hundreds or thousands of resources.

Agencies that use the ICS can transition seamlessly and immediately from their agency's structure and hierarchy to the ICS structure. The US Forest Service and other ICS-trained agencies frequently respond to an incident together; no announcement or declaration is necessary to move into an ICS organization. The on-scene operations become a blend of personnel and equipment that work together smoothly, regardless of land ownership or responsibility. Decisions such as dispatching, the number and type of assets responding, and on-scene command are among the items clarified between agencies prior to the emergency. The US Forest Service and



their partners annually review and update these pre-season agreements to facilitate seamless responses.³

The ICS has contributed to the successful management of a wide variety of emergency incidents, including earthquakes, tornadoes, wildfires, floods, and the Deepwater Horizon oil spill in the Gulf of Mexico. These incidents required close coordination and cooperation with numerous agencies. The flexibility of the ICS is proven through its use for planned, non-emergency events. For example, the ICS was used to manage the 2002 Winter Olympics, hosted by the United States of America in Salt Lake City, Utah.

³ A standard requirement for the US Forest Service and numerous other agencies is to establish approved agreements, administrative processes and financial arrangements with all cooperating agencies long before the agencies respond to incidents together. Annual reviews and updates for these agreements are also standard requirements. The administrative documents and arrangements play an important role in the success of the ICS.

THE UNITED STATES OF AMERICA EXPANDS THE USE OF THE INCIDENT COMMAND SYSTEM

The 11 September 2001 attacks in the United States of America on the World Trade Center and the Pentagon brought a realization of the need for a comprehensive nationwide approach to incident management (Department of Homeland Security, 2004). The country required a “system of systems” that would bring every discipline (fire, medical aid, law enforcement, etc.) from all levels of government – local, state, federal and tribal – to work effectively and efficiently together to manage all domestic emergency responses. In February 2003, the President issued Homeland Security Presidential Directive 5 (Executive Office of the US President, 2003), which called upon the Secretary of Homeland Security to develop and administer a National Incident Management System (NIMS). As a result, the United States of America adapted the ICS to develop the NIMS (Department of Homeland Security, 2004).

2 Multi-branch response organization chart

The NIMS was released in March 2004, with five components:

- Preparedness,
- Communications and Information Management,
- Resource Management,
- Command and Management, and
- Ongoing Management and Maintenance.

The ICS is now a subsection of the Command and Management component.

THE GLOBALIZATION OF THE INCIDENT COMMAND SYSTEM

Incident management complexity has increased the need for a standard incident management system, not only within an individual nation, but also globally. For example, in 31 of the past 32 years, the United States of America and Canada have exercised reciprocity for wildfire firefighting assistance when their respective assets were depleted. Through the commonality of using the same emergency management

system, Canadian and US suppression assets work side by side, as a seamless and effective unit.

The ICS was adopted at the International Wildland Fire Summit held in Sydney, Australia in October 2003 (*International Forest Fire News*, 2003) as the international standard for all wildland incident management agencies participating in international or interagency agreements and exchanges. The system has a proven record in many countries around the world. Several nations, including Australia, Canada, Mexico, New Zealand and South Africa, have evaluated and adopted the ICS. Additionally, France, India, Indonesia, Mongolia, the Philippines and Thailand are among the many countries that have received ICS training, and the ICS is being adapted to help manage responses to the Ebola virus spread in West Africa. The ICS is emerging as the “common language” of international disaster response.

Under US law that allows the US Forest Service to work with foreign governments, the US Forest Service works with many countries around the world to introduce the ICS and provide capacity-building activities. This includes formal classroom training, hands-on training, consultations, seminars, study tours in the United States of America, exchange programmes, simulation exercises, shadowing assignments, and observation of training or response efforts.

INCIDENT MANAGEMENT HAS COME A LONG WAY

Looking back some 40 years to the days before the ICS, the improvement in ability to manage incidents is evident. Many of the problems experienced with 1970s-era wildfires no longer exist.

- The ICS has increased the ability of interagency emergency response personnel to work together towards common objectives.

- Responses to incidents are more effective through improved communications such as common terminology, clear-text speaking and compatible radio frequencies.
- Clear objectives, conveyed through written Incident Action Plans, allow on-scene operations to work seamlessly across multiple agencies.
- The US Forest Service has expanded its incident management capacity, as well as shared capacity with interagency partners at the local, national and global levels.
- The ICS has made institutions stronger and better equipped to meet the challenges ahead. They have learned from each other and become more efficient and effective.

Incidents are no longer segregated by jurisdiction due to an inability to integrate suppression actions effectively. There is no confusion created when requesting a



NIMS session in preparation for the Boston marathon

US Forest Service
next-generation
air tanker



“tanker”: expecting to receive an engine and instead receiving an aircraft. Today, the global language of the ICS allows international partners to arrive and merge seamlessly on incidents.

In 1970, who would have imagined this evolution of incident management? One former Sector Boss did not. ♦



References

- Anear, G.** 1987. *Disastrous Laguna fire of '70 recalled*. The San Diego Union.
- California Office of Emergency Services.** 2003. *Some highlights of the evolution of the Incident Command System as developed by FIRESCOPE*. Sacramento, California, Office of Emergency Services.
- Chaney, K.** 1971. *Countdown to Calamity* (documentary film). Sacramento, California, United States of America, Division of Forestry and Resources Agency Department of Conservation.
- Chase, R.A.** 1980. *FIRESCOPE: a new concept in multiagency fire suppression coordination*. General Technical Report PSW-40, Pacific Southwest Forest and Range Experiment Station. Berkeley, California, US Department of Agriculture, Forest Service.
- Department of Homeland Security.** 2004 (March). *National Incident Management System*. Washington, DC, Federal Emergency Management Agency (FEMA).
- Department of Homeland Security.** 2008 (December). *National Incident Management System*. Washington, DC, FEMA.
- Executive Office of the US President.** 2003. Homeland Security Presidential Directive 5 (HSPD-5) (available at <http://www.dhs.gov/sites/default/files/publications/Homeland%20Security%20Presidential%20Directive%205.pdf>).
- FIRESCOPE.** 1988 (October). *Firefighting resources of California organized for potential emergencies: past, current and future directions*. A progress report. California, United States of America, Governor's Office of Emergency Services—FIRESCOPE (available at <http://www.firescope.org/fire-scope-history/past%20present%20future.pdf>).
- FIRESCOPE.** 2012. *Field Operations Guide, ICS 420-1*. California, United States of America, Governor's Office of Emergency Services—FIRESCOPE (available at <http://docs.epageview.com/California-Emergency-Management-Agency/California-Emergency-Management-Agency/b9a12a11-ced3-4db2-809c-a1ef00c6991f/big-fog-with-links-complete-07-02-13.pdf>).
- International Forest Fire News (IFFN).** 2003. Summit communiqué outcomes of the International Wildland Fire Summit, Sydney, Australia, 8 October 2003. *IFFN*, 29 (July–December): 2–4 (available at http://www.fire.uni-freiburg.de/iffn/iffn_29/iffn-29.pdf).
- NWCG.** 1983. *The National Interagency Incident Management System (NIIMS): the what, why, and how of NIIMS* (unpublished).
- NWCG.** 1994. *History of ICS*. National Training Curriculum. Boise, Idaho, United States of America, National Interagency Fire Center (available at http://www.fws.gov/contaminants/fws_osc_p05/fwscontingencyappendices/c-ics/ics-history.doc).
- Task Force on California's Wildland Fire Problem.** 1972. *Recommendations to solve California's wildland fire problem*. Sacramento, California, United States of America, California Division of Forestry.
- US Forest Service.** 1973. *FIRESCOPE RD&A Program Charter*. March 26, 1973 (unpublished).
- US Forest Service.** 1974. *FIRESCOPE: Multiagency Coordination System Development Agreement*. June 26, 1974 (unpublished).
- US Forest Service.** 2009. *The unmarked trail. Managing national forests in a turbulent era*. Pacific Southwest Region R5-FR-011, Region 5 Oral History Volume II: 1960s–1990s. US Forest Service (available at http://digitalassets.lib.berkeley.edu/roho/ucb/text/unmarked_trail_vol2.pdf). ♦



