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# **INTERNATIONAL FOREST FIRE NEWS**

**No. 39  
January – June 2010**



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<http://www.fire.uni-freiburg.de/iffn/iffn.htm>

**Call for contributions**

Readers of the International Forest Fire News are warmly invited to send written contributions to the editor at the above address. These may be in the form of concise reports on activities in wildland fire management, research, public relations campaigns, recent national legislation related to wildfire, reports from national organizations involved in fire management, publications or personal opinions (letters to the editor). Photographs (black and white) and graphs, figures and drawings (originals, not photocopies, also black and white) are also welcome. Contributions are preferably received by e-mail.

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## EDITORIAL

The first issue of IFFN in 2010 has been prepared at a time of an extreme heat wave hitting the Eastern part of the UNECE region. Currently wildfires burning in formerly drained and now deeply desiccated peat lands in Western Russia are burning and emitting smoke that is covering Moscow region and the Southwest of Russia. We will report about this extraordinary situation in the second issue of 2010.

In this issue the reader will find two essays. In "Forestry and Forest Governance: A Brief Interpretive History" the American fire historian Stephen J. Pyne is opening our eyes towards understanding how forestry globalized from Europe to other continents, and how fire was encountered, sometimes with misinterpretations and misconceptions, or as evil, often forgetting that natural fires and fire cultures had shaped forest dynamics, composition and productivity. In his second essay "The Hand on the Torch: A Survey of Woods Arson" the author brings the reader to the roots of universal cultural fire history.

The following reports from three countries – Nepal, Guatemala and Cameroon – reveal the challenges of fire management today in the post-colonial world of Asia, Central America and Africa, and the solutions that emancipated from the traditional views of fire protection in these continents.

Next year – in May 2011 – the 5th International Wildland Fire Conference will be organized in South Africa under the lead theme "Addressing Global Change through Integrated Fire Management". We are looking forward to learn more about the advances in fire management in many parts of the world where traditional "fire protection" approaches are increasingly replaced by fire management solutions that consider ecosystem requirements, cultural practices involving fire use and community-based involvement.

Freiburg – Geneva, July 2010

Johann G. Goldammer

## Forestry and Forest Governance: A Brief Interpretive History

“*The Forester is a soldier of the State, and something more ...*”  
Sir D.E. Hutchins (1916)<sup>1</sup>

As long as humans have lived in or around forests, they have practiced means to govern their usage. Customary law is thick, empirical, and tenacious. But the modern epic of forestry emerged in 18<sup>th</sup> century Europe. It hammered ancient lore into new forms on an Enlightenment forge, made a devil's bargain with the state, and during Europe's global sprawl during the 19<sup>th</sup> century, became an instrument of imperial rule. It rose during the colonial era, and it has fallen with the decolonizing impulses that have succeeded it. The former lasted 50-80 years; the latter, still underway, enjoyed a brief revival in the postwar years and now promises a similar cycle of declension. Like the forests they oversee, institutions of forestry, it would seem, grow, mature, either senesce or are felled, and then regenerate or die.

### Folk Customs and Agronomic Concepts

Europe's notions of forest and governance matter especially because they have spread, for good or ill, throughout the Earth. Prior to its Enlightenment reformation, Europe had basically two notions of the woods. One was that wooded wildlands – dark, unbroken and uncultivated – were dangerous places full of masterless men. The English term “savage”, for example, derives from the Norman French *sauvage*, which derives from the Latin *silva*, or woods. A savage was someone who lived in the forest and by the chase, seemingly without a fixed residence or social order. Savages hunted, fished, foraged, and raided. The way to eliminate their threat was to eliminate the wild woods.

The competing view was the domesticated woods, or orchard. The *silva* became one of the three divisions of civilized land; the others were the *ager*, or arable field, and the *saltus*, or pasture. Classical agronomy wanted all three, but the ideal, an equal division among them, was rarely achieved and never in the Mediterranean hearth, where pastoralism sent flocks up and down mountains out of sync both geographically and seasonally with farming. (Revealingly, the cultivation of the *ager* led to *agriculture*, and that of the *silva*, to *silviculture*, but no comparable cultivation was devised for the *saltus*.) The ideal came closest to realization in temperate Europe, which, not accidentally, became the point of origin for modern forestry. The woods supplied mast, rough pasture, fuelwood, edible nuts and fruit, coppice, litter for supplementary fallow, silvi-chemicals such as potash and turpentine, and timber.

Forestry thus emerged out of the rootstock of European agronomy. It was cultivation by other means, and it both complemented and competed against the other two sides of Europe's land triad. All had a common enemy in the wild, which was unproductive, threatening, and ungovernable.

But farmers could reduce woodlands by expanding their fields or over-harvesting trees for fuel or construction; and pastoralists could shrink woodlands by releasing their herds and flocks to graze and browse away young growth. Worse, both groups resorted to fire, which could break free from its point of origin and become feral, and thus render free-burning flame another expression of the savage wilds that loomed over civilization. By the 18<sup>th</sup> century, population pressures and the climatic stress from the Little Ice Age led to serious encroachments on existing woods and to a search for new lands to cultivate. Forestry promised to stop the former and promote the latter.

The expression *forest* was distinct from *silva*. Forest was a legal definition, not a biological one, and it referred to reserved landscapes typically set aside for royal or aristocratic hunting and thus protected against trespass by farmers or grazers, and outside traditional usage. Given Britain's later significance for the spread of forestry globally, it is useful to recall that the Norman conquest put nearly a quarter of English land under royal forests, guarded by foresters, a practice and a group resented and detested by the displaced folk. The forests had their own law and court system. When the barons rebelled against Henry III, they forced a Forest Charter to complement the more famous Magna Carta. When lands were spared from wholesale clearing and browsing, however, they tended to encourage shrubs and woods (valued as covert), and hence “forest” came to be equated with “woods”.<sup>(1)</sup>

<sup>1</sup> David E. Hutchins, *A Discussion of Australian Forestry* (Perth, 1916), p. 142.

## The Enlightened Forest

Writing a survey history in 1911, Bernhard Fernow, a Prussian who emigrated to America, observed that Germany was “of the greatest interest”. It had developed the “highest and most intensive application” of forestry, it displayed all the phases of development “which other countries have passed or will eventually have to pass,” and it had influenced directly or indirectly “many if not most of the other countries of the world”. The magnitude of German precedents made it “the fatherland of forestry”.<sup>(2)</sup>

All this was true. Germans invented the rudiments of modern forestry, determined its social standing, aligned it with the state, and for nearly a century carried its precepts to other countries. This diaspora followed a long tradition of professionals who sold their services to whatever nation was willing to pay, and closely echoed a parallel diffusion of German naturalists (on the Humboldtian model) who attached themselves to national surveys, including those of the colonial powers. That Germany did not have overseas colonies only added impetus to the emigration elsewhere.

Still, these freelancers of forestry could no more recreate a precise facsimile of their academic ideal in other countries than they could a German village or university professorship. In truth, only in select sites did the ideal even find expression in Germany itself. A 19<sup>th</sup>-century Finnish forester wryly observed that what German textbooks criticized in remote, swiddened Finland might as aptly characterize parts of Germany. A British forester, on study leave to tour the hearth of his profession, was aghast at smoke-filled valleys around the Black Forest, the product of agricultural fire regimes (*Brandwirtschaft*) that he found indistinguishable from his previous post in east Africa.<sup>(3)</sup>

Equally, Fernow’s outburst of Prussian pride might have been tempered with a dose of irony, for the restructured Prussian forest in its purest expression has become, in contemporary times, a paradigm for how the Enlightenment state had wished to see the world and what those wishes have cost socially and environmentally. Further, for such critics Enlightenment forestry has come to symbolize the havoc caused by ill-conceived international developmental projects – many of which have historically concerned the forest sector. What the 18<sup>th</sup> century thought a paragon, like Max Weber’s idealization of the Prussian bureaucracy, the late 20<sup>th</sup> century has often viewed with horror, a case of reason turned to nightmare.<sup>(4)</sup>

Its pact with politics made forestry powerful. It also compromised what the guild regarded as its disinterested rationalism. What foresters viewed as a necessary and progressive alliance could become simply an instrument of the state, for ill as well as good. Forestry’s pact was, in retrospect, a Faustian bargain.

## Forestry Claims State Sponsorship

In the 18<sup>th</sup> century a crisis and an opportunity came together to provide a catalyst for reform. The crisis was economic, which took the form of a wood shortage (for both fuel and timber); the opportunity was intellectual, the promise of replacing primitive practices, full of waste and superstition, with “rational” ones grounded in the premises of modern science. In brief, the Enlightenment spread to the woods; it sought to codify existing knowledge, to bolster production through experiment and close observation, and to submit all to the glare of Reason. Forestry slowly sloughed off its overtly peasant-spun chrysalis and became a distinctive subject for academic discourse.

That was one veneer of what became a three-ply synthesis. The second was a bonding with the state. Again, Germany (Prussia, particularly) pioneered, as it began placing restrictions over private and communal exploitation of woods and as it commenced state sponsorship of reclamation by forestry, notably, along the sandy margins of the Baltic. Announced controls were always negotiated: any restraint was unpopular. But plantings were a means to convert “wasteland” to productive land. Pine plantations spread like rye fields, and through them, the state could enhance its revenue, support a denser population, and expand its claims over wooded lands. By 1754 Prussian foresters were given supervision over communal forests generally. (A parallel, less expansive but more systematic effort was underway in France, epitomized in the Code Colbert.) By the mid-19<sup>th</sup> century the tenets of forest administration and the apparatus to apply it were present in most of the advanced European nations.<sup>(5)</sup>

Foresters long insisted that an alliance with the state was essential because peasants would chew up existing woods to satisfy immediate needs, because trees took so long to grow that a liberal market would never allow a proper industry to emerge otherwise, and because forests produced assorted collective goods through their environmental “influences,” such as stabilizing climate and reducing floods, that properly fell under state responsibility and that only the state could sustain. In effect, foresters expanded the traditional communal forest to one the scale of the state and reorganized its principles and practices along lines deemed appropriate for a modern society. As *cameralists*, they sought to do for forests what their colleagues tried to do for other aspects of what they collectively conceived as an ill disciplined and misallocated economy.

That required that they justify their assumed power by something other than raw force. Accordingly, they established a discipline, academic forestry, as a subset of political economics. Professorships and support came through the state and became institutionalized in special forestry schools. This became the third ply, and with it, the origins of modern forestry were complete. It could boast an academic base, a pact with the state, and a corps of self-identified practitioners. It would speak equally with the authority of science and government; its members could pose a common front against ragtag congeries of farmers, graziers, and villagers mired in customary usages as ill-formed as a fallowed forest. Both the folk and their woodlands needed tending.

Still, forestry’s state alliances were as fragmented as a pre-unified Germany. Its fuller symbiosis with political power occurred in France. The *Code Colbert* (1669) had sought to liberalize communal forests, or more properly perhaps, to subject it to the *dirigiste* economy of the state. By 1825 a *Code Forestier* had modernized that ambition, and valenced it to an emerging alliance between the economics and environmentalism of the day. Although honored in the breach more often than in observance, the Code proposed a valence not only between state and forestry but between economics and environmentalism in which the state could do well by doing good. It disseminated widely and inspired reformers everywhere. “I know of no modern system of Forest Exploitation, based on modern Forest Science,” wrote John Croumbie Brown in 1883, “in which I cannot trace its influence”.<sup>(6)</sup>

In particular, France directed forestry to underpin large-scale public works, of which two became internationally renowned; the reclamation by pine plantings of Gascony’s sand dunes, and the reforestation of the alpine regions to prevent floods (known as “torrents”). The first enlarged the practice initially devised for the Baltic of converting *Landes* wasteland into agricultural landscapes. The second sought to rehabilitate landscapes denuded by reckless felling, browsing, and burning, which is to say, the excesses of agricultural colonization. The state’s interest was justified primarily by the effect of damaged watersheds on downstream farmlands, cities, and riverine transport. Behind both impulses, too, lay an inchoate if crystallizing belief that planting trees improved climate.

The establishment of a national forestry school at Nancy, which later fell under German jurisdiction after the 1870 war, advertised an emerging global culture of forestry and state-sponsored conservation. What remained was to project that Franco-German condominium outward, not only to the peripheral regions of Europe such as Spain, Italy, Greece, Russia, and Scandinavia but to Europe’s colonies. Around Europe’s fringe, this took the form of exported ideas, and often of institutions, as each state judged its modernity against its neighbor. As traditional economies broke down, forest “engineers” became a vehicle for modernizing landscapes – converting lands from subsistence agriculture to commodities valued by an industrializing economy. Always, too, there was the promise of more revenue to the state.

But it was overseas that forestry became truly powerful. It bonded to the imperial state even more firmly than in Europe, and it acquired powers it could never have known in its homeland. It could compel fundamental reforms in land use, and it could justify its power by appealing to science, by its self-proclaimed status as a profession, and by the benevolent “forest influences” a properly managed forest brought to society as a whole, even when that commonwealth had been acquired at gunpoint. In brief, forestry became a means of projecting state power and a means of justifying it.

## Imperial Forestry

The expansion of Europe came in waves. The Great Age of Discovery kindled one, led predominantly by Iberians and organized by such institutions as the military, the church, and a late-Medieval or early-Modern monarchy. The late 18<sup>th</sup> century witnessed a second outburst, cresting a century later, that

primarily featured northern Europeans, and it replaced the Cross with the *Encyclopedie*. This was an Enlightenment epoch: secular bureaus based on nominal science replaced ministries based on religion. Older institutions stubbornly resisted retrofits, but the newer colonies grew up with them or their formative ideas.

In this second era, foresters did much of the hard work of colonization. They were an international guild of engineers much like those who opened mines, built railroads, or surveyed military cantonments. France projected its foresters – outfitted with uniforms and ready for drafting into military duty as needed – into the trenches of land reform as it leaped across the Mediterranean into North Africa. Germany exported the system to its late-acquired colonies in Africa. The Netherlands brought rudimentary forestry to Indonesia. Russia established a forestry institute the way it did an academy of sciences, by importing its experts, mostly from Germany. All the colonizers established forestry schools to furnish staff. But the primary vehicle for expansion – certainly the most globally important – was the British Empire.

The irony is thick, for by the mid-18<sup>th</sup> century Britain no longer had any meaningful forests and was busily stripping Norway and then Sweden to supply its craving for timber, and, when it acquired valuable woods in overseas colonies, it had to recruit forester-administers from Germany and train cadets overseas, not only for overseas assignments but for the Home Islands. Not until 1887 when private subscriptions endowed a forestry chair at the University of Edinburgh did academic forestry appear, and then staffed by a German who had previously worked in India. Forestry was an artifact of empire; it became an indispensable adjunct of imperial administration. A country without forests became the paragon of professional forestry's engagement with the modern world.