© SYLVIE WABBES

Trees and forests – lifelines for resilience

D. Burgeon, T. Hofer, P. van Lierop and S. Wabbes

Healthy forests and trees are symbols of resilience, helping to prevent, reduce and adapt to risk and crisis. They sustain life, livelihoods, well-being and dignity in a planet at risk, and play a crucial part in FAO's work on resilience.

Dominique Burgeon is Strategic Objective Coordinator on Resilience and Director of the Emergency and Rehabilitation Division, FAO. **Thomas Hofer** is Team Leader, Mountains and Watersheds, in FAO's Forestry Department and Coordinator, Mountain Partnership Secretariat. **Pieter van Lierop** is Forestry Officer (Fire Management) and Focal Point for Emergencies in FAO's Forestry Department. **Sylvie Wabbes** is Emergency and Rehabilitation Officer, FAO.

The ever-increasing socioeconomic and environmental impact of disasters and crises is a strong wake-up call for longer-term prevention, impact reduction and emergency preparedness and recovery. Unfortunately, once a crisis has hit it is often too late and the damage may be irreversible. A crisis is the tip of the iceberg, which may mask a far greater problem of natural resource over-exploitation and degradation, coupled with an underestimation of the value of fertile land and ecosystem services that are essential for clean air, fresh water, wildlife and biodiversity. Development is often neither risk-sensitive nor risk-informed. Today, disaster-risk-reduction (DRR) measures

must be placed at the forefront of rehabilitation and development interventions, where trees and forests have a pivotal role to play.

Economic losses due to the impact of natural hazards are on the rise, despite the more than 168 countries that ratified the Hyogo Framework for Action (HFA) in 2005, thereby committing to actively reducing disaster risks. Until now the focus of the HFA has been on broad disaster risk reduction, and related advocacy and actions have not yet been anchored into specific sectors. However, an ongoing FAO analysis (FAO, 2015) shows that

Above: Coastal forest barriers in Aceh after the Indian Ocean tsunami

the agriculture, fisheries and forest sectors are extremely vulnerable to shocks, affecting both natural resources and food and nutrition. According to this analysis, damages and losses due to large-scale natural disasters (including extreme climate events) in agricultural sectors alone (including crops, livestock, fish and trees) accounted for 22 percent of total damages and losses across all sectors during the period 2003–2013. The impact of disasters and crises on the fundamental functions played by forests and trees is still broadly underestimated, and will require a more detailed analysis of losses and damage. Additional cost-benefit studies are also needed in order to capture the broader impact of disasters and crises on ecosystems and livelihoods and to advocate for and mobilize stronger investment in forests and trees for disaster risk reduction.

SAFEGUARDING FORESTS' IMPORTANT ROLE BEFORE, DURING, AND AFTER DISASTERS

Healthy trees and forests are at the heart of resilient livelihoods and ecosystems. They play a vital role in sustaining life and livelihoods across the full range of natural and urban systems, including

before, during and after disasters. They provide material for shelter, fibre and infrastructures, and energy for heating and cooking; are a source of food and nutrition for humans and animals; and generate income and livelihoods (not to mention their recreational and spiritual healing functions). In addition, forests, trees and their well-managed ecosystems underpin core environmental services such as fresh water, fertile soil, agro-biodiversity and wildlife. Finally, they help to prevent, protect and/or lessen the impacts of natural disasters such as avalanches and landslides in mountain areas, and tsunamis and cyclones in coastal areas.

The articles in this issue of *Unasylva* illustrate forests' key role in protecting and alleviating disasters, as well as how they are affected by such shocks. Typhoon Haiyan, which struck the Philippines in 2013, caused massive damage to trees for example, but the fallen trees and palms contributed to relief efforts by providing materials for rebuilding houses and boats, for fuel and more. The role of mangrove and coastal forests in protecting land or mitigating the effects of natural disasters such as tsunamis and cyclones should also not be overlooked.

In mountainous areas, forests and trees can contribute to the prevention and reduction of the impacts from avalanches and landslides. The case of Pakistan, where the 2009 earthquake was followed by floods in 2010, demonstrates the value of watershed management as an integrated approach to DRR, linking natural resources management, agricultural production and livelihoods.

Wildfires remain a serious threat, and do not only affect forests and trees but also infrastructure, agriculture, livelihoods, and the lives of both humans and animals. The case of the Black Saturday fires in Australia bears witness to the need for planning that uses an integrated landscape approach when dealing with forest and other vegetation fires.

The ongoing Ebola outbreak in West Africa exemplifies the intimate links between livelihoods, food consumption and trade (including bushmeat), public health and the ecosystem. Technological disasters, such as those of Chernobyl and Fukushima, can also lead to complex situations involving multiple interlinked threats, or so-called “concatenated crises”.

Finally, conflicts and protracted crisis situations, such as in the Central African



**Degraded landscape
in the High Atlas
of Morocco**

© THOMAS HOEHR

Republic or South Sudan, affect many people whose daily survival increasingly depends on forests and trees for protection, food and energy. About 20 percent of the world's undernourished people (a total of about 166 million) live in countries in protracted crisis (FAO, IFAD and WFP, 2010). The growing number of internally displaced people (IDPs) and refugees increases demand for fuelwood and charcoal, yet energy is seldom part of the international assistance kit. FAO, in its current work with refugees and IDPs in Ethiopia, South Sudan and Myanmar, has therefore included the safe, sustainable and reliable provision of energy as a key component of both DRR measures and emergency response.

It is also important to note that natural disasters not only directly affect trees and forests but also heighten the risk of future disasters, including an increased fire and forest health risk when dead wood accumulates after a shock or increased coastal vulnerability where mangrove areas have been damaged. In addition to extreme climate events, which are a major cause of natural disasters, climate change also represents a slower-moving menace, which

exacerbates threats and vulnerabilities and is expected to worsen in coming years.

In all cases, it is clear that overall land management and planning can help to prevent and mitigate the impact of disasters. In turn, as land management cannot take place without involving stakeholders, participatory approaches are essential for resilience building.

THE IMPORTANCE OF FORESTRY FOR RESILIENCE

One of FAO's five strategic objectives focuses on increasing the resilience of livelihoods to threats and crisis, building on the need to anticipate, prevent and address the threats and crises that can affect crops, livestock, fish, trees and natural resources. It encompasses a range of norms, tools, approaches, experiences and technologies developed over the past 20 years for risk reduction and crisis management.

FAO's work to increase the resilience of the most vulnerable small-scale farmers, fishers, herders, foresters and dependent communities in disaster-prone countries is based on a multidimensional long-term commitment to disaster risk reduction (FAO, 2013a). Building from and going beyond the Hyogo Framework for Action, FAO's agenda on resilience (see Figure 1) encompasses partnerships

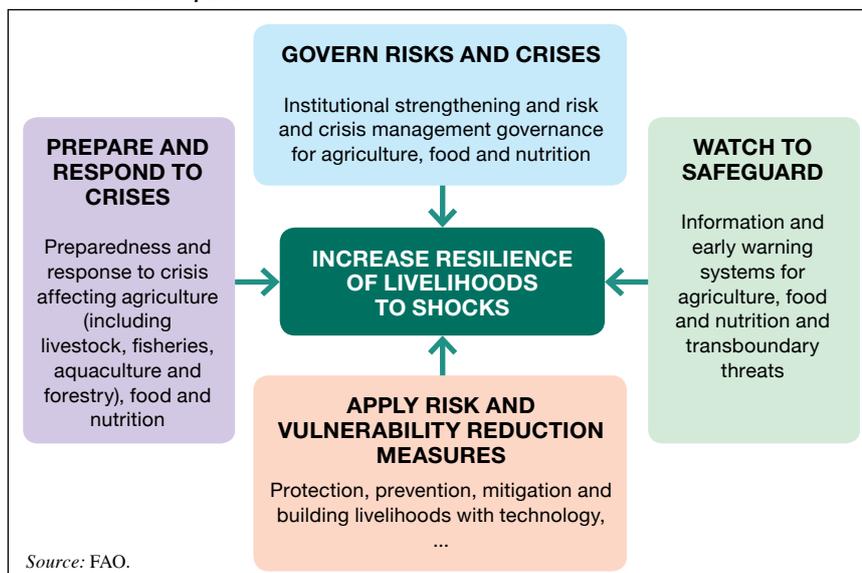
and actions across four complementary key areas: governing risks and crises by promoting appropriate legislation, policies and institutional frameworks; "watching to safeguard", through better risk and food and nutrition security information and early warning systems; applying risk and vulnerability reduction measures through the application of appropriate technologies, practices and approaches; and preparing to respond to crises by strengthening emergency preparedness and response capacities.

Watershed management and dryland management are two key areas that demonstrate the importance of forests for the longer-term resilience of livelihoods.

Upland and mountain ecosystems, which cover 23 percent of the earth's land surface and are home to 23 percent of the world's forests, provide essential environmental goods and services. These include the provision and protection of 60 to 80 percent of the earth's freshwater resources for domestic, agricultural and industrial consumption, regulation of water flows, a natural resource base for local livelihoods, renewable energy, and the preservation of biodiversity including agro-biodiversity. In this context, watershed management provides a framework to organize different land-uses (forestry, pasture, agriculture) in an integrated way. In addition to helping reduce risks of natural hazards, such as landslides and local floods, watershed management creates resilience against climate change as well as adaptation benefits. FAO is working in this area in its capacity as member of the Mountain Partnership and supporting organization of the International Consortium on Landslides, amongst others.

Drylands, with 18 percent of their land covered by forests, support the livelihoods of over 2 billion people of which 75 percent are considered poor.¹ Drylands are suffering from increasingly frequent and interrelated drought and conflicts. Building on its long experience in restoration of

1
Resilience:
FAO's four thematic pillars



¹ See <http://www.fao.org/forestry/aridzone/en/>.

Forests protect steep slopes from erosion and landslides in Guatemala

drylands forests and agroforestry systems, FAO has, since 2010, been providing support to the African Union Commission and 13 partner countries for the Great Green Wall for the Sahara and the Sahel Initiative, which is supporting the management and regeneration of natural resources on which the poorest and most vulnerable communities depend, thereby supporting resilient livelihoods.

A PARADIGM SHIFT FROM CRISIS RESPONSE TO RISK MANAGEMENT

As explained in the article by Ms. Wahlström, Special Representative of the UN Secretary General for Disaster Risk Reduction, resilience work calls for a paradigm shift from reactive crisis response – where disaster and crisis are seen as the exceptions – to a more proactive approach in order to anticipate and prevent the increase in frequency and magnitude of shocks affecting vulnerable agriculture-, fishery- and forestry-based livelihoods. To this end, FAO, together with its partners, is striving to bridge the humanitarian–development divide.

FAO has grouped the various types of shocks affecting the agriculture–food–nutrition nexus into five main categories (FAO, 2013b, pp. 37-38), which include: natural disasters, which originate from natural hazards such as floods and fire (Burton, Kates and White, 1993); food chain crises, which include high-impact transboundary pests and diseases or technological threats; socioeconomic crises, originating from for example the 2008 global food price crisis or recent financial shocks; violent or conflict-related crises, including civil unrest and wars; and protracted crisis situations, which are complex, prolonged emergencies that combine several different types of shocks (see FAO, IFAD and WFP, 2010).

Today, the Hyogo Framework for Action, which focuses only on natural hazards in generic disaster risk reduction and



management terms, is being reviewed in the context of the World Conference on Disaster Risk Reduction (Sendai, Japan) in March 2015. Ideally, it should include other types of threats and shocks, in order to better equip all actors to face the natural and human-induced multi-hazard challenges ahead. Today, livelihoods that depend on forests and trees are affected by a combination of types of shocks and stresses, as mentioned above, which increases the fragility of ecosystems and human well-being.

Well-managed forests and trees are a key part of natural disaster prevention infrastructures. They can also contribute to humanitarian relief after a disaster and are essential for resilience, which is in turn a pre-condition for sustainable development. Yet their crucial role in reducing the risk of disaster and its impact is frequently overlooked. It is essential that forests and trees be considered in broader integrated approaches, to inform both disaster-risk-reduction measures, including policies and actions, and overall resilient and sustainable land management. ♦



References

- Burton, I., Kates, R.W. & White, G.F.** 1993. *The environment as hazard*. New York, Oxford University Press.
- FAO.** 2013a: *Resilient Livelihoods – Disaster Risk Reduction for Food and Nutrition Security*. Rome (available at www.fao.org/docrep/015/i2540e/i2540e00.pdf).
- FAO.** 2013b. *The Director-General's Medium Term Plan 2014–17 and Programme of Work and Budget 2014–15*. C2013/3. Thirty-eighth Session of the Conference, 15–22 June 2013. Rome (available at <http://www.fao.org/docrep/meeting/027/mf490e.pdf>).
- FAO.** 2015. *The impact of natural hazards and disasters on agriculture and food and nutrition security. A call for action to build resilient livelihoods*. Rome (forthcoming).
- FAO, IFAD & WFP.** 2010. *The State of Food Insecurity in the World 2010. Addressing food security in protracted crises*. Rome, FAO (available at <http://www.fao.org/docrep/013/i1683e/i1683e.pdf>). ♦



FAO FORESTRY



© ROSE DAVIES

An online FAO conference on the economics of climate change mitigation highlights the role of forests

The significant mitigation potential that forests have to offer was highlighted in a recent FAO-led international conference on the economics of climate change mitigation options in the forest sector, held from 6 to 27 February 2015.