#### *British India: template*

The originating motives were Burmese teak and, after the British East India Company consolidated its reach, the role of land clearing in upsetting climate and public health. Whether or not rain followed the plow, drought seemed to follow the axe. After several experiments, Governor-General Dalhousie proposed in 1855 a Charter of the Indian Forests and the next year appointed Dietrich Brandis superintendent of forests for Pegu, Burma. Together the reforms sought to introduce the kind of rationalization that Dalhousie was pursuing for Indian government, society, and economy through the introduction of telegraphs, railroads, revenue settlements, and rule of (British) law. The revolt of 1857 quickly halted the process, but it roared back stronger than ever after India became a Crown colony (and then an empire in 1884).<sup>(7)</sup>

Though trained as a botanist, Brandis knew academic forestry and understood the systems of management practiced in Europe. He instituted systematic reforms, leading to the Indian Forest Act VII of 1878, which effectively founded the Indian Forest Department. He hired as deputies two other Germans, Wilhelm Schlich and Berthold Ribbentrop. Schlich succeeded him as Governor-General before assuming the forestry chair at Edinburgh, editing the *Indian Forester* (for several decades, the premier forestry journal in the world), and writing the standard text, the 4-volume *Manual of Forestry*. Ribbentrop replaced Schlich, wrote a book on forestry in British India, and found himself memorialized in a Rudyard Kipling story that explains what happens to Mowgli, of the *Jungle Book*, after he grows up (he joins the Indian Forest Department).<sup>(8)</sup> Recognizing the need for trained staff, Brandis arranged for cadets to study at Nancy, embark on a Grand Tour of European forest management, and then do their field apprenticeship in India before assuming assignments elsewhere. To create an Indian support staff, he established a forestry school at Dehra Dun. In 1884, as India officially joined the Empire, education transferred from Nancy to Cooper's Hill College for Indian Engineering, and then to Oxford University in 1905. In 1925 its scope expanded into the Imperial Forestry Institute.

#### *Diffusion by personality*

To an astonishing degree, the vision of forestry rooted in central Europe diffused throughout the world not only as a standard but as a working prescription applied by the major imperial powers, sometimes successfully, most often with very mixed results, as they sprawled across the globe. The fusion of academic discipline, guild, political clout, and actual land management proved hard to unseat. Critics could not muster an equivalent compound of ideas and institutions to act as a counterforce. Specifically, forestry had two things its challengers did not have. One, unlike academies and research institutions, it had real power because controlled lands. And two, unlike many other government agencies created to promote public good, forestry promised to pay for itself; it might even generate additional revenue. Foresters declared themselves, with some justification, the vanguard of state-

sponsored conservation globally. And like victors everywhere, foresters even wrote the histories of their triumph.

As an illustration, consider the remarkable career of Bernhard Fernow. Trained in Prussian forestry, he married a visiting American woman, emigrated to the U.S., where he became its first professional forester, and directed the Bureau of Forestry from 1888-1898. At this point he established a forestry school at Cornell, with ties to New York's Adirondacks Park, until controversies over logging methods pushed him into Canada, where he founded Canada's first forestry school at the University of Toronto. He ended his career deeply involved with Canada's embryonic conservation movement while writing a world history of forestry. His personal career might stand as synecdoche for forestry's.<sup>(9)</sup>

Even the United States, nominally independent, found itself within the orbit of Britain's forestry. Fernow was succeeded at the Bureau of Forestry by Gifford Pinchot, who considered Dietrich Brandis an inspiration, later writing in his autobiography that he hoped to achieve something in the U.S. akin to what Brandis had achieved in India. At Brandis' suggestion he studied for a while at Nancy before returning to the U.S. to speed up the cause for reform, all the while continuing to correspond with his mentor. He soon joined the Committee on Forests that the National Academy of Sciences had created to review how the country should manage the forest reserves it had begun creating by presidential proclamation. In that assignment he helped deflect arguments, partly based on the experiences of British India and partly by the success of the U.S. Army in running the national parks, that the country teach forestry at West Point and create a corps of forestry engineers. Instead, the U.S. would find civilian alternatives. Pinchot showed where and how.

In 1900, more out of expectation than from actual demand, Pinchot and Henry Graves founded the Society of American Foresters, and then devised a way to fill its ranks. The scion of a wealthy family, in 1900 he convinced the Pinchot estate to endow a school of forestry at his alma mater, Yale University. In 1905, a year after the School's first class graduated, Pinchot persuaded President Teddy Roosevelt to transfer the forest reserves that had been created since 1891 to the jurisdiction of the Bureau, which Roosevelt did. The Bureau of Forestry became the U.S. Forest Service. Henry Graves, also went through the Nancy regimen, with a valedictory field trip to India before stopping by America's recent imperial experiment in the Philippines, soon to have a forestry bureau of its own. Graves returned to the U.S., where he became dean of the Yale School of Forestry before assuming the office of chief forester in 1910 after an over-zealous Pinchot got fired. In less than five years the apparatus for forestry, in all of its parts, had arrived in America.

#### *Diffusion by guild and institution*

The project commenced a secondary radiation to American territories and commonwealths, but it propagated with special force through Canada. As Fernow's career illustrates, Canadian forestry had two major tributaries, one from the U.S. and the other from Europe, partly through British imperial forestry and partly from France, through Quebec. The American influence was compelling; the U.S. Forest Service became a model for the Canadian Forest Department, Pinchot seconded several deputies to assist the birthing, and chief foresters for several provinces (including Quebec) graduated from the Yale School of Forestry. Forestry's dominion was vast; and virtually all of Rupert's Land, acquired from Hudson's Bay Company, fell under a loose forest administration, save the prairies. That federal presence expired in 1930, however, when the dominion government ceded its estate to the provinces. The Canadian Forest Service imploded, surviving as a diminutive rump in a role as a research organization. Thereafter the provinces assumed control of field forestry.<sup>(10)</sup>

Similar transfers and transplants occurred throughout the European imperium. British India trained foresters from Hong Kong to Belize and effectively staffed Thailand's Forest Service; the Burma Forest Department became the model for the Federated Malaya States and Kedah. The Soviet Union carried its system to China, Mongolia, Eastern Europe, and Cuba. And apart from direct state transfer, a global circulation of foresters sponsored by aid agencies and development bureaus propagated their professional norms. So the cascade continued, with each subsidiary recipient altering in the process, so that the several-generation progeny might little resemble their patriarch; but the ideals remained coded in their institutional DNA nonetheless.

That process of hybridization had always been the case. The narrative that forestry had simply stamped its way out of Germany and impressed itself around the world like heelmarks had ever been a caricature. Always there had been local adaptations; always, too, the ideal persisted. Sir D.E. Hutchins, for example, could recognize that "Often, what is right in European Forestry is wrong in

Extra-tropical Forestry”. Yet he could equally rail against slovenly Australians who insisted that their circumstances were unique and justified a calculated indifference to the norms. “What foreigners can do in Southern Europe, or Englishmen can do in India and South Africa, Englishmen can do in Australia if only the matter is put squarely to them!”. What endured was System and its disciplined application.<sup>(11)</sup>

So if Indian foresters had to accept early burning, if Burmese foresters had to yield teak silviculture to Burmese peasants, if Cypriot foresters had to accommodate goats, if Algerian foresters had to turn an occasional blind eye to encroachments by transient Berber pastoralists, they did. They would do what had to be done. But they yielded grudgingly and with full acknowledgement that they were making the best of a bad hand. However elusive the ideal, it shone brightly, and the grandees of the caste would chastise and belittle them if they failed to measure up. They were a brotherhood with a cohesion that transcended local circumstances; they could always refer back to standard texts, to their group identity as a guild of engineers, to foundational landscapes. That they transferred from one colony to another reinforced the sense that, behind all the distortions of the material world, there lay a Platonic ideal to which they would strive.

### **Global Forestry: The Good, the Bad, the Ugly**

The program had plenty of attractions. For almost two centuries European scientists had observed the blowback from forest clearing on such islands at St Helena and St Kitts, and devised what has been termed a “desiccation discourse” that linked deforestation with drought. It was also only too apparent that the outwash of global capital was capable of denuding vast landscapes, and that loosely managed colonies like India under the nominal rule of the British East India Company could do little to halt it, even if they wished.<sup>(12)</sup>

The ritual of ruin was tediously common. Local communities, with their oft-pliable or corruptible headmen, could not resist the blandishments of money and power. The land would be nominally bought or transferred by treaty and then cleared of its most valuable timbers like teak, much as buffalo hunters in North America slaughtered immense herds for their humps and tongues. A brief flush of high-grade timber was followed by decades of weed trees and the prospects, which grew to alarming proportions by the end of the 19<sup>th</sup> century, for an outright “timber famine” that would cripple both agricultural and industrial economies. Private wealth and public squalor – a few individuals or companies became fabulously rich, while societies had to pick up the pieces and endure the collective deterioration of their air, soils, waters, and habitation generally.<sup>(13)</sup>

State forestry promised to stop the bad and promote the good. As an institution of government (whether national or imperial), it could stand between the ravages of global capital and local communities; it could halt the forest scalping, the dislocation of watersheds, the ravenous wildfires, and the perturbed climates that unchecked logging left behind with its slash. It could, through the power of the state, conserve the forests for society overall and for the future. Equally, it did not propose to stop commercial use. Rather, outfitted with modern science and academic rigor, it promised to rationalize the harvest of timber, and such was the power of its discipline that it would generate revenue in the process. Forestry would pay for itself, and more. To its proponents, there was no downside to such an agenda.

But of course there was. By arguing that it would pay its own way, state forestry was forced to harvest timber, and as expenses increased, it had to log more, not only for its own expenses but to enhance the revenue of the state generally. During economic and political crises (such as wars or the aftermath of large fires), regulations seemed to vanish, and overcutting could result that was indistinguishable from what foresters had been empowered to prevent. Just as insidious, state forestry established a premise that it repeated over and over that further compromised its capacity to do what its justifying claims said. Each reform in its own land usage, every response to past failures, cost money; and it was only by logging now that it could get the funds to instigate improvements later. The cutting always got done; the promised reforms came spottily. Unlike other public services, foresters ever insisted that their agenda would pay for itself. It rarely has.

Moreover, the guild was so cohesive and self-identified that a subtle collusion evolved between practitioners within government and those within industry: they all had the same education and the same caste values, and came to identify among themselves more closely than with their governments or sustaining societies. In time, the private sector, which generated the most money and jobs, could

supplant the public sector as the norm for good practice. There was often no comparable body of experts or public servants to stand against it. If forestry colluded with other agencies of the state, there might be no rival organ of government either. In time it could move from being an exemplar of conservation to a nemesis; and too often it did.

Not least, forestry's origins in central Europe severely undercut its capacity when far removed from that setting. This proved particularly the case with fire. Temperate Europe had no natural basis for fire, which it associated with primitive technology and social disorder, and it sought to extirpate fire as it would spruce budworm or blister rust. But most of Europe's colonies, where state forestry found its greatest power, were awash with burning. In such places colonial forestry became one long firefight. Foresters could, at times, hardly see the forest for the flames. Yet, paradoxically, in such places fire's abrupt removal could prove more damaging than its free-ranging continuation. Here all the aspects of forestry that made it attractive to the state – its academic base, its coherence as a guild, its conviction, its engineering impulse to act in the field – worked against it. Foresters were unable to cope with the fire scene and in the end undid much of their good works by trying to shut down a phenomenon whose crime was that it challenged the precepts of Franco-German forestry and the capacity of foresters to control their land as they determined.<sup>(14)</sup>

Even the nominal science behind forestry often proved suspect, or at best mediated by its circumstances of origin. European forestry remained, at heart, a graft on the rootstock of European agriculture: the ideal forest was a planted forest, raised as a crop. The great expressions of state sponsorship had reforested or afforested to reclaim wastelands, to undo the excesses of overclearing and overgrazing, and to assure a dependable supply of fuelwood, timber, and later pulp. In all these cases, the landscape was barren; foresters planted it as they might potatoes. In colonial settings, however, the forestry bureaus often oversaw vast estates that most observers considered either unruly fallow or outright wildland. To install the forestry ideal – and to make tree farming pay – the preferred practice was to log the land clear and then replant it to suitably commercial trees grown according to “scientific” standards.

So how did this differ from industrial-era logging and folk reclamation for farms? As trained engineers, foresters insisted they knew how to do the logging properly; as civil servants, they would see that the proceeds went to society; and as a professional guild, they could police themselves. They would not be unduly influenced by outside (and irrelevant) considerations, whether political, commercial, or ideological. To critics, of course, none of these assertions was true, and the guild had become a self-referential world unto itself, incapable of seeing its own failings or, worse, a puppet bureau of raw state power or outright extortion.

## **Strategies of Forest Administration**

### *Protecting forests, reserving forests*

At the core of colonial forestry was a program of forest regulation, which had its purest expression as a system of reserved lands. The project returned “forest” to its original, legal definition, as an area set aside for a special purpose. Without control over land, forestry had little power: it was simply another among a chorus of bureaucratic counselors. The point is worth repeating. While state forestry agencies did research, regulated practices, and advised government, their control over land is what differentiated them from scientific bureaus, regulatory agencies, constabularies, and consultation councils. Where they oversaw land, they were powerful; where not, not.

Reserves were justified where the state deemed unregulated land as a threat to public safety or as an impediment to a modern economy. Especially when conveyed in the form of reserves, forest law was a vehicle to prevent abusive land use, to forestall timber famines, to ensure public health by stabilizing climate and watersheds, and to enact compulsory modernization, a latter-day version of the enclosure movement. They were most complete where the state could impose its will most forcibly.

Still, a constellation of options and categories of tenure existed. A “protected” or “reserved” forest could mean many things, and that meaning for any country could change over time. How completely state forestry might control a reservation varied; there were degrees of control, just as there were degrees of imperial power exercised over its colonies. Much of the British “empire”, after all, depended on indirect rule, and the same was thus true for its gazetted forests. Forestry's rule could bring it into conflict with other imperial agencies and of course with locals, which is why the program worked best

with uninhabited lands. And of course the program, designed for temperate Europe, inevitably struggled to realize its ambition. Some state forestry bureaus thus oversaw lands for which they had little say apart from regulating logging; others, lands over which they could ban or segregate local farmers and grazers; and some, from which most use was proscribed, which functioned more or less akin to parks.

*Scandinavia: from forests to tree farms*

Applying such doctrines in long-established countries was always troubling; most lands were already occupied, and protest lay worryingly close to the capital. Most often an alternative strategy emerged whereby the state exerted its influence through legislation that prescribed what landowners could do or not do with their holdings. Germany and France again pioneered, but the concept achieved perhaps its finest expression in Scandinavia.

It was through forests that Sweden and Finland began their serious industrialization, for not only did forests provide timber and tar for export but fuel for emerging iron factories. Helpfully, most of the northern lands were lightly settled or occupied only seasonally. The state claimed approximately 25% as public forest while companies took an equivalent amount. The real innovation was the conversion of private lands, most notably through Sweden's succession of forest laws, beginning in 1903. The legislation was intended to assist the conversion of marginal farms into tree farms. Landowners were told what to plant, when and how to prune, and when to harvest. While the land remained theirs, the timing and output of timber and pulp remained under the control of society, manifest in local forestry boards.<sup>(15)</sup>

Seemingly radical, the idea was mostly evolutionary. It kept forestry securely within an agricultural matrix – literally so. It did not result in massive resettlements, collective farms, or wide-scale abandonment. Instead it replaced an existing, faltering agriculture with an upgrade such that even the landscape retained its infrastructure, with trees substituting for rye much as silica replaces lignin in petrified wood. While the concept fed nicely into emerging expressions of what would become Swedish socialism, it really modernized what already existed, and it relied on cultural conventions inherited from past times, which granted all citizens certain kinds of access to land. The concept has not proved widely transferable outside Scandinavia.

Still, Europe shows several variants, which look as much to the Baltic and Landes origins of forestry as to Sweden. World War I alarmed Great Britain with its dependence on imported timber, an essential war material. It approached the crisis from two directions. One, it formalized its loose-jointed imperial forestry operations by sponsoring conferences, creating a journal, and otherwise seeking to assure a reliable source of supply. And two, it established a Forestry Commission to create an internal woods industry by selectively reforesting Britain by means of plantations on marginal farmland. As the plantations have matured, they have run afoul of environmentalists, save where they use native species to recreate ancient forests as in Caledonia.<sup>(16)</sup>

Another experiment emerged from Iberia. During the Franco and Salazar dictatorships, the state sought to convert marginal communal lands (*montes*), mostly given over to pastoralism, to industrial forestry, and commenced afforesting with eucalypts. The exercise was an eerie echo of the Carlist liberalization program, and ended no better. Local communities resented the confiscation and detested the exotic trees. Not only was traditional usage legally denied, but the allelopathetic trees denied biological access as well since the local flora and fauna could not survive within them. In dual protest, as the trees reached pole size, arson fires broke out. The lesson in both instances is that the "modern" vision of forestry, with an emphasis on commercial species and plantations, would fail unless it built upon a legacy of custom and a culturally useful biota.<sup>(17)</sup>

*Colonial model: Inhabited lands*

The real contest laid overseas where the state could exert its will more freely and where the only civil society to oppose the program could be deemed insurgents and hence suppressed. The project played out in two general contexts, one on inhabited lands, and one on uninhabited. The former typified British imperialism in India and French rule in Algeria; the latter, the United States, Canada, Australia, and in a different way, Russia.

Gazetting forest reserves in countries that were already inhabited provoked endless fights, often violent. People who were moved off lands, or denied seasonal access, or were constrained in their traditional use felt oppressed rather than environmentally uplifted. They denounced state-sponsored conservation as a land-grab, engaged in trespass as acts of both protest and subversion, and lit proscribed fires. Officials might point to the ineffectiveness of local politics to resist the suasions of footloose capital and leave a landscape wrecked for decades, and they might sanctify their decisions on the basis of a “rational” science, but indigenes tended to see only restraints and hardship and a disregard for customary lore and usage. Higher causes and a modern market meant little, while prohibitions against burning, gathering plants, and goat grazing brought immediate hardships.

Traditional usage was, to use James Scott’s term, “illegible” to officials. Indian landscapes, for example, resembled Indian society; syncretic, layered, dense. Foraging for *mowhia* flowers, nuts, medicinal plants, small game, and bee hives could not compete with teak, *sal*, and *chir* that had monetary value in the international market and could serve as sleepers (ties) for the rails that would modernize India. Official scorned such “minor forest products” and were baffled that villagers would not agree with them. The timber brought money, and money could help pull India out of its bullock-rutted mire of superstition and subsistence living. And better, foresters could regrow the trees to make the process sustainable. “Forest conservancy” it was called. Indians viewed it as Saxons did Norman confiscation, and English peasants did Parliamentary enclosure. What was true in British India was often magnified in Cyprus, Cape Colony, Kenya, and Sierra Leone.

It was even worse in Greater France. French forestry had grown in temperate France, and as France expanded southward it had to grapple with very different environments within its national estate in ways not true for Germany or Britain. Provence, the Cezennés, and the Midi exhibited wildly different settings from the north, particularly for fire and grazing; but it was the French genius (and burden) to try to yoke them within a common administrative and conceptual system with the Ardennes and the Paris basin. When France acquired Corsica, it could no longer pretend to impose a common order; and the scene only worsened across the Mediterranean. Foresters throughout French West Africa, but especially in Algeria, found themselves in one long upheaval, usually in the form of a firefight.<sup>(18)</sup>

Still, France posed an alternative to British imperial styles, and to that of Germany, particularly once it was weakened and isolated by the Great War. Americans, especially, rekindled an interest in European forestry through participation with French colleagues during World War I. After the war Theodore Woolsey, Jr., published a study of French forestry, with an eye to improving American silviculture, a position with which William Greeley, then chief forester of the U.S. Forest Service, concurred. Gifford Pinchot wrote a preface in which he agreed, noting that Americans could learn much from French experiences in Algeria (what exactly, other than getting out, is unclear). Where their experiences did bear resemblance was to the American South, then the heartland for American logging and soon to acquire national and state forests, all built out of formerly open range and soon to have a stubborn insurgency.<sup>(19)</sup>

#### *Colonial model: Uninhabited lands*

The contrast with the American far west is striking – and that highlights the global contrast between a colonization that imposed forest reserves on inhabited landscapes and a colonization that moved into territory more or less vacated by war, relocation, and disease. Here, the reserves could be vast, and while foresters had to fight off the trespass of pastoralists and the occasional homesteader, the reserves predated the bulk of settlement. Their politics were completely different.

This made it possible to enact the precepts of Schlich’s *Manual* without constant harping from indigenes. American foresters, especially, were quick to distinguish between bad use, which they prohibited, and good use, which they sought to promote. It was positive use that distinguished state forests from parks which only “locked up” resources. While this was never enough of a justification for locals, aside from Indian tribes sequestered onto reservations, they had no traditional claims or rights of usufruct. The irony is that the features that made the lands remote from settlement also made them remote from markets. For decades the charge to foresters was to hold those lands until such time in the future that they might be needed. They remained wild lands under the managerial hands of a caste that by training and temperament distrusted wild lands and who bided their time until they could practice what their education and guild mores told them they ought to do.

This was the situation generally in Australia and Canada, and in a skewed way in Russia. They all show variations on a theme. In North America the proportion of public (or crown) land increases to the

west, as larger expanses of acquired lands coincided with the growth of state-sponsored conservation as an idea. A third of the U.S. is now public land, with a third of that in Alaska. Roughly 97% of Canadian forests lie in crown land, almost all under the jurisdiction of the provinces. The Yukon and Northwest territories have, for purposes of forestry, moved from status as territories under federal purview to provinces with control over their woods. Australia's public lands followed the Canadian example and reside in the provinces (save for national parks).

The spectacular examples of state forestry are those on public or uninhabited lands. Here forestry bureaus flew the flag, laid down an infrastructure, codified practices, and sponsored research; they did what in private lands would be called "settlement." If their reach was astonishing, so was their ambition; in 1910 the U.S. Forest Service had only one fire guard for every 670 square miles. It's astounding – and unmistakable testimony to their conviction and zeal – that they even attempted to exert control under such circumstances. They saw themselves in a crusade for conservation, as proconsuls of a global project, and they acted accordingly. Their larger societies generally agreed and knighted many leading British foresters for their achievements.

Yet the overreach extended to ideas as well as staffing. The forestry they learned at Nancy said little about the realities of sprawling wildlands that mocked the prospect of wholesale felling and replanting according to the prescriptions of formal silviculture. About all they could do was to protect, not manage: they fought fire, expelled trespassers, pushed back against political schemes to privatize. They made token gestures toward wildlife and watersheds and recreation, but they regarded such amenities as the equivalent of minor forest products. The only genuine market value lay in timber – and timber harvest, or its future promise, was what paid for forest administration. They did not consider their reserves as parks or nature preserves. They were working forests, whose capital was presently banked, but would eventually to be spent.

Ultimately, they succeeded, or failed, not by forcing indigenous communities to modernize but by holding land while, from other causes, those surrounding communities and sustaining societies changed, and the two agendas came into alignment. A general industrialization unwound some of the land-competing pressures that had traditionally pitted foresters against farmers, grazers, loggers, and charcoalers. State forestry was less an instrument for reform than a means to hold out while that general reformation worked out its narrative. As the British expression "forest conservancy" implied, forestry was a conservative presence. That, paradoxically, left it vulnerable to societies that changed in ways that came to value those public lands for purposes other than forestry. Post-industrial societies could challenge forestry as fully as pre-industrial ones.

State forestry was thus poorly positioned for the post-World War II era. In developing countries, it could not resist becoming a tool of the state for purposes other than conservation, and in developed ones, it could not address the emerging amenity and ecologically based values of an industrial society. As the forestry guild became more technically proficient, it became more culturally illiterate. In place of their founding vision as fearless protectors against waste, public corruption, and private monopoly, they came to resemble pliant state banks, a vehicle for political manipulation, without significant checks and oversight from the civil service that staffed them.<sup>(20)</sup>

## **Decolonizing Forestry**

The great bureaus had swelled during the era of European imperialism, and in places like the United States and New Zealand they later became vehicles for massive environmental and social engineering during the Great Depression when national states exerted themselves more forcibly over their homelands. But the postwar period commenced an era of decolonization, and those agencies shrank, imploded, or reconstituted themselves according to the particulars of their political setting.

### *Developing nations*

Surprisingly (or perhaps not), much of the developing world kept those institutions, and sought to redirect them to more suitable purposes; this was the case with India, for example, as it refused to disassemble the elaborate apparatus of the forestry raj and instead baptized it in the waters of Nehruian socialism and had it born again as "social forestry." Ghana kept its Forest Department and its gerrymandered forest reserves, but without effective funding to run them. South Africa's

Department of Water and Forestry Affairs retooled to establish a softwood industry. Myanmar's Forest Department became a hollow shell, or a cover for timber looting by the ruling junta.

But state forestry in these countries had always been compromised from an ideal because of local resistance, not only social and political hostilities but a pervasive ecological obstinacy. The further the scene from a central European ideal, the more widely practice diverged from published precepts. Foresters had always relied on local staff, which gradually tweaked and accommodated mandates into something that could survive local circumstances. Certainly in British forestry indirect rule proved as necessary in woods as in cities. In India, for example, forest guards often lit so many "protective" fires that the outcome might be indistinguishable from the indigenous burning it was intended to prevent. When European notions for regenerating teak failed, a hybrid agro-silvicultural system (*taungya*) was devised – with approval from Brandis himself – to substitute. In Burma the jungle of resistances, ecological and ethnic, became so great, and the failure of British silviculture so massive, that in 1907 the Conservator of Forests simply withdrew formal fire protection, a response so radical that the scheme found itself quarantined as another expression of Burmese exceptionalism.<sup>(21)</sup>

#### *FAO: Shadow empire*

There is one striking anomaly in the process of shedding or redefining the vestiges of colonial forestry. As Peter Vandergeest and Nancy Peluso have argued, the U.N. Food and Agricultural Organization (FAO) effectively reconstituted the old imperial network for several decades after World War II. In countries that had thriving bureaus, the FAO presence provided a neutral political network to connect forestry officers with best practices as defined by the global guild. The FAO allowed countries that had poorly developed bureaus to build them up by providing the kind of support that the imperial powers had previously extended. Equally, it allowed those with flourishing bureaus to maintain status and academic currency. In both cases state forestry could modernize without the compulsions and stigmas that had marred the earlier epoch.<sup>(22)</sup>

If FAO became a shadow empire, it came with the worst contaminants of imperialism stripped away. It could present itself as apolitical, a purely technical project, a creation of the forestry guild, which sought new institutional habitations like a hermit crab occupying a new shell. But of course the FAO merely transferred the politics to more local hands. In a sense, what appears to be a revival is also a devolution that empowered newly independent national governments to assume the roles of the imperialists. It appears, moreover, that the reign of FAO as a major force lasted only through the postwar development era, providing a kind of external leveraging for the developing world that the developed nations already possessed. As FAO has faded, other development agencies have stepped in, all eager to work with the kind of trained staff and an economically informed discipline that forestry offers.

The attractions of even moribund institutions are several. For one, they exist. They may no longer receive the care and funding they once enjoyed from the state, but the global reach of development can replace the imperial reach of former colonizers. Funds have a place to go to; institutions can be revived to satisfy their founding purposes or be redirected to more contemporary ones. It is not necessary to invent a structure, only to reoccupy agencies that already exist. For another, forestry argues economics. It has always prided itself on its fiscal sensibilities, that it is a business that it will pay for itself and more. (That this has rarely happened is irrelevant: it *should* happen in principle.) This disposition makes it an attractive venue for agencies that cannot afford to subsidize enterprises indefinitely, and a legible message for the economists who advise them. Whether as public reserves or private holdings, the land will be used, but used with technical competence. It will be, in today's parlance, sustainable.

The issue, however, is not whether state forestry has revived in places, but what the character of its new avatar might be. In principle, such agencies could equally resuscitate the old vision of state-sponsored conservation; they could lead to an era of environmentalism. The contemporary obsession with sustainability, after all, has a great deal in common with old-style conservation. But those agencies could just as readily become vehicles for simply extending state power, including state-sponsored environmental havoc, appropriation, and outright looting. What matters is not the presence or absence of the agency; what matters is the larger social and political setting that can offer checks and balances on the agency's actions. While this is often related to a past history of colonialism, such that nations like Thailand that modernized without being colonized or Myanmar that sloughed off much of British forestry rule, behave differently than the Philippines or Indonesia, the chronicle effectively begins anew in the postwar development boom.

### *Developed nations*

What astonishes more, perhaps, is the implosion of state forestry in the developed countries, especially those where state forestry established itself on largely uninhabited lands. The fragmentation began in the 1970s, and has accelerated under hammer blows from indigenous land claims, public revulsion over forestry practices, economic interests urging privatization of land and services, a general distrust of government, political pressures arguing for devolution, the emergence of NGOs to dispute forestry's claims, rival scientific research to question forestry's doctrines, and other challengers to what had become a government hegemony. The old Establishment fractured, and in many places, folded.

As with decolonizing nations, the particulars of local politics have sparked a range of responses. Greece downsized forestry, even ceding control over fire protection to urban fire services. New Zealand disestablished its Forest Service, parsing a massive public-works agency into commercial plantations (which it sold off) and conservation areas, mostly in the mountains (which it turned over to a new department). Australian state forestry agencies vanished, save in Tasmania; some fragments of commercial woodlands have gone into public corporations, but the bulk of land has been transferred to national parks or other species of nature preserves. Meanwhile, the Mabo decision by Australia's Supreme Court has adumbrated effective sovereignty from crown land agencies to Aboriginal rule or some hybrid institution. Canadian devolution began earlier (in 1930), which left the provinces responsible for crown-land forestry; but the provinces have become cameos, reacting to the same reforming pressures and adjusting (or not) accordingly. Among those prompts are native (First Nation) land claims as old treaties are subjected to renegotiation, or as in the case of British Columbia, which had seized land without the bother of treaties, a first-time negotiation.

The trend characterizes even the most robustly developed of national forestry bureaus, notably those of Russia and the United States. Both had become an apparatus of the state as it expanded its territories and sought to incorporate the new lands under the rule of institutions; in a sense, they were internal empires. With the breakup of the Soviet Union in 1991, the national forest service has undergone almost continual reforms that climaxed in 2007 with devolution to the "federal subjects" of Russia, that is, to the major 83 administrative units – the republics, oblasts, and krais – that make up the political fabric of the Russian Republic. These reforms were formalized in the 2008 constitution. Russian forestry is thus trending toward the structure common to Canada and Australia, two other countries that amalgamated former colonial entities into a single nationality. The likely outcome will be more intensive resource exploitation and diminished protections – the prediction does not depend on any peculiarities of Russia but reflects experiences globally.<sup>(23)</sup>

The United States, almost alone, has retained its national forestry service. It survived its 2005 centennial with its name and lands intact. But the organization is no longer a hegemon and no longer a subsidiary of the forestry guild. It more resembles a heritage building whose exterior walls have been strengthened, but whose interior has been ripped out and rebuilt with modern designs and wiring. Since the apparatus of forestry by the 50 states largely reflects cooperative programs with the U.S. Forest Service, they have also experienced the impact of reform and citizen challenges. The extent of their power (and autonomy) generally depends, as with the national institution, by the extent of state lands they oversee.