How best to mitigate climate change and curtail global warming is now an established debate. With a new climate-change regime expected to emerge from the upcoming UNFCCC's Climate Change Conference in Paris in November, forestry may gain the limelight in mitigation discussions.

In keeping with the goal of reducing carbon emissions, the conference organizers took an innovative approach, conducting all 6 conference sessions online. The event attracted around 1 800 people from 141 countries, bringing together the expert knowledge of field leaders and more than 30 country case studies from all over the world. The outcomes of the conference demonstrated a range of emission reduction options, from planting trees and reducing deforestation to more cross-sectoral options such as changing forest management practices, green buildings and sustainable packaging.

In his closing remarks, the Assistant Director-General of FAO's Forestry Department, Eduardo Rojas-Briales, suggested that although climate change is a formidable challenge, forestry can offer sustainable and cost-effective solutions to convert this looming crisis into excellent opportunities.

The conference was organized by FAO's Forest Economics Team with the support of FAO's Mitigation of Climate Change in Agriculture (MICCA) programme.

Highlights from the event can be found here: <http://www.fao.org/forestry/cc-mitigation-economics/en/>

Left: Costa Rica's forestry strategy prioritizes both climate change mitigation and ecotourism

An expert workshop on criteria and indicators (C&I) emphasized the crucial role of C&I in achieving sustainability

The international workshop, held by FAO from 15 to 16 January 2015 in Rome, Italy, brought together global, regional, national and practitioner-level experiences and perspectives regarding the needs and potential for C&Is and possible further work on socioeconomic and governance-related indicator sets.

Citing the Sustainable Development Goals and targets, the United Nations Forum on Forests (UNFF) and relevant Rio Conventions, the experts who attended the workshop called for holistic, integrated forest indicators. They stressed C&Is' potential role in cross-sectoral sustainability assessments, as well as for broader issues such as biodiversity, ecosystem services and climate change. They noted the need for accountability and performance-based, measurable results in policy processes, emphasizing that C&I are useful at many levels – from government administration to small-scale operators.

The approximately 40 attendees together represented the main C&I process secretariats, including the International Tropical Timber Organization (ITTO), the African Timber Organization (ATO), the Amazon Cooperation Treaty Organization (ACTO), the Montréal Process, FOREST EUROPE, the Association of Southeast Asian Nations (ASEAN), the Central African Forest Commission (COMIFAC), the Economic Community of West African States (ECOWAS), the Tehran Process Secretariat for Low Forest Cover Countries (TPS LFCC); global initiatives and processes, such as the Sustainable Development Goals, UNFF, FAO's Global Forest Resources Assessment (FRA), the United Nations Convention to Combat Desertification (UNCCD) and the Convention on Biological Diversity (CBD); and bodies at management practice levels, including the Forest Stewardship Council (FSC), the Programme for the Endorsement of Forest Certification (PEFC), the Forest and Farm Facility (FFF) and the International Model Forest Network (IMFN).

The workshop enabled the presentation and discussion of the interim results of the FAO C&I project and provided recommendations on concrete steps to promote C&I in 2015, in the context of UNFF11 and post-2015 arrangements on forests, the SDGs, the XIV World Forestry Congress and three forthcoming regional C&I workshops to be held during 2015 in Peru, the Philippines and Cameroon.

Highlights and the summary report from the workshop can be found here: <http://www.fao.org/forestry/ci/88504/en/>



The Latin American and Caribbean Forest Communicators Network met in December 2014 to strengthen environmental and forest communication

In December 2014, in conjunction with the Lima Climate Change Conference (COP 20), participants from Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Paraguay, Peru and Uruguay met in Lima at a workshop organized by FAO and the Universidad Nacional Agraria La Molina, bringing together experts in forest communication from various fields: government ministries, media, universities and non-governmental organizations.

The workshop aimed to define the work strategy for the renewed Latin American and Caribbean Forest Communicators Network. The network's mission is to make environmental and forest communication into a key tool for supporting national policies and programmes on sustainable forest management. It aims to

strengthen the capacities of journalists, public affairs officers and other communicators to build capacity, share success stories and promote learning among its members. The network agreed to share and strengthen common messages, such as the importance of the region to global food security.

FAO has promoted Forest Communicators Networks since 2011, with financial support from Austria, Finland and Germany. In addition to the Latin American and Caribbean network, there are regional networks in the Asia-Pacific region, the Mediterranean and the Near East, as well as Francophone Africa and Anglophone Africa, comprised of more than 300 communication professionals. There is also a global coordination group to consolidate and strengthen regional networks and provide a mechanism for mutual support.

For more information on the Latin American and Caribbean Forest Communicators Network, see <http://www.fao.org/forestry/communication-toolkit/76357/en/>

Red de Comunicadores Forestales y Ambientales de América Latina y Caribe

Red de Comunicadores Forestales y Ambientales de América Latina y Caribe Community

2,991 likes

Invite your friends to like this Page

ABOUT

Red de comunicadores forestales y ambientales creada para compartir información, experiencias exitosas, cursos y proyectos que se relacionen con el sector...

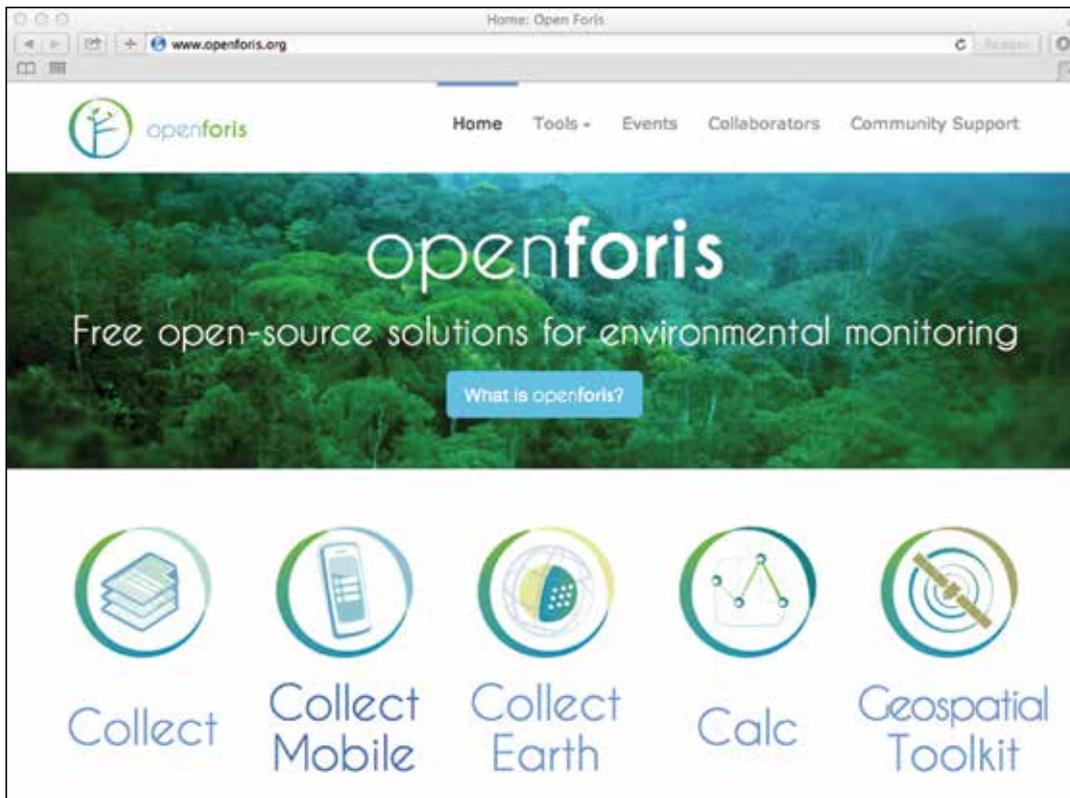
Post Photo / Video

Write something on this Page...