Critics abound, and have successfully used environmental legislation (e.g., National Environmental Policy Act) to check agency autonomy in the courts. Nor are the challenges solely external: the Forest Service Employees for Environmental Ethics (FSEEE) operates as a civil-society voice within the organization. Today the U.S. Forest Service is widely excoriated by outside critics for what it does, and by its own staff and the forestry guild for what it fails to do. The agency, in sum, for all the oddities of its peculiar subplot, follows the same narrative arc as state-sponsored forestry globally.

## State Forestry, Rebound and Recession

Consider three brief examples. Each traces a different evolution of postwar state forestry. In one, the imperial era undergoes a revival; in the others, the agencies of state forestry recede.

### *Malaysia and Indonesia*

Independence was a complex process; not only did Japanese occupation intervene, but the new nations themselves underwent periods of expansion and consolidation. For Malaysia this meant uniting the Federated Malay States with the Unfederated States to create Malay (1957), and then absorbing Sarawak and Sabah, on Borneo, into a Federation of Malaysia (1963). For Indonesia it meant integrating the Outer Islands with a Javanese core. Dutch Borneo (renamed Kalimantan) united with Java in 1950; it was subsequently parsed into four provinces. For forestry, this left a small island with intensive management, and a large one with almost none. Likewise, the transfer of state forestry from the colonial power to a national one often came in stages. Colonial foresters frequently continued to run bureaus for some time after independence. And Malaysia's autonomy was delayed by the long British fight against insurgents. In several respects the national task became a miniature of the imperial one.<sup>(24)</sup>

Both nations, as Vandergeest and Peluso put it, "adopted doctrines of economic development and national political organization as their central activity and source of legitimation," saw their existing plantations and untapped backcountry (mostly in Borneo) as raw material to support that development, and expected forestry to assist that conversion. Both also looked to the FAO as a surrogate for imperial forestry. Not only could it help transfer knowledge and technology and align the fresh national bureaus with practices elsewhere, but it sanctioned a logging industry as a vehicle to a modernizing economy, much as imperial forestry had done. The "creation of modern, territorialized, political forests", it has been argued, was "key to the emergence of Southeast Asia as a major exporter of tropical hardwoods". But the two nations made that transition differently.<sup>(25)</sup>

Malaysia had inherited a vigorous state forestry program from Britain, one that included a research program, plantations (including rubber), a journal (*The Malay Forester*), solid revenue, and good connections with the global circuit of the forestry guild. British influence lingered past nominal independence, and then the FAO could replace it shorn of the political stigma of colonialism. It completed the segregation of agricultural lands from forest lands that had always been a fundamental ambition of state forestry, and then expanded seamlessly into its Borneo possessions. FAO's "empire of forestry" assisted the process but was probably not mandatory for it to happen; sufficient momentum remained from its legacy of British colonialism.

Indonesia had a stickier time. Its politics was harder to consolidate; and it had not become a secondary center for forestry in its own right, as Malaysia had, and it relied on colonial foresters who remained after independence and otherwise looked to Wageningen. This ended in 1957 with an effective declaration of independence from Dutch forestry. The act left it isolated from the global guild, just as it looked to its immense tropical woods as a "subsidy from nature" that it wanted to tap for national development. The FAO midwifed that transition. It helped train, connect, and justify the wholesale opening of Kalimantan and other Outer Islands. It became a formal extension of state power at a time when the Javanese metropole needed to assert its authority more forcefully over its dispersed archipelago of national territories. FAO's reign, however, lasted only through the time it took to consolidate power. Thereafter the national state assumed the tasks that imperial powers and their apolitical successor had previously done.

Whether state forestry only enabled logging companies to strip the landscape more efficiently, even granting some nominal patina of legitimacy, or whether it did abate the process, is unclear. But their forestry agencies were certainly a means to shape land use and project state power. They make an interesting contrast with, say, Brazil, also bent on developing its tropical backcountry but without the apparatus of state forestry. Brazil was an offshoot of earlier, Iberian imperialism and lacked many of the Enlightenment institutions that characterized colonial administration under Britain and France. Both Indonesia, and especially Malaysia, had evolved with state forestry as part of its governing apparatus. Brazil – and for that matter, Portugal – had not. What differences the presence or absence of state forestry have made will be interesting to evaluate.

## *Alaska*

In the postwar era even major industrial powers sought to develop their remote territories – the Soviet Union turned to its “virgin lands” steppes, Canada to its Northwest Territories, and Australia to its tropical north; the equivalent for the United States was Alaska. When it was admitted to the Union in 1959, Alaska was granted 25 years in which to select lands for the state itself (other states had been admitted with a percentage of public lands left in their charge to support education).

The undertaking became complicated as oil was developed in the Arctic, as indigenous peoples clamored for land and political presence, and as the Lower 48 began to covet Alaska’s relatively untrammelled vastness as wilderness. The process deadlocked, not resolved until President Carter intervened, followed by passage of the Alaska National Interest Lands Conservation Act in 1980. The resolution is revealing. A strategy of native corporations defused the indigene crisis, while large fractions of national public lands went to wilderness, national parks, and wildlife reserves. None went to national forests.<sup>(26)</sup>

Already the U.S. Forest Service was becoming a pariah to modern environmentalism. It was cast as an agency committed not to emerging ecological values but to old-style commodity production - its hunger to log long delayed, but now ripping over landscapes in ways that appalled citizens and landed a lordly agency in court where it was routinely chastened. Yet that logging paid for much of its other activities. The Forest Service would endure, but it would lose most of its battles and survive only by rechartering its purposes to resemble those of its bureaucratic rivals such as the Fish and Wildlife Service and the National Park Service. Chief foresters were recruited from fields other than forestry.

## *Canada’s Northwest Territories (NWT)*

The Canadian Forest Service had early planted a flag along the Mackenzie River, almost the only real administrative presence of the Dominion, but all it could attempt was fire protection, and fighting fires in the Territory’s unbroken boreal forest was quixotic. In the postwar era, however, the federal government tried again, linked in general ways to development schemes. While forestry (along with mining and hydropower) had traditionally pioneered much of development in Canada’s boreal outback, here it faltered.<sup>(28)</sup>

Resistance took three forms. One, the basis for a full-bore forest industry did not exist, and was unlikely ever to exist; wood stocks, infrastructure, and markets were inadequate. Two, forestry operated as it did in other Canadian provinces: it produced timber and pulp and revenue for the province. In the NWT, however, indigenous peoples were more concerned with fur than timber, and Canadian elites were acquiring a slow-spreading enthusiasm for wild nature, both of which left a commodity-obsessed forestry on the margins. Three, the politics of devolution was shifting the power of decision away from national agencies, of which forestry was a prime expression. The Territory split off an Inuit province, Nunavut; the Cree and especially Athabaskan peoples wanted to control the remaining NWT in a similar way, and got their wish at least for natural resources. State-sponsored forestry proved incapable of satisfying these needs and lost its historic status as an *imperium in imperio*.

## *Forestry and society*

The premise that forestry as a guild – that foresters as a corps of engineers, trained to practical solutions based on science and economics, insulated from political control, self-regulating in their professional character – can substitute for a broadly based civil society or legal checks and balances has little basis in history. Foresters no more challenge their sponsors than do state-run banks or civil servants in a postal service. Absent outside critics and the means to contest with them, such agencies can become instruments of oppression as readily as of uplift. In brief, institutions of state forestry take on the personality of their sustaining societies and political cultures.

Whether the FAO and comparable developmental programs have the punch and stamina of old imperial forestry, they perpetuate many of its means and ends. The FAO, in particular, keeps land management in hock to forestry, and forestry in bondage to its agronomic origins, and both subservient to an old plutocracy of purposes that ignores the upwelling of environmental concerns which must inform modern public land management. It seems at best paradoxical that thoughtful and well-intentioned organizations should promote an institution and idea that developed nations are abandoning.

## Future of Forestry

Forestry will not only survive, it will thrive. But it will likely flourish best apart from its pact with the state. Within government bureaus forestry will serve as one discipline among many; on private lands, committed to timber production, it will stand unchallenged even as it modernizes to accommodate values society deems important in addition to pulp and sawtimber. The issues before the field and its guild might collapse into three categories: internal, external, and relationship to the state.

### *Internal issues*

From its origins forestry has been a guild, although one that has consistently claimed professional status. It has always displayed a high degree of self-identity and self-regard, much of which seems to derive from its rigorous and consistent training, and the degree to which it has functioned as a vertically integrated enterprise with its own schools, professional society, and common tasks, all of which insulate it from the larger culture. In general it has not responded well to outside critics; rather, it resists until its members absorb those criticisms and introduces them within the context of the guild itself.

In recent years forestry education, particularly in the United States, has expanded to embrace a full constellation of land management concerns that includes wildlife, non-commercial species, and an "ecological" paradigm overall. It has done so under compulsion. Having converted, however, it now displays an astonishing collective homogeneity. Nearly all American foresters, for example, regard as mandatory reading Aldo Leopold's seminal *Sand County Almanac* in which the author argues for wilderness, wildlife, and a land ethic. But it is worth noting that Leopold began his career as a forester (Yale School of Forestry, with later duty as a U.S. Forest Service ranger), and hence can be claimed by the guild as one of their own; and it is remarkable that they *all* read it. This kind of consensus has always been one of the great powers of the forestry guild – as well as one of its greatest liabilities.

### *External matters*

Forestry has consistently failed to satisfy social purposes beyond timber and pulp. It has done what it was trained to do: grow and harvest trees efficiently. This focused vision would not matter had foresters remained like their counterparts in agriculture. It mattered hugely when they became the overseers of vast tracts of public land. Even though they honored "forest influences" as legitimate concerns, and used them to sanction their dominions, they were speaking of *trees* – of the consequences of reckless forest clearing and the benefits of forest planting.

Its bargain with the state reinforced these tendencies. Forestry, its proponents have insisted over and over, is a business. It will so manage the forests under its care that they will yield plentiful and renewal timber, and hence revenue for the state. It will pay for itself. In this way the many other benefits of extensive forests will be enjoyed by society. If forestry is a public service, it resembles a public corporation that can self-finance its operations, and perhaps make money for society as it prevents both environmental ruin and monopoly by private capital.

There is little reason to believe this assertion. Timber is practically the only component of a forest that has a clear market value, so in practice it consistently dominates all other interests. Besides, if a forestry agency does not yield revenue, it will not exist for long except in wealthy nations. So a logic evolves that goes, logging is necessary in order to pay for the other goods the agency produces, and the more money the agency makes, the more good it can do. The more it logs, the better. (Forestry may be further complicit in that its old belief tends to revive, like a spore coming out of dormancy, that it must convert wild woods to domesticated ones.)

The problem is that the revenue is never enough to satisfy all the social goods under consideration. The logging gets done; the rest either gets ignored or becomes a public service like education or sponsored research. Forestry has never worked well within such a model, or amid circumstances in which society makes complex and often contradictory demands. In developed countries, the solution has evolved to include forestry as part of advisory teams also staffed with other disciplines. In developing countries, the syllogism can be shortened to promote efficient logging without any money returned to the land for other, non-commercial purposes.

The upshot is that forestry remains both appealing and deeply suspect.

### *Forestry's relation to the state*

In retrospect, it is clear that forestry was a very flawed instrument for managing public lands. Yet it is not clear what single discipline or guild might have replaced it, given Enlightenment expectations about the need to “rationalize” landscapes and to modernize traditional economies. Forestry deserves the credit for much of the good that the reservation system did, although any agency that successfully checked awful practices might have accomplished as much. The difficulty came when forestry sought not just to stop disastrous land usage but to promote its own vision of appropriate land use. In this endeavor it became culpable for much of the bad that has resulted from its tenure.

Its strengths define equally its weaknesses. The homogeneity of the guild, the guild's control over education and standards, an agronomic and utilitarian perspective, all became robust and more resistant when it successfully bonded with the state. Without the power of the state, forestry believed it could not succeed, but with that alliance, its every flaw became a fissure. In time state forestry came to epitomize the Establishment against which a modern environmentalism campaigned.

It is unlikely that irony will end with the humbling of state forestry. Its preferred replacement, certainly among the developed world, might be termed state-sponsored ecology. The exchange will test which of the core problems lay with policy and which with politics. If the problem was policy, then the substitution will more closely approximate what societies say they want; if the issue was really politics, then the question of how to decide what uses a society wants from its land will dominate. State ecology may prove as distasteful a half century hence, as forestry a half century ago.

Similarly, the return of control over their natural resources to local communities may lead to unexpected consequences. One of the founding purposes of imperial forestry was to shield such groups from the clutches of cut-and-run global capital; without powerful lobbies at the national or imperial level, they could not resist the onslaught of money, corruption, and outright looting. To local eyes, of course, the imperial program seemed to advertise another agenda: to siphon off local resources into the pockets of the metropole and otherwise deny residents in or around reserves access to basic necessities. Eventually these dissatisfactions, combined with others, contributed to independence, which all too often left the new nation in an eerily similar position with regard to its locals as the colonial power.

The drive to return control of their surroundings to communities answers this charge, at least politically. But the quarrel involves more than the politics of colonizer and colonized: the resources might still remain at risk, as a new wave of global capital seeks out accessible forests or the lands on which they grow. It is unlikely that today's villagers and pastoralists can resist any better than their predecessors did without outside support. Some surrogate institution to state forestry will likely be necessary if local environmental goods and services, none of which have explicit market value, can survive the new quest for commodities.

### *Soldier of the State*

In the end, forestry has been no better or worse than its setting. It could be a vehicle for uplift or oppression. It could rehabilitate mauled landscapes and protect pristine ones, or it could just as equally clearcut old-growth woods and replace biodiverse forests with exotic plantations. When it bonded with the state, those tendencies could be magnified because they moved from idea to action and from woodlots to national estates. They would do good or ill along with the state generally.

The Forester, as Sir David Hutchins declared a century ago, has indeed been “a soldier of the State.” But perhaps it is time to call a truce, and let the latter part of Hutchins' declaration – that a Forester is also “something more” – take root.

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## The Hand on the Torch: A Survey of Woods Arson

*"The hand that holds the torch will never be burned by the fire"*  
Tuareg saying

### Introduction

It's astonishing that the Earth does not burn more. From the origins of its atmosphere it has had in lightning an ignition source. For two billion years it has had an oxygen-rich atmosphere. For over 400 million years it has had hydrocarbons thriving on land. Fire itself simply takes apart what photosynthesis puts together: it is among the most fundamental biochemical reactions on the planet. The Earth burns, in brief, because it holds life. When combustion occurs within cells, it's called respiration; when it occurs in the wide world, fire. What astonishes is not that fire exists but that it does not constantly reduce the planet to a cinder.<sup>(1)</sup>

The fundamentals of fire's appearance follow rhythms of wetting and drying. A place must be wet enough to grow combustibles, and dry enough to ready them for burning. This can occur annually; some of the Earth's wettest places (e.g., in Asia and Indonesia) burn each year. The chancy element is the matching of such places with a suitable spark. Lightning's lottery can be seasonal, and often, random. Many places, if considered strictly from a climatic perspective, ought to burn and don't, not naturally – for example, lands with a mediterranean climate.