Red de Comunicadores Forestales y Ambientales de América Latina y Caribe 3 hrs · 🌿

Para el conocimiento de todos.
<https://www.facebook.com/ministeriomeioambiente>
 See Translation

The Latin American and Caribbean Forest Communicators Network facebook page



Open Foris provides a range of tools and interfaces

Improving national forest monitoring systems through open source software

On 10 October 2014, FAO launched Open Foris, a set of free software tools that aims to improve the way many developing nations monitor the state of their forests to tackle deforestation and climate change.

Accurate information about forests is crucial for governments to manage their natural resources sustainably, but nearly 80 percent of developing countries have difficulty obtaining and using basic information about their forest resources. At the same time, deforestation and forest degradation – largely taking place in developing countries – are among the largest sources of carbon emissions globally caused by humans.

Open Foris is designed to assist countries through the entire lifecycle of a forest inventory – from assessment, design and field data collection to analysis and reporting. The tools simplify the complex process of transforming raw data such as tree measurements and satellite imagery into valuable information in the form of interactive web pages with statistics, graphs, maps and reports.

In addition, the software includes built-in functions to help countries meet international reporting requirements, for example in the context of REDD+ activities related to reducing emissions from deforestation and forest degradation and increasing the carbon stock in forests.

Released at the International Union of Forest Research Organizations' World Congress in Salt Lake City, Open Foris tools are already being successfully tested in more than ten countries in Africa, Asia and Latin America. For example, Ecuador and Tanzania completed their first national forest inventories with the help of Open Foris tools, and a number of experts from other countries, such as Argentina, Bhutan, Papua New Guinea and Uruguay have received training to use different components of the software. Viet Nam carries out a national forest inventory every five years, and for the first time has been piloting Open Foris in one region after adapting the open source code to use the software in Vietnamese.

The governments of Finland and Germany have supported the development of the software.

For more information on Open Foris, see <http://www.openforis.org/>
Adapted from a press release issued by FAO on 10 October 2014.

WORLD OF FORESTRY

Forests featured strongly at the sixth World Parks Congress

The sixth World Parks Congress (WPC) was organized in Sydney from 12 to 19 November 2014 by the International Union for the Conservation of Nature (IUCN).

Forest areas were an important focus of the Congress, across all of the eight streams, which covered the areas of conservation, climate change, health and well-being, support to human life, development challenges, diversity and quality of governance, indigenous and traditional knowledge and culture, and inspiration for the new generation. During the Climate change stream for example, panelists examined the connections between climate change, biodiversity and forests, including the impacts of environmental change on rural livelihoods and funding issues. The Supporting human life stream looked at forest ecosystem services and agroforestry, among other areas, and highlighted the importance of forest and landscape restoration.

A summary of the event by the International Institute for Sustainable Development (IISD) Reporting Services can be consulted here: <http://www.iisd.ca/iucn/wpc/2014/html/crsvol89num16e.html>.

Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC COP20) – towards a new climate change agreement

UNFCCC COP20 took place in Lima, Peru from 1 to 14 December 2014, involving two weeks of negotiations by over 190 countries.

One of its most important tasks was to lay the path for a new universal climate change agreement, expected to be reached in Paris in late 2015. Countries worked together to elaborate the elements of the new agreement, while also establishing the ground rules for submitting their contributions.

These Intended Nationally Determined Contributions (INDCs) will form the foundation for climate action post-2020, when the new agreement is set to come into effect.

During the two-week 20th Conference of the Parties (COP), countries also made significant progress in elevating adaptation onto the same level as action to cut and curb emissions.

Zhang Xinsheng, President of the International Union for Conservation of Nature, Opening Ceremony of the World Parks Congress, Sydney



Not least, pledges were made by both developed and developing countries prior to and during the COP that took the capitalization of the new Green Climate Fund (GCF) past an initial US\$10 billion target.

Read the advance unedited version of the Lima call for climate action: http://unfccc.int/files/meetings/lima_dec_2014/application/pdf/auv_cop20_lima_call_for_climate_action.pdf

Multifunctional landscapes at the Global Landscapes Forum 2014

The Global Landscapes Forum was held from 6 to 7 December 2014, on the sidelines of the Conference of the Parties to the United Nations Framework Convention on Climate Change

(UNFCCC COP20) in Lima, Peru. The aim of Global Landscapes Forums is to create a platform for positioning landscapes in international agreements on climate and sustainable development.

The Lima event brought together negotiators, world leaders, researchers, civil society leaders, business leaders, practitioners and policymakers in agriculture, forestry and development, funding organizations and the media.

Multifunctional landscapes and land uses were at the heart of the event, with forests seen not as isolated elements but as part of a wider landscape in which all land uses are integrated, including farms, water bodies and settlements.

The event focused in particular on the need for coherent policy and legal frameworks for sustainable land use; the need to take



Global Landscapes Forum
Lima

Outcome Statement

6-7 December 2014 | Lima, Peru | Held on the sidelines of the UNFCCC 20th Conference of the Parties (COP20)

The vision of using integrated landscape approaches to address climate and development challenges was shared by the 1700 participants of the 2014 Global Landscapes Forum, in recognition that a very large part of the climate and development solutions will have to be found in landscapes. Landscapes hold the solutions for livelihoods for billions, food for everyone, diversity and protection of nature, and the foundation of the green economy. At the same time, landscapes are the source of one-third of our greenhouse gas emissions, encompass severe market failures related to natural resources, represent a fragmentation of sectors, and are subject to major conflicts and human rights problems. Against this backdrop, the 2014 Global Landscapes Forum offers the following messages.

Key messages

1. Coherent policy and legal frameworks for sustainable land use are essential for climate and development efforts
2. Act on emerging research findings related to indigenous peoples and local communities
3. Scale up landscape finance by reducing risks for investment and transforming capital markets
4. Align actions on climate change with the Sustainable Development Goals
5. Climate-smart agriculture is a large part of the solution
6. Landscape approaches can combine and reinforce climate change adaptation and mitigation efforts
7. Well-designed fiscal measures in a landscape context can be significant in addressing deforestation and forest degradation
8. The values of ecosystem services play an important role in national economies
9. Land use information technologies can transform national policies

Outcome statement of the
Global Landscapes Forum 2014

**Martha Isabel 'Pati'
Ruiz Corzo**



indigenous peoples and local communities into account; the importance of appropriate financing and fiscal measures; climate-smart agriculture; ecosystem services; and the integration of actions with the Sustainable Development Goals.