This geography changed dramatically when a creature appeared who had the capacity to create sparks at will. Probably *Homo erectus* could maintain fire, and did. But *Homo sapiens* could kindle it out of a general toolkit by striking, drilling, and abrading. It's a species monopoly that we will never willingly surrender. Over and again, myths about the origin of fire testify to a common scenario: humanity was weak and helpless; then fire came, usually by stealth or theft, occasionally by violence; and humanity shot to the top of the food chain. Fire meant power.

From this point on, wherever humans went, and they went everywhere, they carried fire. Ignition became more or less constant across the Earth. This does not mean every place burned: the power of fire resides in its power to propagate, and outside of hearths, this requires landscapes that are in a condition to carry it. Humanity can then magnify its firepower by modifying landscapes to accept it, primarily through slashing, drying, draining, or introducing livestock that can tromp and chew and otherwise rearrange a biota. More places can burn and they can burn in longer seasons. Still, this extension has its limitations: a biota can only produce so much surface hydrocarbons as fuel before extractions exceed its ability to recover. The solution has been to exhume fossil biomass in the form of lignite, coal, petroleum, natural gas, and so on. These require special chambers to combust in. Increasingly, humanity's firepower is being routed through machines and applied to the land indirectly through petrochemicals, tractors, chain saws, and transportation systems that have redefined what constitutes a natural resource.

Every human has the capacity to start fire. Every child, every malcontent, every sociopath, every klutz, every terrorist, every mental defective, every criminal, every Boy Scout and every Nobel Laureate can kindle fire instantly. There are no legal restrictions on access to ignition; the only constraint resides in when and where it might be applied. It is astonishing that societies succeed in controlling fire, that conflagrations have not swept cities and fields any more than they have the Earth's biosphere. Yet breakdowns do occur. When they happen, they generally go under the label of either accident or arson.

### The Functions of Fire

Free-burning fire dates back to the early Devonian, some 425 million years ago. That means much of the living terrestrial world has evolved with flame, and has reached various accommodations with it. In recent decades the realization has grown how intimate this association can be. The removal of fire from ecosystems long accustomed to it has proved as ecologically disruptive as the sudden introduction of fire into ecosystems for which it is not naturally present.

Most human fire practices on the land emulate natural precedents. Fire foraging relies on the observation that certain useful flora grows best after being burned. Fire hunting mimics the fire drives evident in natural burns. Pastoral burning seeks the same flush of nutritious grasses and forbs that

draw wild game to burned sites. Slash-and-burn agriculture is applied fire ecology, with an identical cycle of exuberant growth by exotics, followed by a rapid recovery of native species.

So, too, pyrotechnologies abstract from free-burning fire their critical chemistry and remake them into tools. Pliny the Elder observed with a mix of awe and dismay that “we cannot but marvel that fire is necessary for almost every operation.” Fire is the ultimate interactive technology, an almost universal technological solvent. Fire does work, fire catalyzes, fire transmutes; and it does this in hearth and field equally. Wherever people go, they carry fire, and whatever they do, fire appears somewhere in the chain of causality. We have brought fire to Antarctica. We go into space on a pillar of flame.

Whether a fire belongs or not depends on its circumstances. What one social group considers a suitable, even necessary, fire can be viewed by another group as a disruptive, even disastrous burn. Shepherd fires might stray into arable fields or orchards; fallow burning might bolt into protected pasture; a campfire might flare into forest conflagration. Fire has served as a weapon of war both directly in combat and indirectly through scorched earth policies. From early times those who loosed destructive fires deliberately or through carelessness have been held liable for damages. In cities, which were often reconstituted fields and forests, with wooden structures and thatched roofs, arson was typically deemed a capital crime.

The bottom line: fire is almost everywhere in nature and suffuses almost every act of material culture. Fire will be found wherever people are. But whether such fires are productive or abusive depends on their setting, and whether they are legitimate – whether they come with a social imprimatur – or are unwanted, demonized, or criminalized depends on how society chooses to judge them.

### **Globalizing Fire**

This ancient chronicle has changed dramatically over the past 150 years. Industrialization is fundamentally rewriting humanity’s fire practices, replacing open fire with confined combustion, while European imperialism established state-sponsored conservation, often overseeing vast reserves for which fire protection was declared a foundational principle. Together these two trends largely inscribe the matrix within which fire now exists on the planet, and together they define what constitutes arson.

#### *Fire industrializes*

From the perspective of fire history the vernacular identification of industrialization with the combustion of fossil fuels is altogether apt. Its essence is that the Earth’s keystone fire species began to route its firepower through machines fed by fossil biomass. The process isolated fire’s traditional output – its heat, light, and transmutative powers – from the sites of their use. Fire as an invented instrument became more divorced from fire as an ecological process. By technological substitution and active suppression industrialized societies have sought – and largely succeeded – in banishing open fire from houses, cities, fields, and, where possible, even from wildlands.

Satellite images of the Earth show clearly a division between regions dominated by industrial combustion and regions still characterized by open burning. Only in a few nations do the two appear to coexist; but that simultaneity disappears upon closer inspection as a fine-grained mosaic of segregation emerges. Moreover, such scenes appear to be transitional. Where the transition lags it does so in countries like India, Indonesia, or Mexico, where traditional village life persists, often with official sanction amid a vigorous petro industry. With time they, too, will convert.

The period of conversion – what might be termed the ‘*pyric transition*’ – is typically a time of promiscuous and abusive burning. Like the better known demographic transition that accompanies modernization, the population, in this case of fires, explodes as old ignitions persist and new ones arise, all amid landscapes unraveled and delaminated by an influx of capital, the appearance of transportation systems, and combustion-powered machinery. Eventually, the conversion works through its cycle, and as confined combustion replaces open burning, the population of fires plummets below replacement values. Many landscapes (notably, sites reserved for nature protection) begin to suffer from fire deprivation, a kind of fire famine. Agencies set up to protect against the reckless burns of the transition find themselves retooled to promote fires in the protected estates. Such fire demographics will, in principle, over time, stabilize.<sup>(2)</sup>

The transition matters, however. The onslaught attacks forests with particular vehemence, fluffing landscapes with slash and sprinkling sparks over them. For half a century in the U.S., around the Great Lakes from 1870-1920, disastrous fires swept scalped landscapes and rampaged through wood-structured communities. The “Great Barbecue,” as cultural critic V.L. Parrington later termed the era, provided a lurid backdrop that helps explain government interventions and a policy that demonized fire. The U.S. experience was repeated throughout the larger imperium of European colonization.<sup>(3)</sup>

Proposed solutions were many. Fire prevention legislation, public awareness campaigns, voluntary associations among timber companies – none had much impact. Only two seemed to work with any measurable success. One was a *laissez-faire* strategy, not surprisingly favored by colonizers and logging companies: speed up the process. The “problem,” as they defined it, was a too-slow transition that left a dangerous fire scene to fester; the solution was to hurry along land conversion (and the pyric conversion). Once wild lands disappeared, so would wildland fires. Once alternatives to free-burning fire were abundant, economics would argue to use them, and flame would subside from the land. Ultimately, fire vanished only when the rural population itself left the countryside.

The other strategy called for government intervention, of which the only manageable means was to stop settlement by creating protected reserves. This was a global project that reached a climax in the early 20<sup>th</sup> century. Its immediate effect, after strenuous efforts to halt the tide of colonization at often arbitrary borders, was to shut down burning. The long-term effect has been to create permanent habitats for fire.

#### *State-sponsored conservation*

This unintended consequence explains the paradox that highly industrialized nations continue to experience outbreaks of wild fire. The eruptions tend to fall into two groups. One, well exemplified by Mediterranean Europe, thrives amid a natural fire climate in which a rural depopulation has allowed the native flora to flourish and fire control capabilities to decay. Portugal, northwest Spain, Provence, Greece – the breakdown in social order has its environmental expression in broken landscapes prone to burning. The other group involves nations with large public domains under the administration of national agencies.

The world’s primary firefighting nations – the U.S., Australia, Canada, Russia – all share a history of European colonization that left, in the 19<sup>th</sup> century, vast areas either lightly populated or effectively barren of inhabitants. In such circumstances public forests and parks could putatively prevent further deterioration by logging, land clearing, overgrazing, and untrammelled burning. Equally, however, the colonial powers tried to install similar reserves onto landscapes still inhabited, if only by herders or seasonal users. In such instances, they met a sullen rebellion, one often expressed by incendiarism. The story of forestry in such places as India, Algeria, Cypress, and Corsica became one long firefight.<sup>(4)</sup>

The justification for the reserves came from new doctrines of conservation, under which the state would place lands outside both folk settlement and commercial exploitation in the name of a common, greater good, notably, to stabilize the climate, to reduce flooding and droughts, to ensure a permanent supply of wood, and so on. Whether or not rain followed the plow, drought seemed to follow the axe – and the fires the axe fed. The belief abounded that, once removed from the burden of burning landscapes, like societies unburdened of malaria or banditry, protected lands would blossom into productive modernity. Since most such lands were forested, they were turned over to the emerging guild of foresters, a self-designated caste of professionals. Leading foresters became proconsuls of a global environmentalism. They condemned fire – any fire – from the onset, and typically announced that until fire protection was in place, no other program of land reform or forest management could succeed.<sup>(5)</sup>

State-sponsored conservation thus sought to remove fire from the hands of folk practitioners and to exclude fire of any source wherever possible from protected lands. Control over fire could not be unwound from the control over people. If you controlled fire, you controlled what people could do on the land and what threats they might pose to reserved lands. Any fire practice not sanctioned by forestry was denounced as arson. In this way control over fire migrated to government agencies which came to exercise a *de facto* monopoly.

The two processes fed each other. The more deeply a country industrialized, the more fire vanished from daily life and vernacular landscapes. The more developed a country, the more that society tended to reserve lands for the collective good. Where industrialization and imperialism converged, as in the United States, large public estates could thrive. Over time, however, a paradox emerged: instead of being refugia from burning, those reserved lands became permanent habitats for free-burning fire. Lightning, arson, accident, and agency-sponsored burning kept fire on the ground. Even today the reserves remain flashpoints for controversies over proper fire practices – and hence over what constitutes arson.

### Avatars of Arson

Arson is a legal definition, and hence ultimately a political determination about which kinds of fires a society will encourage, which it will condone, and which it will condemn. These categories – what a people consider “malicious” and “damaging” – vary among societies and evolve over time within them in what a semanticist might describe as definitional mission creep.

The varieties of anthropogenic burning are all but infinite, and categories of arson, only a little less so. But a useful taxonomy might include some six species: (1) *accidental arson*, in which carelessness might be of such magnitude as to constitute criminal negligence; (2) *incendiary arson*, in which incendiarism is a charge one group levels against another; (3) *economic arson*, in which fires are set for profit; (4) *political arson*, in which fires are a means of protest; (5) *official arson*, by which people or agencies charged with fire protection deliberately or accidentally set damaging fires; and (6) *psychological arson*, or fires set out of true pyromania or for celebrity-seeking.

These categories are porous. Incendiary burning to promote one form of land use over another can easily segue, for example, into economic arson and then inflect seamlessly into political arson.

#### *Accidental arson*

Unwanted fires follow people much as rats and weeds do. In a sense, they are an expression of what might be termed “fire littering.” When they result from traditional practices, they tend to be overlooked legally, unless they inflict serious damages. At such times they reflect a degree of carelessness that many societies consider indistinguishable from malicious arson; those accountable for kindling them will be prosecuted accordingly.

The usual variants include abandoned campfires, escaped field fires, discarded firebrands such as cigarettes, and the burning of leaves, prunings, or trash. The common element is that all are started by people and thus have an identifiable agent. Legal systems treat them variously. The laws and customs governing such acts are ancient; the Old Testament, for example, specifies restitution for fires that bolt out of control and harm another’s assets.<sup>(6)</sup>

Anglo-American law distinguishes between strict and negligent liability. Under *strict liability* any fire, whether set for any reason good or bad, whether handled well or poorly, is the responsibility of its setter who must answer for any and all damages. The simple act of using fire is considered inherently dangerous. This is the stand of English common law. Its intention is to discourage the use of fire. Paradoxically, it is found today in a few American states (like Oklahoma) precisely because it places no restraints on fire use, because it does not distinguish suitable circumstances from inappropriate ones, and therefore allows for easy public access to fire. Interestingly, the word *arson* appeared in English (from French and Latin roots) around 1680, a couple of decades prior to Queen Anne’s law, which remains the basis for defining strict liability.

Under a regimen of *negligent liability*, culpability depends on circumstances. It matters whether the agent acted with reasonable prudence, obtained a mandatory permit, set the fire with malicious or fraudulent intent, and so on. Some American states wishing to encourage proper burning, notably Florida, have enacted legislation that defines what constitutes negligence with the intention of eliminating nuisance suits or relieving fire setters from undue concern over factors over which they have no control. Passed in 1990 the act has not been tested in court. An escaped fire set by a state agency in January 2007, however, created an unexpected “superfog” over Interstate 4 which resulted in an 80-vehicle pileup and four deaths; litigation is anticipated, and how the courts rule will likely determine the future of prescribed burning.<sup>(7)</sup>

In general, accidental fires, while subject to prosecution, are not regarded technically as arson since they lack the intent to cause injury. Still, under a regimen of strict liability – and within many societies – they are indistinguishable from arson in their outcomes and yield similar consequences for their setters. If the Florida law fails its court test, it will tend to encourage the de facto trend that defines any open fire as effectively an act of arson. Such a decision would reinforce the tendency in industrial societies to remove fire from the hands of ordinary citizens, to treat flame as though it were so intrinsically dangerous that it must become a government monopoly, like atomic energy. In colonies, the seizure of the torch was a calculated political decision, a transfer of power; in contemporary times, it happens more covertly, midwifed by technological substitutions.

### *Incendiary arson*

Incendiarism is a charge frequently leveled by one group against its rivals. It reflects competing uses of land, and thus of appropriate kinds of burning. What one group – say, herders – regards as a legitimate and necessary burn to flush up pasture, another group – perhaps, foresters or environmentalists – might condemn as incendiarism, which is to say, arson. This quarrel has lasted forever.

Examples abound from everywhere. In the ancient Mediterranean, shepherds moving their flocks up and down the mountains with winter and summer routinely burned the routes and upland pastures. Such fires could spill over during drought or winds and threaten surrounding farms and villages; and it seems that some burns might be allowed to “accidentally” spread, which effectively enlarged the grazing lands available. Such behavior encouraged the torch-wielding shepherd to morph into the cloven-hoofed satyr (or Satan). In medieval times foresters charged with protecting game preserves tried to counter such behavior by denying even traditional grazing rights to places that had been burned, hoping to reduce the incentives to loose fire of any origin. They wanted unburned landscapes.<sup>(8)</sup>

But herders had to compete against other incendiarists. When Spanish missions appeared in California, for example, they met a pattern of aboriginal firing for hunting and foraging that conflicted with their preferred forms of pastoralism (and which not incidentally encouraged a seasonal mobility that frustrated efforts to fetter the indigenes to missions); they denounced the indigenes as incendiarists and pyromaniacs. Almost the identical situation occurred in early-colonized Australia. The newcomers could not establish themselves amid a landscape burned according to a regime out of sync with their purposes. Punishment included flogging, or worse. The quarrel was finally settled by politics, backed up by a constabulary or military force, but it ultimately succeeded because of a demographic collapse among the native population.<sup>(9)</sup>

An interesting variant flared along the northern frontier of Scandinavia when swiddening Finns (and to a lesser degree, Swedes) collided with reindeer-herding Saame. The reindeer migrated to the mountains in the summer, and back to the lowlands in the fall, where they trampled on or fed upon swidden fields. The newcomers responded by burning large swathes around their settlements, a scorched-earth *cordon sanitaire* that stripped away the slow-growing lichens the reindeer needed for winter forage.<sup>(10)</sup>

More recently, incendiarism became, for public and commercial foresters, a perceived plague in the American South. (The state forester of Florida announced early in the 20<sup>th</sup> century that 105% of the state had burned over the past year, principally because open-range pastoralists had fired land in the spring and then reburned much of the same land in the fall.) Regionally, the collapse of the traditional economy, which had relied on regular burning for herding and hunting, gave way to clear-cut landscapes, hunting plantations, public forests on lands acquired by purchase or tax delinquency, and commercial forest plantations, once the southern pines could be converted to pulp. This was effectively an enclosure of formerly open-access lands; and the local population responded by burning, either on their own lands (with fires that overflowed onto the estates of others) or by surreptitiously firing the new enclosures, which had the dual effect of frustrating the new owners while rendering the land useful for its old purposes.