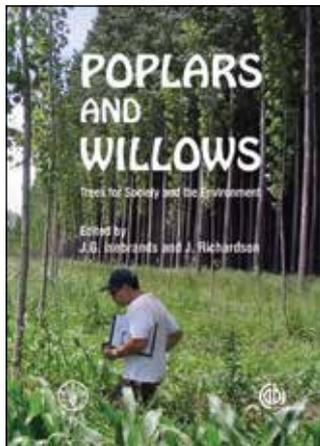
The outcome document can be consulted here: http://www.landscapes.org/wp-content/uploads/2014/12/2014-GLF-Outcome-Statement_web.pdf

2014 Wangari Maathai Award awarded to Martha Isabel 'Pati' Ruiz Corzo

On 6 October 2014, Mexican environmental campaigner Martha Isabel 'Pati' Ruiz Corzo was awarded the Collaborative Partnership on Forests (CPF) Wangari Maathai Award for her pioneering work to preserve forests and alleviate rural poverty in her native country.

One of the most prestigious forest accolades, the Wangari Maathai Award recognizes extraordinary efforts by an individual to improve and sustain forests and the people who depend on them. The award was established by the Collaborative Partnership on Forests (CPF) to honour the memory of Kenyan environmentalist Wangari Maathai, a champion of forest issues worldwide and the first African woman to win the Nobel Peace Prize.

Ruiz Corzo is recognized for making conservation profitable for rural communities in the Sierra Gorda Biosphere Reserve, one of the most ecologically diverse areas of Mexico and home to threatened species such as jaguars and green macaws as well as 800 types of butterfly. Through her Sierra Gorda Ecological Group, Ruiz Corzo successfully lobbied the government for the creation of the reserve in 1997 and instituted an intensive programme of conservation education and training for local communities, turning the reserve into a flagship for public–private ecosystem management.



A comprehensive overview of poplars and willows

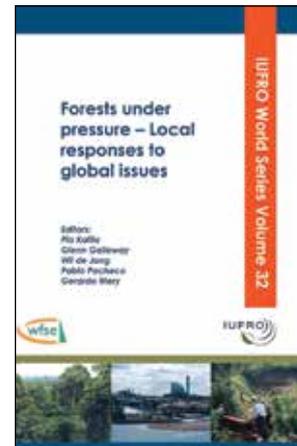
Poplars and willows. Trees for society and the environment. J. Isebrands, J. Richardson. 2014. Rome, CABI. ISBN 9781780641089 (CABI) 9789251071854 (FAO).

Natural and planted forests of poplars and willows cover about 95 million ha in the world. In many industrialized and developing countries they have become significant resources, ideally suited for supporting rural livelihoods, enhancing food security, alleviating poverty and contributing to sustainable development. Indeed they are trees for the people (Latin: *populi*) and for the earth.

This encyclopaedic reference work offers a worldwide overview and guide to the basic characteristics, cultivation and uses of poplars and willows. It summarizes the latest knowledge and technology, linking these to the achievement of sustainable livelihoods, land use and development. The book greatly expands the scope of previous publications, to include more information on willows, thorough and up-to-date treatment of taxonomic and classification issues, more global reporting, including from China and Russia, and an evaluation of applications to provide industrial, environmental, social and economic development benefits.

The book, published by the International Poplar Commission (IPC) through FAO and CABI, includes 13 chapters by nearly 70 contributing authors from 15 countries worldwide. It has more than 600 pages and is fully illustrated in black and white, with 3 sections of colour plates.

The book can be purchased and preview chapters are available online: <http://www.cabi.org/bookshop/book/9781780641089>



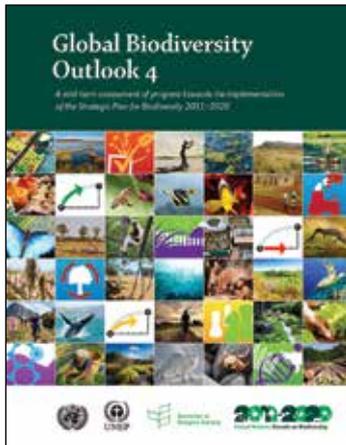
Informing progress towards sustainable forest management

Forests under pressure – Local responses to global issues. P. Katila, G. Galloway, W. de Jong, P. Pacheco, G. Mery (eds.). 2014. IUFRO World Series Volume 32. Vienna, IUFRO. ISBN 978-3-902762-30-6.

This book aims to increase the understanding of the conditions and combinations of conditions that foster or hinder progress towards sustainable forest management (SFM) and forest-related sustainable development. The book focuses on these conditions at the local level, building on 27 case studies from different parts of the world. It also includes processes and influences originating at broader national and global scales.

The idea for this book originated from discussions at the International Union of Forest Research Organizations' Special Project: World Forests, Society and Environment (IUFRO-WFSE) Steering Committee meetings in Vienna (2011) and Helsinki (2012), which concluded that increased understanding of the aspects that foster or hinder progress towards SFM is needed. The sustainable management of natural resources, especially forests, is of vital importance to global, regional, and national efforts to achieve sustainable development and should play a key role in efforts to mitigate and adapt to climate change and further low-carbon development.

Also available online: <http://www.iufro.org/science/special/wfse/forests-pressure-local-responses/>



Bringing biodiversity into the mainstream of the development agenda

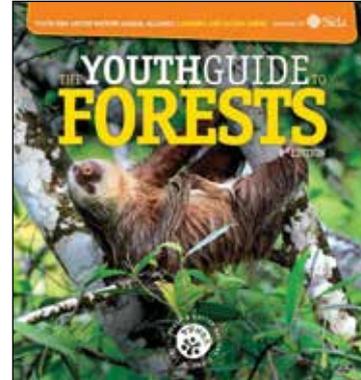
Global Biodiversity Outlook 4: a mid-term assessment of progress towards the implementation of the Strategic Plan for Biodiversity 2011-2020. 2014. Montréal, Canada, Secretariat of the Convention on Biological Diversity. ISBN 92-9225-540-1.

Published almost at the halfway point of the 2011–2020 Strategic Plan for Biodiversity, this fourth edition of the Global Biodiversity Outlook (GBO-4) provides a timely report: on progress towards the 20 Aichi Biodiversity Targets and potential actions to accelerate that progress; on prospects for achieving the 2050 Vision on “Living in Harmony with Nature”; and on the importance of biodiversity in meeting broader goals for sustainable human development during this century.

The Aichi Biodiversity Targets cannot be tackled in isolation, as some targets are strongly dependent on the achievement of others. Of particular relevance are the targets relating to the underlying causes of biodiversity loss (generally those targets under Strategic Goal A), developing national frameworks for implementing the targets (Target 17), and mobilizing financial resources (Target 20).

Meeting the Aichi Biodiversity Targets would contribute significantly to broader global priorities on the post-2015 development agenda: namely, reducing hunger and poverty, improving human health, and ensuring a sustainable supply of energy, food and clean water. Incorporating biodiversity into the Sustainable Development Goals, currently under discussion, provides an opportunity to bring biodiversity into the mainstream of decision-making.

Also available online: <https://s3-ap-northeast-1.amazonaws.com/ap1-www-docs/gbo4/gbo4-en.pdf>



A fact-filled guide to forests for young people

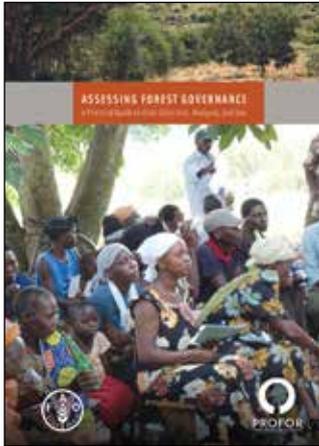
The youth guide to forests – 1st edition. C. Gibb, C. Miller, I. Sloman, R. Sessa (eds.). 2014. Rome, FAO. ISBN 978-92-5-108435-9.