Some locals darkly suggested that the new fire lookouts were really prison towers so the government could spy on residents – and at night they dragged lighted ropes soaked in kerosene behind horses to get the burning done. A sign appeared in threatening doggerel:

You've got the money,  
we got the time.  
You cut the hardwoods,  
we burn the pine.<sup>(11)</sup>

Such incendiarism infuriated foresters, who condemned it as mindless arson. But prosecution was almost impossible. Even if a suspect was apprehended, local juries typically refused to convict. So foresters turned to publicity, creating movies and hiring publicists. One of the most celebrated episodes, the Dixie Crusaders, modeled their campaign on traveling evangelists, save that these preachers proselytized for fire prohibition. When that also failed, the U.S. Forest Service enlisted the help of anthropologists through the American Association for the Advancement of Science, and at one point hired a psychologist to investigate why southerners continued to burn when it was so manifestly irrational. Of course the practice was not in the least irrational to the locals, who considered the outsiders delusional. The psychologist concluded that the indigenes set the woods on fire out of mindless tradition: they burned because their fathers had and because they derived from the flames a small measure of excitement in hapless lives otherwise ground to powder by poverty and ignorance. It was an old charge, but one that added psychological disorder to the usual criminalization of undesired fire.<sup>(12)</sup>

In recent times one of the most flagrant conflicts has been playing out in Madagascar. It should surprise no one that a core contest revolves around pastoralism – an easy target since herders not only burn but move around the landscape, spreading fire and evading authorities avid for social control, taxes, and conscription. The vast grasslands of interior Madagascar are routinely aflame. To these fires, however, swiddeners burn their patches in the mountains and woods. During the French colonial era foresters denounced both groups, with little to show for their effort since local populations were indifferent to the burning or surreptitiously supported it. (Eventually colonial officials had to turn a blind eye to the practice – shocked, *shocked*, as it were, to discover burning still going on in the back rooms of their *departement*.) After independence, state foresters continued their campaign with even less effectiveness until more recently environmentalists have replaced them. “Red” Madagascar remains as vigorous an emblem of reckless burning as before. Now it represents not only woods arson, a crime against forestry and the state, but environmental arson, a crime against nature.<sup>(13)</sup>

In the usual scenario incendiarism flares during times of transition. New landowners take over, new economies redefine and claim the products of usufruct, the pyric transition slams together the matter and antimatter of pre-modern and industrial practices. The outburst abates only when the transformation ends. Here and there, however – Madagascar is a good, stubborn example, and contemporary Mongolia is likely another – the transition doesn't complete its cycle; the mixture persists, a kind of biotic nitroglycerin ready to explode at every shake; and incendiarism becomes itself a way of life amid a land and society that seem unable to restabilize.<sup>(14)</sup>

### *Economic arson*

Arson for profit can apply to landscapes as well as to cities. If the former lacks the clarity of the latter, that may be because there is rarely an insurance structure to monetize the act. But give people an economic incentive to do something, and they will likely find a way to do it. This observation characterizes members of the fire community as much as the general public. The range of potential manifestations is legion; a few select examples will have to suffice.

*Fire and salvage logging.* Over and again, officials have sought to reduce incendiarism by banning usage after a burn, for example, by prohibiting graziers from sending flocks through a burned area for a period of several years. The point is usually to encourage timber. But when that timber burns, the loss is too great to tolerate; and one recurring response is to allow access to “salvage” that burned resource before it decays beyond commercial usage. This exception, however, provides an incentive to burn the forest in order to harvest it.

A perverse outcome, but one that has repeated itself over time and space. It happened in Europe; it has happened in Chile; it has happened in the United States, on national forests, on Indian reservations, on state lands; it has happened wherever the incentives outweigh the punishments. It is, as with so many expressions of arson, often difficult to prove, and nearly impossible to prosecute.

What makes it particularly insidious is that enforcement – refusing salvage - compels the state to forego otherwise legitimate revenue, and thus invites officials to collude if only indirectly or out of despair.

An interesting example comes from the western United States. As environmental legislation began shutting down logging during the 1990s, operators and forest workers sought ways to evade the restrictions; salvage logging was one means. In 1995 a provision expanding the opportunities for salvage logging to include dead or dying trees was passed as a rider to other legislation. Because cutting occurred under “emergency” conditions, salvage projects were exempted from normal environmental legislation and public review. Operators were quick to seize on the opening, which shut a year later as the fear bubbled up that it was only a question of time before a lack of burned area would incite a wave of arson, as has happened in the past. Congress, however, declined to reenact the bill, which expired before it could be truly tested under fire.<sup>(15)</sup>

*Fire and land conversion.* At least with salvage logging, the intent is not to replace the forest with some other land use. Just such conversion is the case, however, where illegal fires are employed to convert woods to agriculture or to exurbs. What makes fire especially attractive is that it diverts attention from the underlying fundamentals – land conversion – into squabbles over fire protection and, in southeast Asia, into smoke abatement. Similar scenarios play out in the developed world as well. Southern California and Australia routinely blame a repeating cycle of conflagrations on “arsonists,” who are almost always outsiders to the community, rather than on powerlines, real estate developers, shake-shingle roofing, and the other features of settlement that allow fires to spread and wreck havoc. In such instances the charge of arson is a means of misdirection.

A prominent example today has appeared in Indonesia and Malaysia, where land conversion from native forest to palm plantation involves draining and burning peaty soils. Without burning the sites are useless; and once again, burning is an apparently anonymous way to effect a change in use without fingering a culpable agent. Whether the state is openly complicit or not, it is unwilling, once the land is burned, to deny new economic use. In the meanwhile it may engage in political theater by pretending that the problem is really a fire problem and flying some water bombers over the scene.<sup>(16)</sup>

In much of Mediterranean Europe no real cadastral system of land ownership exists, and forest laws apply only to actually wooded areas. If those trees are removed, the law ceases to apply. There is a social asymmetry at work: it’s difficult to illegally cut, but it’s simple to illegally burn. Accordingly, serious fires break out, which burn away the protective shield of the forest law, and shortly afterwards, construction commences on new houses.<sup>(17)</sup>

*Pay to Play: Firefighter arson.* Incentives, too, exist for firefighters to kindle illegal ignitions. As soon as people were paid to fight fires, they had a reason to set them. “Job-hunting” was listed as early as 1908 as a significant cause of fires in the U.S. During the early 1930s, the Depression inspired a tidal wave of fires set by destitute men, particularly in the West. Without regular crews, wardens and rangers relied on local labor; stories abound of wardens showing up to attack a fire and finding a queue of locals lounging on their shovels waiting to be hired. What worsened the scene was the incentive by others in depressed rural communities to kindle fires in the expectation that could then sell firefighting equipment, provide meals, or furnish transportation and lodging to crews. The situation spun so badly out of control that four counties in Idaho were actually placed under martial law for one season.<sup>(18)</sup>

What ended the outbreak were the public relief programs of the Roosevelt Administration and its creation of the Civilian Conservation Corps (CCC), staffed with unemployed youths. The CCC crews severed the reliance on local labor, thus removing the incentive to burn for employment. Of course such fires did not cease entirely. The Rattlesnake fire of 1953, which killed 15 crewmen, was started by a man who hoped to be hired as a firecamp cook. The Rodeo-Chediski fire (2002), the largest recorded in Arizona, was started by an Apache Indian who likewise expected to be hired to fight it.

Southern Italy, however, has taken the practice to the level of organized crime. Observers speak openly of a “fire industry,” which is really an extortion racket. Unless the state hires locals seasonally to staff fire crews and lookouts, fires break out. Everyone understands the dynamic at work. It is a form of state subsidy granted under the cover of fire protection and under the very real threat of wildfire. It is, in truth, a fire Mafia.<sup>(19)</sup>

The problem is in principle insoluble. If fire protection matters, then society will pay someone to do it, and if society pays, people will find ways to game the system and extract money from it, even at the expense of the land being protected. Money transfers replace resource management. Still, well-paid fire crews remove the incentive for job-hunting ignitions, and ferrying crews and equipment around regions or nations, which seems absurdly expensive, reduces the incentives for local communities to set fires for which local merchants will receive windfall profits. Such transfers among regions may seem illogically costly, but only because the hidden expenses associated with misplaced incentives aren't factored into the ledger.

### *Political arson*

Barn burning, rick burning, woods burning – all are acts of economic vandalism that can segue seamlessly into political sabotage. They are, in the words of James Scott, among the “weapons of the weak.” They are a means of protest, a means of attack, and a means of damaging what an oppressor values. And in ways perhaps unique to fire, they are also a means to transmute a resource a victimizer wants into one the victim can use.<sup>(20)</sup>

The record of fire exploited for broadly political purposes is ancient and extensive. As the Prometheus myth (and almost all its variants) testifies, fire is power: who holds the torch can command whole landscapes by deciding where it will be applied and where withheld. Almost never is fire freely given; only in modern times, when matches and Bic lighters are everywhere and can be carried in pockets and purses, has fire become so banal that strangers might ask freely for “a light”.<sup>(21)</sup>

Moreover, fire has two properties that make it particularly attractive for political arson. It propagates, and it can be anonymous. The first renders fire different than a shooting or theft. A kindled fire more resembles a contagion; it can spread; a single kindling can, in the right circumstances, consume an entire city or forest. The second property derives from the ease with which fire can be set and the simplicity by which it can be made to ignite after the arsonist has passed from the scene. (In the American South, for example, a fascies of matches might be tied around the bottom of a cigarette. As the cigarette smolders away, it eventually reaches the match heads, which flare and ignite the surrounding vegetation.) All in all, it is usually difficult to catch an arsonist in the act. This is especially true when the arsonist acts with the tacit support of the local population. Fire takes the place of a roadside bomb or assassination.

Illustrations abound. Unsurprisingly, European imperialism produced an endless stream of examples. French expansion across the Mediterranean sparked a firefight in Corsica that still continues, and then yielded a ceaseless fire war in Algeria. Ethnic and economic interests colluded: by displacing graziers for farms and protected forests, French colonizers kindled a chronicle of reactive fires. When climatic conditions were favorable, the fires became a plague that could cripple the colony. Officials responded with edicts, threatened punishments, stronger enforcement, and rules that demanded local communities attack the fires around them, all of which only stirred up further resentments until even the landscape simmered with an ecological insurgency to match the political one. The French attempt to suppress fire never succeeded in any meaningful way.<sup>(22)</sup>

Similar scenarios played out for the British. The collision between a sodden Britain and fire-flushed tropical and subtropical colonies forced British imperialists to confront an expansive burning unlike anything in their historical consciousness. Everywhere – Australia, Cape Colony, Sierra Leone, Zambia, and especially India – they sought to control fire, and understood that controlling fire was a means to control the indigenous population. The indigenous population understood that same logic, and sought to reinstate fire. Over and again, critics denounced Britain's forward fire policy as among its worst oppressions, one that struck to the core of everyday life.<sup>(23)</sup>

British officials never achieved their ideal, a landscape free of fire. Repeatedly, they had to compromise, and they understood that if they did not they would be burned out. When the rhythms of the monsoon produced the right mix of wet years followed by a drought, fires could be explosive. In 1921 Kumaon was simply aflame; the British raj had to watch helplessly. A few years later M.D. Chaturvedi observed that “Prosecutions for forest offences, meant as deterrents, only led to incendiarism, which was followed by more persecutions and the vicious circle was complete.” But the removal of indigenous burning could be equally disruptive. After attempting fire exclusion in Burma's teak forests, the British realized that they had destroyed the capacity of teak to reproduce and had encouraged conflagrations.<sup>(24)</sup>

The only pragmatic response was to surrender the goal, to co-opt the locals, or to seize the torch and do the burning themselves. In Burma they yielded, and surrendered landscape burning to the Burmese. In India they tried to co-opt the practice, and did, reluctantly, and as quietly as possible. They adapted swidden into *taungya*, a species of agro-forestry. They burned protective fuelbreaks around forest reserves to shield them from the infestation of burning going on around them. As Inspector-General Berthold Ribbentrop fumed, it was a task that consumed a sizeable fraction of their annual workload.<sup>(25)</sup>

Often, they found it necessary to project such burning into the reserves, carving them into manageable blocks. Local forest guards nominally hired to fight “jungle” fires often practiced “protective” burning on such a scale that it became indistinguishable from native use. By 1924 “early burning” (so called because it was conducted early in the dry season) was incorporated into the India *Forest Manual* as a bad practice but preferable to the alternative. Better to have controlled burns under official sanction, they reasoned, than conflagrations set by hostile natives.

The popular logic behind jungle arson was that it made the lands biologically accessible for traditional uses. The locals had little interest in mature timber. They wanted fallowed woods that they could readily hack into swidden plots, grassy pasture that their herds and flocks could feast on, edible forbs and medicinal plants and honeyed hives they could gather. Even where it worked (selectively) fire exclusion shifted the biota towards dense woods or more mature trees; but once burned, the biota reverted to those characteristics valued by the indigenes. They had every reason to burn. The only way to abolish what the authorities called arson was to ban the locals from the woods altogether or to have their sustaining economy evolve into something else.

Russia relates, as so often, a weirdly inverted narrative. When Tsarist Russia began liberalizing its economy after the emancipation of the serfs, arson flourished – and fire protection became a symbol of modernization’s success, or at least its necessity. The alternative was peasant superstition and fatalism, like holding up icons of the prophet Elijah to ward off wildfires. Fire control became a public emblem of modernity – an expression of an attitude as much as a practical reality. So far, so similar.<sup>(26)</sup>

The Bolshevik revolution reinforced the conviction that fire was a threat to full production and the sense that continued burning was both an archaic superstition and an implicit threat to state control. The process that, in most of the industrial world, took the torch out of the hands of folk practitioners and placed it under state sponsorship, such that the state claimed a de facto monopoly (as through fire were atomic energy), here achieved its purest expression. The 1921 fires along the Volga folded into drought and famine and civil war to create a sense of uncontrolled fire as part of a larger threat to the state, as though nature had become another partisan in the civil war.