This fact-filled guide explores forests from the equator to the poles, from the depths of the rainforest to high-altitude mountain forests. It also demonstrates the many benefits that forests provide, discusses the negative impacts of certain human activities and explains how good management can help protect and conserve forests and forest biodiversity. Inspiring examples of youth-led initiatives are provided, and an easy-to-follow action plan to help young people develop their own forest conservation activities and projects.

The Youth and United Nations Global Alliance (YUNGA) is a partnership between United Nations agencies, civil society organizations and other groups working with children and young people. YUNGA aims to empower children and young people to play an important role in society, encouraging them to become active agents of change. It does so by creating engaging educational resources, activities and opportunities for participation in areas of key environmental and social concern from the local to the international level.

The *Youth guide to forests* is part of YUNGA’s Learning and Action Series which seeks to raise awareness, educate and inspire young people to take action. It was jointly developed by the Convention on Biological Diversity (CBD) and FAO, with contributions and support from many other institutions and individuals.

Download this guide and other educational resources at www.yunga-un.org



A step-by-step guide to forest governance assessment

Assessing forest governance: a practical guide to data collection, analysis, and use.

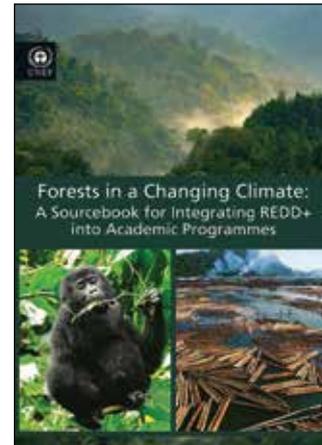
P. Cowling, K. DeValue, K. Rosenbaum. 2014. Washington DC, PROFOR and FAO.

Forest governance assessment is an expanding practice. People use assessments to watch for problems, diagnose needs for reform, monitor the progress of programmes, and evaluate impacts. Governments, civil society organizations, development partners, academics and coalitions of stakeholders have all performed assessments in recent years.

This guide presents a step-by-step approach to planning a forest governance assessment, designing data collection methods and tools, collecting and analysing data, and making the results available to decision-makers and other stakeholders. It also presents five case studies to illustrate how assessments have applied the steps in practice, and includes references and links to dozens of sources of further information.

FAO and PROFOR oversaw the production of this manual with the guidance of a representative committee of experts, following the recommendation of an FAO expert meeting to create a guide to good practices in forest governance assessment and data collection.

Also available online: <http://www.fao.org/3/a-i3918e.pdf>



Engaging universities as strategic partners in REDD+ education, research and outreach

Forests in a changing climate: a sourcebook for integrating REDD+ into academic programmes.

2014. Kenya, United Nations Environment Programme.

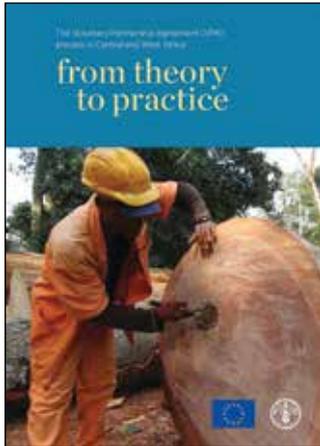
ISBN 978-92-807-3392-1.

This book represents a comprehensive syllabus for the academic study of REDD+ (Reducing Emissions from Deforestation and Forest Degradation), designed to facilitate the integration of REDD+ concepts and approaches into a multidisciplinary university programme. It identifies relevant information, tools and experience within the UN-REDD programme, and seeks to engage universities as strategic partners in REDD+ education, research and outreach.

In the words of Achim Steiner, UN Under-Secretary-General and Executive Director, UNEP, "While it is clear that REDD+ is an opportunity to build links between forests and climate change mitigation, achieving success will require contributions from researchers, scholars and students around the world. We have to invest now in building REDD+ expertise through tools such as the REDD+ sourcebook."

The sourcebook is divided into 12 modules introducing the REDD+ context and the links between forest carbon and climate change, the REDD+ approach and REDD+ readiness process, and technical aspects of REDD+ such as safeguards and measurement, reporting and verification of forest carbon. Together the modules provide background information, case studies, and key questions for discussion along with reference material and tools and methodologies. These can be used to develop university courses, produce lectures, stimulate class discussions, and draft assignments and tests.

Also available online: http://www.unredd.net/index.php?option=com_docman&task=doc_download&gid=13205&Itemid=53



Good practices in implementing Voluntary Partnership Agreements

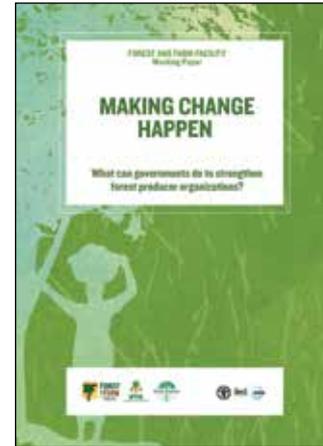
The Voluntary Partnership Agreement (VPA) process in Central and West Africa: from theory to practice. 2014. Rome, FAO.

The year 2013 marked the tenth anniversary of the adoption of the Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan. This prompted the FAO FLEGT Programme to analyse the experience of the FLEGT Voluntary Partnership Agreement (VPA) process. This study aims to foster strategic reflection in partner countries already engaged in negotiating a VPA – or those who will be entering into such negotiations – by documenting existing good practices.

The publication highlights a range of possible ways of meeting the challenges facing VPA countries. Chapter 1 looks at the pre-negotiation phase, focusing on: mobilization of stakeholders, awareness-raising and consultation, assessment of the present situation and the emergence of a national consensus. Chapter 2 addresses issues related to the negotiation phase: mobilizing stakeholders (participation and consultation), capacity-building for stakeholders, improving access to information, adapting the development of the Legality Assurance System (LAS) to the local context, and adopting a differentiated approach for domestic and industrial production.

These good practices are drawn from the experiences of eight VPA countries in West and Central Africa, the European Forest Institute's (EFI) EU FLEGT Facility and the European Commission.

Also available online: <http://www.fao.org/docrep/019/i3731e/i3731e.pdf>



Strengthening forest producer organizations for more sustainable forest management

Making change happen – What can governments do to strengthen forest producer organizations? P. deMarsh, M. Boscolo, H. Savanije, S. Grouwels, J. Zapata, J. Campbell, D. Macqueen. 2014. Rome, FAO.

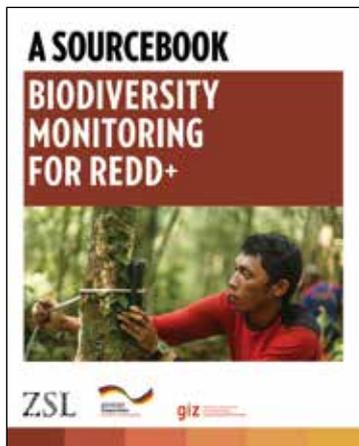
Families, communities and indigenous peoples own or manage more than 30 percent of the world's forests. Yet despite their demonstrated capacity to manage their forests sustainably, they have received little policy attention from national governments and international agencies.

Encouraging the establishment and successful development of forest producer organizations (FPOs) should be a priority for governments wishing to promote sustainable forest management and prosperous rural communities. This paper explores the factors that help build constructive relationships with government counterparts, and the policy and institutional conditions that encourage or hinder FPO development.

At least four fundamental conditions must be in place to enable sustainable forest management by communities, families and indigenous peoples: 1) secure tenure; 2) fair access to markets; 3) access to support services, especially extension; and 4) FPOs. FPOs can ensure – through lobbying and direct services to their members – that the first three conditions are in place and are maintained.

Governments should encourage the development of FPOs because FPOs can: improve policymaking by proposing supportive policies; provide coherent assessments of policy impacts from the perspectives of families and community forest producers; make services available to forest producers at a lower cost and more effectively than is often possible by government; help increase the efficiency of markets and boost government revenues by formalizing previously informal revenue streams; help resolve conflicts over competing land claims; and protect and monitor forests more closely than governments.

Also available online: http://foris.fao.org/static/fff/Making_change_happen.pdf



Clarifying the complex relationship between biodiversity and REDD+

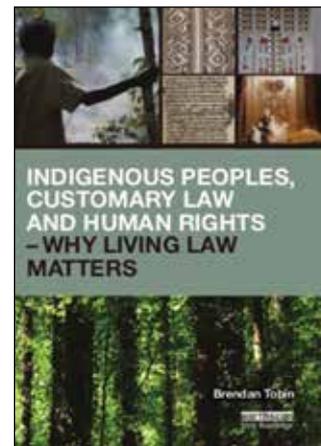
Biodiversity monitoring for REDD+: a sourcebook. J.E. Latham, M. Trivedi, R. Amin, L. D'Arcy (eds.). 2014. London, Zoological Society of London.

Biodiversity is complex. REDD+ (Reducing Emissions from Deforestation and Forest Degradation) is also complex. Monitoring biodiversity as a part of REDD+ could therefore add a complexity and cost to REDD+ that stymies rather than promotes progress. A large range of approaches is available for both project- and national-level REDD+ stakeholders in designing purposeful, effective and realistic monitoring systems. To bring clarity to the options, this sourcebook adopts a simple four-stage monitoring framework:

- Defining objectives: Why monitor biodiversity for REDD+?
- Selecting indicators: What to monitor for REDD+?
- Implementation of monitoring: How to monitor for REDD+?
- Informing relevant audiences: Sharing and using the information generated.

Five real-world examples of national, subnational and project-scale biodiversity monitoring initiatives across the globe are used to illustrate the sourcebook framework. These scenarios emphasize the range of approaches and methods used when monitoring biodiversity for natural resources management and REDD+.

Also available online: http://www.zsl.org/sites/default/files/media/2014-10/ZSL_GIZ_REDD_Sourcebook_2014_0.pdf



Customary law and indigenous people's rights

Indigenous peoples, customary law and human rights – why living law matters.

B. Tobin. 2014. Routledge studies in law and sustainable development. Abingdon, United Kingdom and New York, USA, Routledge. ISBN 978-1-138-01968-3; 978-1-315-77879-2 (e-book).

This book highlights the role of customary law for indigenous peoples' human rights and for sound national and international legal governance. It reviews the legal status of customary law and its relationship with positive and natural law from Plato's time up to the present, examining its growing recognition in constitutional and international law and its dependence on, and at times strained relationship with, human rights law.

The author analyses the role of customary law in tribal, national and international governance of indigenous peoples' lands, resources and cultural heritage. He explores the challenges and opportunities for its recognition by courts and alternative dispute resolution mechanisms, including issues of proof of law and conflicts between customary practices and human rights. He concludes that indigenous peoples' rights to their customary legal regimes and states' obligations to respect and recognize customary law, in order to secure their human rights, are principles of international customary law, and as such binding on all states.

At a time when self-determination, land, resources and cultural heritage of indigenous peoples are increasingly under threat, this book presents the key issues for both legal and non-legal scholars, practitioners, students of human rights and environmental justice, and indigenous peoples themselves.

Editorial: celebrating and safeguarding the Spirit of the Earth

by Mrs Martha Isabel 'Pati' Ruiz Corzo



For 27 years, Mrs Martha Ruiz Corzo, winner of the 2014 [Collaborative Partnership on Forests](#) Wangari Maathai Award, has worked to conserve the biodiversity of the Sierra Gorda Biosphere Reserve in Mexico. Together with the *Grupo Ecológico Sierra Gorda* she has strived to maintain the integrity of the Reserve's biodiversity and ecosystems and to provide local people with the means to rise out of poverty through the sustainable use of the Reserve's resources. In her editorial, Ms Ruiz Corzo describes why this work is so important and why at the global level we need a similar loving commitment if we are to save the planet and maintain the legacy of Wangari Maathai.

Read more ...

Ms Wangari Maathai

In 2004, the late Ms. Wangari Maathai, Kenyan environmentalist and champion of forest issues around the world, received the Nobel Peace Prize. The following year, FAO had the honour to welcome her as a keynote speaker at its [high-level meeting on forests](#). In 2012, following Ms Maathai's demise, the Collaborative Partnership on Forests established an [award](#) in her memory to pay tribute to her outstanding achievements.



FAO Forestry news

FAO Forestry announces the passing away of Mr David Harcharik, former FAO Assistant Director-General, Forestry Department, and FAO Deputy Director-General

It is with great sadness that we announce the passing away on the morning of 3 December of Mr David Harcharik. Mr Harcharik, a US national, was a former Assistant Director-General of the FAO Forestry Department and subsequently FAO Deputy Director-General. He was also a dear friend and champion of forests and foresters around the world. FAO Forestry wishes to extend its profound sympathies and condolences to the family of Mr Harcharik at this very sad time.

An editorial and tribute to the memory, work and achievements of Mr. Harcharik will be included in the next issue of inFO news.

World Forestry Congress: calls for ...



... **abstracts, deadline extended to 30 January 2015.** Abstracts on the Congress's central theme "*Forests and People: Investing in a Sustainable Future*" and on topics aligned with any of its six sub-themes will be accepted until 30 January. **View more** details here in English, French and Spanish.



... **events, deadline 27 February 2015.** Applications to organize an event related to the Congress's central theme or on topics aligned with any of its six sub-themes are now being accepted. The Congress organizers welcome proposals for side events, networking events, launches, performances or regional events. **View more** details here in English, French and Spanish.

No. 24

Forward to a friend



WFC2015
XIV World Forestry Congress

Unasylya



English | French | Spanish

Recent videos



[Celebrating mountains](#)



[Interview](#) with Foday Bojang, FAO Forestry Ghana, at the Agroecology Symposium for Food Security and Nutrition

Follow the work of FAO Forestry

... and its partners in inFO news, a regular electronic news bulletin published in English by the FAO Forestry Department. Keep up to date on major activities and events designed to support countries and local communities in increasing sustainable

forest management and food security, and reducing climate change.

To subscribe, go to <http://www.fao.org/forestry/infonews/en/>. InFO news is distributed free of charge by email and you may unsubscribe at any time.



Food and Agriculture Organization
of the United Nations