Yet burning persisted – had to persist. Then in 1972 stubborn fires in peat plagued much of European USSR, surrounded Moscow with flame and smothered it in smoke (just as the country was negotiating the ABM Treaty with the U.S.), and resulted in a veritable *ukase* that banned all burning. Thousands of years of agricultural practice were now, officially, a crime. The burning of course had to continue, and did. It just proceeded without formal assistance. In May 1986, whipped by *burya* winds, some 12-14 million hectares burned in Trans-Baikalia. Official records deny the event, although it is well documented in satellite imagery. Since the burning began around villages, it is likely that many communities were swept up in the flames. The official response is that nothing out of the ordinary happened.<sup>(27)</sup>

By contrast, the smoke that settled over Moscow in 2005 was officially attributed to careless mushroom pickers, and unofficially to suggestions of calculated mayhem. Ultranationalist parliamentarian Vladimir Zhirinovskiy charged that the fires were the result of sabotage, arson, or “something from outer space”.<sup>(28)</sup>

In more recent times, the Mediterranean has furnished the most vigorous examples of political arson. Palestinians burning Israeli afforestation projects is an obvious expression. But the more instructive illustrations come from Greece and Iberia.<sup>(29)</sup>

Greece has an ideal geography for fire – a Mediterranean climate, rugged terrain, a long history of fire-catalyzed agriculture. What held Greek fire in check was close cultivation and political force. Under the 1960s Rule of the Colonels, wild fire was rare. Then the dictatorship collapsed, a modernizing economy began unraveling the ancient structure of the landscape; rural folk started their migration to Thessalonika and Athens; the untended countryside began to overgrow, and to burn. The process

accelerated after Greece joined the European Union in 1981, despite the EU's agricultural subsidies.<sup>(30)</sup>

The background count of burned area steadily rose, powered by the rise in landscape combustibles. But the chronicle shows extreme spikes from time to time; these correspond precisely with national election years. The Right burns to portray the Left as incompetent to maintain security, a matter of public safety. The Left burns to provoke an overreaction from the Right. In the past, protest fires were buffered by the character of the surrounding landscape: they could only progress so far. Now, with more of the countryside effectively fallow, they can propagate. The decision to remove rural fire protection from the Forest Service and assign it to a national emergency service organization has further weakened the capacity to respond. The scene is deteriorating so rapidly that the borders between arson and accident are becoming meaningless.<sup>(31)</sup>

Iberia has displayed a different sequencing of protest burning. These began seriously under the dictatorships of Franco and Salazar when they confiscated former communal lands (*montes*) for afforestation, primarily with eucalypts. Local objections were two. First, they protested the loss of lands, and the forced shift from an economy of herding to a putative one as woods workers. Second, the eucalypts were an alien species, and a toxic one, that precluded local fauna. The planted woods became ecological deserts – a biotic version of classic enclosures. They were useless to the local inhabitants, a woody weed whose single purpose had negative value for the traditional economy.

As the plantations matured, they reached stages at which they could carry fire, and that lag describes exactly the scale of burning. They became mirror images: the curve of fired area replicates that of planting. This is incendiarism sliding into a classic expression of political arson. In a classic state response,<sup>(32)</sup> the Franco regime built up a fire suppression organization to contain the fires and reimpose order.

Then the dictatorships ended; Spain and Portugal joined the European Union; and their economies, like that of Greece, suddenly modernized. Rural populations poured into metropoli. Where rainfall was sufficient to support lush vegetation, notably, in the northwest – Galicia and northern Portugal – the land overgrew. It was now laden with an accelerant in the form of the eucalypts, a phoenix genera, which burn avidly and create conditions for their own perpetuation. Without close cultivation, the land has become a tangle of combustibles, and a hornet's nest of wild fire. The cause of ignitions is no longer politically inspired. It is, rather, the politics of modernization that has created conditions for fire's spread.

Simply sending in more fire crews and airtankers will not contain the menace, however attractive to CNN and political oratory. The fire scene spiraled out of control because of demographic shifts, and it will only be contained by a countershift that creates an alternative to close cultivation. If the EU's Common Agricultural Policy were to subsidize landscaping apart from commodity production – if it were to substitute the production of ecological goods and services in place of wheat and olives – it would be possible to work the land into a less fire-prone state.<sup>(33)</sup>

All this is no longer political arson as normally understood, but has morphed into a politically constructed fire plague. Fire synthesizes its surroundings: those surroundings are often, as here, the outcome of political decisions.

#### *Official arson*

“Official arson” – the phrase sounds like an oxymoron. The point of arson is that it is anti-social; it seeks to damage assets, attack ideas, and harm institutions. Officialdom is its antagonist, not its ally. To accuse fire agencies of arson would seem a stretch.

It is. Yet fire can be a weapon of the strong as well as of the weak. Fire policies are a means of social control. While historically this has most often meant stopping the fires of locals, it can also mean replacing them with another suite of fires. It may mean ignoring *sub rosa* burning that accompanies or quickens illegal logging, road building, or housing developments, or actively (if surreptitiously) supporting such activities. Instead of protecting against fires, official institutions become vectors for starting them. In an eerie echo of *Fahrenheit 451*, the fire agency becomes an arsonist.

The distance between purpose and practice can even spawn a kind of vigilantism, as in the case of Van Bateman, a fire officer of the Coconino National Forest (USA), who was arrested on charges of

woods arson and pleaded in his defense that he was only doing what had to be done – getting fire back on the land. In his judgments the constraints on officially conducted prescribed fire had grown too onerous. The requisite burning had fallen behind. Setting fires on his own was a means to boost those numbers. His motive was not economic, nor was it political; in a sense here was a case of officialdom at odds with itself. Like locals unable to set the fires they considered necessary, civil servants, operating outside the bounds of the law, were doing the burning they believed essential. The old quarrel between folk and official has here been internalized into the institution.<sup>(34)</sup>

It is worth noting, too, that official burning, if done poorly, can break out of its prescriptions and roar over the countryside. In 2000 the U.S. National Park Service set two fires that did just that. One at the North Rim of Grand Canyon National Park bolted away, forced an evacuation, and stopped only when it hit the Canyon's rim. The next day a prescribed fire at Bandelier National Monument, New Mexico, broke free and raced through Los Alamos, scouring out a good fraction of the town and even burning into the national laboratory. Was this incompetence, or de facto arson? It depends who you ask. The outcome is identical. (It might be worth observing that the largest recorded fires for the American states of Arizona, New Mexico, and Colorado were all set by members of the fire community – one by a man hoping to be hired to fight it, one set by a fire crew that escaped control, and one set more or less accidentally by a technician hired to prevent fires.)<sup>(35)</sup>

A variant quarrel can occur between agencies and professions, each of which considers the other inept or deluded or both. Perhaps the most interesting version is occurring now in Australia where foresters and environmentalists are slugging it out over what burning is acceptable and who should decide. Over the past 25 years state foresters have lost their political power. State forests have been redesignated as national parks or nature preserves, and turned over to wildlife biologists and other guilds for management. In the process virtually everything foresters had previously done was condemned; this included their fire practices.

What makes the quarrel particularly interesting is that Australia's foresters, almost alone in the world, had made routine controlled burning the basis for bushfire protection and forest management. They burned large areas on a frequent rotation in the expectation that these benign burns could hold down fuels sufficiently to reduce eruptive fires to something bushfire brigades could contain or that might at least dampen their damages. They appealed to the manifold adaptations to fire by much of Australia's biota and to the long tenure, with firestick in hand, by its Aborigines. The firestick has passed from lightning to Aborigine to rural Australian to forester, who added the measured discipline of scientific research and bureaucratic control.<sup>(36)</sup>

But in the quarrel over crown lands, "hazard reduction burning" became equated with woodchipping, clear-felling, and vermin control. "Greenies" might accept fire in principle, but felt Australia had too much of it, and wanted nothing to do with its raw rural past or with forestry's presumptions and prescriptions. In order to be justified, they insisted, burning had to have ecological intent, not simply done to abate fuel loads. In practice this meant that the expansive programs of broad-area burning shriveled. Just before the Black Saturday catastrophe of February, 2009, the minister of the environment was reported to have received, and was preparing a response to, proposals to ban fuel-reduction burning altogether under Australia's Environmental Protection and Biodiversity Conservation Act. If accepted, prescribed fire would be equated with feral foxes and predator poisoning. In this way, what had been official fire by the previous public land agency would be redefined as arson, and the ancient quarrel between foresters and herders would be modernized as one between foresters and environmentalists.<sup>(37)</sup>

Like fire, which adjusts its character to its setting, so it would it seem arson does likewise. The conflict that goes under the name "arson" is thus not simply between landowners and the dispossessed, or between officials and citizens, but between those who have the power to determine which fire is good and which bad. It is a contest between those who hold the torch and those who don't and wish they did.

### *Pyromania and celebrity-seeking*

True pyromania – the psychological compulsion to set fires, an ungovernable impulse – is rare. While the charge is often flung, it rarely sticks to the wall. The reality is that if humanity were genetically hardwired such that significant numbers could not control themselves around flames, it would have burned itself to extinction long ago. The reality is that social control is so profound that only preadolescent boys regularly misuse fire; they set fires for the same reasons they would smoke

cigarettes behind the barn or play with power tools. Even pyromania derives not from the properties of fire so much as from fire's association with other psychological traumas and obsessions. That fire is (or was) so common increases the likelihood of that unhappy bonding.

What is more prominent is fire as a means of celebrity-seeking. There is a long tradition of firefighters – the issue is especially prominent with volunteers – who set fires in order to be seen fighting them. It is a chance to be “a hero,” to be in the public eye in an admiring way, or at least act out in public. If caught, such perpetrators are rightly charged with arson. But modern communications has expanded the range of opportunities.

Most residents of the industrial world know fire indirectly through television. They see only its most dramatic and damaging expressions – fire is among the most telegenic of scenes. Setting a fire that can dominate newscasts for a day or week is a way to infamy as surely as the murder of a rock star or the assassination of a politician. The sensationalism of TV news in particular is probably an incitement among some to set fires; and the effect may be more pronounced around media centers like Los Angeles. Statistics are sparse, but it is likely that celebrity-seeking rather than pyromania accounts for some of the fires set that otherwise go into the elastic roster of “unknown” causes.

How many? The United States in 2006 had over 96,000 wildland fires, of which no more than a handful were likely set for such reasons. Yet these are by their nature prone to be those that blow up and capture media attention. The recent outbreak in Australia (Black Saturday, 2009) involved some 400 fires, of which two are believed to be arson, and for one of which an arrest has been made. Judging from media attention, one would think that arson caused the holocaust; similar announcements accompanied the 2001 and 2003 bushfire rampages; and some of the charges are likely true. If so, that still leaves 398 or 399 fires to account for.

Yet it is also true that arson of this sort is a useful exercise in misdirection. The vast majority of the fires resulted from accident, or carelessness, or from powerlines arcing in the high winds. The fires wrecked landscapes and overran communities because conditions favored them: the power of fire, it is worth recalling, derives from its power to propagate. Focusing only on ignition avoids the fundamental question, which is, how do people live on the land, and why do such fires, regardless of cause, acquire such savagery? Instead of discussing irresolvable issues like land use, it is easier to blame arson and the occasional sociopath.

The problem of solitary arson is real. The political uses to which it is typically put, however, can distort the discussion away from the basics of fire protection and into realms that resonate with free-floating cultural anxieties – the suspected arsonist is almost always an “outsider” - but have little possibility of addressing the matters that allow such fires to do the damage they do.

## **Extinguishing Arson**

What might we conclude? What solutions or lessons-learned might derive from a historical survey of woods arson?

The first is that the category is too elastic and generic to prescribe useful treatments by labeling alone. Calling something “woods arson” does not identify either cause or consequence, nor what actions might correct the perceived imbalance. Recall that fire is not a substance but a reaction, and hence takes its character from its context. Understand its context, and you understand a fire. Control that context, and you control that fire.

Instead, treatments require specific solutions based on local geography, firesheds, and ignition sources. Some answers will demand structural responses, some will reside in cultural circumstances, and some may be unique and personal. Overall, if arson is seen to be a problem, a response will focus on ignition or setting or both.

### *Three E's*

Except in nature preserves that exclude people and their habitual fire practices, humans directly or indirectly account for 90-98% of ignitions. The time-honored strategy to contain them emphasizes education, enforcement, and engineering. These considerations apply to all ignitions, arson among them.

Education has a mixed record. There is little evidence that it alters behavior among those committing arson or its incendiary avatars. A long litany of denunciations, proselytizing, and the occasional show trial has yielded little of substance. Advertising does seem to be effective among children, but mostly among children removed from the landscapes in question; that is, it shapes urbanites' understanding of fire in distant sites, not the attitude of those living in the rural, arson-infested countryside. Similarly, it can work across generations if a family moves to a city. Where it seems most effective is in promoting the fire agencies themselves. The U.S. Forest Service, for example, is indelibly associated with its symbol of fire prevention, Smokey Bear, even as Smokey no longer truly reflects the agency's policies. Countries from Chile to Russia to Indonesia – with animal emblems from rabbits to moose to orangutans – have created fire prevention programs.

Enforcement, too, has spotty results. Occasionally it can track down and halt a serial arsonist that the community does not want (the person responsible for the lethal 2006 Esmeralda fire in California is an example). But arson is a tough crime on which to convict, and local juries rarely support the authorities when "arson" has the tacit approval of a community that does not consider such fires as damaging to its interests, and in fact, may worry that the suppression of arson is a conspiratorial wedge intended shut down their access to fire altogether. The threat of punishment may be a deterrent – or not. Attempts to impose an alien edict by police powers, however, cannot boast much success. They only drive a fire insurgency further underground and toward more innovative means of burning.

Nor has engineering, narrowly conceived, proved a bulwark against unwanted flames. It claims its greatest successes with machines, such as fashioning spark arrestors for chain saws and locomotives. Other structural devices, such as fuelbreaks, collapse under extreme circumstances like high winds, which can loft firebrands a mile away. Like many fire strategies, they fail at exactly the time when they are most needed. (Why fire agencies continue to believe in the face of more than a century's worth of evidence that they can make the big fire go away with one more surge of manpower and machinery is another example of a faith-based technocracy – and a theme for another occasion.)

Not engineering as normally conceived but all-purpose land management is the surest solution. In a properly conditioned landscape it is not necessary to abolish fire, which may be neither possible nor desirable. Such a scene can reduce the incentives to start fires and diminish the damages they can cause. It substitutes a policy of fire resistance for one of resilience. If the land is intrinsically fire-prone or is a cultural landscape shaped by fire, the likely outcome will mean substituting tame fire for feral fire. Suitably buffered such places take away the power of arson. The fire is either accepted or easily extinguished.

### *Suppression*

In any event, not all fires can be prevented, absorbed, or made to self-extinguish. Some legitimate burns will escape their prescriptions, some will start from accidents, and some nature will kindle. The solution is rapid detection and attack. Every fire starts as a point source; every fire can be controlled by a single firefighter and simple equipment if attacked before it grows large. This is the logic behind most wildland fire protection programs. And it is the reason for what must appear to outsiders as an obsessive determination to leave no fire behind – to attack completely every ignition, no matter how apparently innocuous or remote. The informing logic is that every large fire begins as a small one; if every small fire is throttled in its cradle, none will grow large. That strategem encompasses arson as fully as a lightning kindled snag, a fallowed field aflame, or a fire started by a catalytic converter that then races over cheat grass.

A century of experience with aggressive suppression among several countries has now accrued a body of evidence. The short summary is, fire exclusion by removing people, preventing ignitions, and suppressing fires that do occur is very effective – for a time. Whether it can sustain itself varies; the primary parameters are whether the land is naturally fire-prone or not, and whether it holds people or not. If empty of people and not intrinsically fire-prone, then a program of calculated fire exclusion may succeed since the land, once fire is removed, will not support burning without other acts such as logging, slashing, or draining.

In fire-prone lands, and particularly where people routinely access them, the exercise fails. Over a period of time, which may range, depending on local circumstances, from years to decades, the area burned decreases, and even arson is shackled. But then fuels build up, the biota rearranges itself in ways that promote more ferocious fires, and the fires that do occur burn so hugely and savagely that they wipe out the gains of the early years. Today in the United States some 98% of all fires are kept

small (under 3 hectares); but there are inevitably times when the number of ignitions overwhelms the system and the ones that escape and blow up tend to become 'megafires'. The overall area burned in the country is increasing sharply.

In brief, the firefight is a necessary undertaking that can put down a temporary ecological insurrection. It is not a means to govern landscapes. It can quell the worst outbreaks of wildfire during a time of social transition, but it cannot substitute for the management of a countryside's fundamentals. This reasoning applies equally to arson. Not all arson fires can be prevented or caught early – the shrewd arsonist will ensure they aren't. Their capacity to damage must be dampened by shaping the character of the landscape, which will determine ignition's capacity to spread.

#### *Where reach exceeds grasp*

Ultimately, control of arson tends to fall back on platitudes: convince the resident population that such fires harm them, remove serial arsonists, quench fires early, and quell their capacity to damage assets. Determining the basics means identifying what kind of arson is at issue. If political, then it means fixing the political landscape; if economic, then the economic landscape; if institutional, then the institutional setting.

It also means deciding where fire has a legitimate role. For places where fire's removal does harm, a solution to arson will mean reinstating fire either through official channels or by co-opting opportunistic fires. Some national forests in the U.S., for example, accept fires of any origin – that is, they allow them to burn – if they occur within specified "prescriptions" or are deemed to advance agency objectives. Such a strategy removes the threat behind an arsonist's challenge; the miscreant is simply doing what the authorities would do. Likewise, fire agencies have in the past dramatically lessened illegal burning by decriminalizing it – by putting it under a permit system that disallows burning under adverse conditions but allows it to proceed when circumstances are favorable.

In effect, what might otherwise be threats are absorbed into the administrative apparatus. Canada, for example, had success doing this for slash burning by agricultural settlers. The most spectacular example, however, is Florida's experiment with wholesale permitting that has converted rural burners into legal agents. By means of certification programs and permits, landowners who would otherwise be guilty of arson are able to do what they must do – burn – but with advice and assistance from the state. Today, Florida burns some 3.2 million acres annually and would like to burn twice that much for purposes of public safety and ecological betterment. The only way to achieve such goals is by enlisting the private sector. Still, Florida has repeatedly proved an outlier; whether its success in taming illicit burning is an exemplar or another expression of exceptionalism remains to be determined.

The sad fact remains, however, that the deeper drivers behind illicit burning and outright arson are beyond the purview of fire agencies or landowners, be they private or public. Fire comes and goes on the land – all fires, legal and illegal both – as populations change and as land experiences new uses and as climatic conditions wane and wax. Rural burning, and the arson associated with it, disappears only when rural populations leave, or the land is reclaimed by a new economic order. It is during this transitional period that fires become most problematic: then they are under the putative control of neither regime.

Historically, the pyric transition seems to last 50-60 years – this is a guess since the topic has not been formally studied and hence anomalies abound. Mexico, for example, has industrialized patchily, a full-bore transformation hobbled by its revolution's commitment, until recently, to a system of communal landholding by local *ejidos*; South Africa, too, has a residual apartheid of fire regimes; and Nigeria seems to have exported its fossil fuels rather than applying them to its own flame-drenched countryside. The differences can follow political borders with remarkable fidelity. South Korea has made the transition; North Korea has not. Thailand has flames mostly in its remote mountains; Myanmar has flames everywhere. It will be interesting to see what figures result for rapidly modernizing countries like India and China, and which fire-history trajectory countries like Indonesia follow. And it will be fascinating to watch scenario play out in places like Mongolia.

#### *The past as precedent*

Historically, solutions have centered on three strategies. One is to fence off the troubled lands into protected reserves. In fact, the spectacle of promiscuous, abusive burning was a powerful incentive to

establish reserves even in the face of hostile economic and political pressures. The second solution is to hurry through (and ameliorate) the period of conversion. The sooner people are replaced and the land rededicated to other, more modern purposes, the sooner the frontier phase with its violence and wastage will pass. When wildlands, peatlands, or fallowed forests are no longer wild, peaty, or swiddened, they no longer burn. Such wholesale transmigration schemes lie well beyond the capabilities of fire agencies to control, and often pull their own train of unintended consequences. The third solution is to co-opt what would otherwise be unwanted and illicit burning and put it to sanctioned purposes.

Yet fire institutions can assist with all these strategies. Where fire is a legitimate presence – something needed for ecological integrity, or an instrument with genuine economic utility – agencies can see to it that the burning happens in helpful ways. Where fire remains a tool for land use, one that that pyric transition will eventually replace, they can ensure that the burning which will happen is executed properly, or even under supervision. Paradoxically, the more they actively assist, the less the wastage and the quicker the conversion. And fire institutions can absorb or collaborate with and shape citizen burning where it will or must occur.

What has not worked is simple denunciation and criminalization, or the use of fire prevention as a further instrument of state oppression. Denunciation is ignored. Criminalization creates a black economy of burning, and surrenders even nominal control over proceedings for none at all. Fire prevention as a vehicle for unwanted state intervention provokes fire insurgencies. Or to state the matter differently, what does not work is calling something that is the result of land use, industrialization, or corruption a “fire problem,” and trying to fix the underlying fundamentals by quenching flames. Southeast Asia, for example, does not have a “fire problem” or a “haze” problem. It has a problem with ill-considered transmigration schemes and transformations of forests and peatlands to palm oil plantations. Inventing animal symbols for fire prevention and dispatching air tankers to douse smoldering organic soils only taints fire management with other bad behaviors by elites and the state.

#### *Hand and torch*

Fire takes its character from its context. It can animate, often vividly and undeniably, those factors that sustain its flames. It is possible to break the reaction and extinguish a particular event. But the flames will remain and return as often as their circumstances permit. Fire is not a creature that can be shot out or removed, or a substance that can be buried or exported or dumped into the ocean. It is a reaction: it is what its constituent parts and their arrangement make it.

Controlling fire means controlling both ignition and kindling, for fire requires both. Who will burn and who will get burned depends not just on who scatters the sparks but on who controls the kindling. If one hand holds the torch, the other must shape what the torch can burn.

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## **A Three-Level Wildland Fire Management Project for Nepal: Towards a Community-Level Wildland Fire Management Planning Approach**

### **1. Background**

In Nepal wildfires are considered to be a major driver of destruction and degradation of forest ecosystems and the environment. Deforestation and forest degradation in tropical forests in many countries, including Nepal, have reduced the quality of environmental services derived from them. These benefits include mitigation of climate-change impacts, conservation of biodiversity, protection of watersheds that supply forest-dwelling and urban communities with high-quality water, provision of amenity and recreation services, production of biomass as an alternative source of energy for fossil fuels and mitigation of water induced disasters like soil erosion, landslides and floods. Recurrent uncontrolled fires have serious impacts on the socio-economy, culture and the natural environment of the country and also affect the regional climate. Fire management efforts by local communities and government professionals to deal with forest fires are severely hindered by lack of financial and technological capability.

After a successful foundation of Regional South Asia Wildland Fire Network under the United Nations International Strategy for Disaster Reduction (UNISDR) Global Wildland Fire Network in Kathmandu in April 2007, a 3-level Wildland Fire Management Project for Nepal was approved and jointly funded by the German Foreign Office, Task Force for Humanitarian Assistance, and was implemented by the Global Fire Monitoring Center (GFMC) in close collaboration with the UNISDR-Regional South Asia Wildland Fire Network (RSAWFN), the Department of Forests (DoF) of Government of Nepal and United Nations Development Programme (UNDP) Nepal and the International Centre for Integrated Mountain Development (ICIMOD).

The main components of the project were:

- Community Forest Fire Management Planning including a training course for local community people
- District Forest Fire Management Planning
- Round Table Meeting for the Development of National Strategy for Wildland Fire Management in Nepal

Overall outputs of the project were:

- Community Forest Fire Management Plan
- 24 trained community forest fire managers (through training course for Community Forest User Group [CFUG] members)
- District Forest Fire Management Plan
- Contribution towards development of national strategic plan for sustainable wildland fire management
- Poster and pamphlet production and distribution

### **2. Rationale of the Project**

Uncontrolled fires in Nepal contribute to serious degradation of forests, ecological changes, as well as deterioration of social and economic conditions in some land-use systems and natural vegetation types. About 400,000 hectares (ha) of forest area are affected by fire annually. At least one hundred villages are burned annually in Nepal, some of which are completely destroyed by forest fires, particularly where the house roofs are made from thatched grass (Bajracharya, 2002). There are regular winter vegetation burnings in the coniferous forests in high mountains in Nepal which results in loss of the regenerative capacity of the forest (ca. 90% regeneration of *Shorea robusta* is completely damaged by fire). Fire-induced loss of soil cover negatively affects hydrological regimes and soil properties, leading to severe erosion and loss of productive topsoil. High economic losses are caused by damaging valuable timber and non-timber forest products and planted forests.

Most of the fires are anthropogenic. A study revealed that fire incidents were 58% deliberate, 22% negligent and 20% accidental (Kunwar and Khaling, 2006).

Nepal has diverse ecosystems, socio-economic and cultural settings and vegetation types resulting from a wide range of land-use systems and climatic conditions, consequently having diverse fire regimes and vulnerabilities.

In one hand, there is increasing interest in Community-Based Fire Management (CBFiM) and the need for institutional and technological capability development at all levels. Also, there is a high expectation from sustainable vegetation cover, which helps to reduce poverty through livelihood support to rural populations. On the other hand, there is a lack of existing local and national capability in fire management, including research, monitoring, early warning and assessment, and facilitating cooperation in fire management.

The 'Kathmandu Declaration – 2007' of the foundation meeting of Regional South Asia Wildland Fire Network has recommended, *inter alia*, “to stress on strategy formulation, fire management plan development and program implementation; to give emphasis on improvement of community-based fire management and institutional and technological capabilities at all levels; and to conduct campaigns to raise the awareness about wildland fires in all sections of the society”.

The Regional Session of the '4th International Wildland Fire Conference-2007' has recommended, *inter alia*:

*“To support countries to conduct national fire and fire management assessments, formulate legal frameworks and strategies, build sustainable fire management capabilities and institutions, develop fire management plans and human resources.”*

*“To give emphasis to improvement of participatory / community-based fire management approaches and institutional and technological capabilities at all levels.”*

*“To support implementation of building fire management capability at both local and national levels, as well as through bilateral and multilateral cooperation agreements”*

*“To create an enabling environment from all possible donors including national, international, bi-lateral, multi-lateral and private foundations for financial, technical and other resource support for sustainable fire management.”*

*“To promote education and awareness-raising programs on wildland fires.”*

Furthermore, the Conference recommended, among other, that “the international wildland fire community pursue the development of a global-scale international resource sharing strategy to assist countries with fire management planning activities”.

In most of Nepal, local forest users do not have proper tools and technical know-how to fight fires. In fact, community forests are not managed properly, nor are forest fires fought in an appropriate manner. Awareness and Training programs targeting Community Forest User Groups are significantly useful to conserve the community resources (Sharma, 2005).

In government-managed forest, some steps taken by the National Department of Forests indicate positive progress in this direction. Strengthening of this Department to cover the sustainable forest management at national and local level is essential if its efforts are to materialize in a tangible manner.

Community involvement has proven to be successful for sustainable resource management. Community-based fire management could be the key to overcoming the recurring problems of forest fires in Nepal (Sharma, 2005).

Forest fire management is not practiced in Nepal. Although, the community forest users' groups try to control forest fires in their own forests, despite lack of a plan, proper training and tools for systematic prevention and control of fires.

A bottom-up planning process is therefore necessary to strengthen local capabilities to address the forest fire issues and problems in the country.

### 3. Activities

#### 3.1 Training Course for Local Community People

##### Introduction

This training course is a fundamental part of the 3-Level Wildland Fire Management Project for Nepal. Aimed at villagers and other members of a CFUG the training course allowed local people an opportunity to develop their own fire management plan and fire risk map. It dealt with tools for community based fire management planning that are intended for use in a process which is as participatory as possible. It has been developed so that it can be applied to any village environment in Nepal.

The community based fire management planning includes:

- Identifying participants, planning area and expectations of participants
- Identifying zones, changes, contrasts, conditions and physical features in the village environment (transect walk)
- Presenting and analyzing information on land use, forests, water and other resources and risk zones (participatory mapping)

As such, the course has designed to increase management capability of wildfire at local community level. The course was also developed together with trainees in accordance with their needs. The main reasons for participatory curriculum development are:

- Much time and money is devoted to fire management training – but courses do not always produce the outcomes desired, and
- As a result many training organizations need to rethink the way they plan, design, deliver and evaluate their courses.

The CBFiM training programme was organized in the Sundar CFUG of Chaukitole in Makawanpur district in Nepal. In the training programme, members of the users group with gender balanced and inclusive representation was the criteria for selection of the participants. The program was carried out in 9-15 October 2007.

##### Objectives

The objectives of the training program were:

- To create awareness on forest fire prevention and control
- To contribute in preparing a community based fire management plan
- To practice use of the fire fighting technique and tools, and
- To develop Sundar Community Forest as a pilot CFUG demonstrating forest fire management practices

##### Outputs

The outputs of the training program were:

- 24 trained forest fire managers (through training course for CFUG members)
- Provision of appropriate fire fighting tools and equipments to the CFUG

Among others, the training course took into account of safety and ergonomic aspects in fire management, including uses of appropriate firefighting tools, prescribed fire for ecological purposes and fuel management, gender balanced representation.<sup>2</sup>

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<sup>2</sup> See the report of the training programme:

[http://www.fire.uni-freiburg.de/GlobalNetworks/South\\_Asia/Community-Based-Fire%20Management-Training.pdf](http://www.fire.uni-freiburg.de/GlobalNetworks/South_Asia/Community-Based-Fire%20Management-Training.pdf)



**Figure 1.** Fire fighting practices during the training course

### **3.2 Community Forest Fire Management Planning (CFFMP)**

#### **Introduction**

A local level management of fire is the means to solve a recurrent forest fire problem in the country as community involvement is proven to be successful for sustainable resource management in the country. But, a systematic forest fire management has not been practiced yet, for instance, there is no single specific forest fire management plan at the community level. Although, the community forest users' groups try to control forest fires in their own forests, despite lack of a plan, a proper training and tools for systematic prevention and control of forest fires.

Sundar Community Forest is located in Choukitole of Hetauda municipality, central part of Makawanpur District, Nepal was selected for a representative community forest as a planning unit. This community forest covers an area of 109.5 ha of forests in the south-west aspect of the Mahabharat range.

The planning process followed the societal choice, acknowledged indigenous knowledge, rights, values and norms, emphasized women in action, inclusive participation, ownership and the ability of the plant to replicated and adapted for other different, but similar, local conditions.

#### **Objectives**

The main objective of the Development of Community Forest Fire Management Plan is to demonstrate the community-based fire management in the context of a developing country by building and enhancing the management capability of local people.

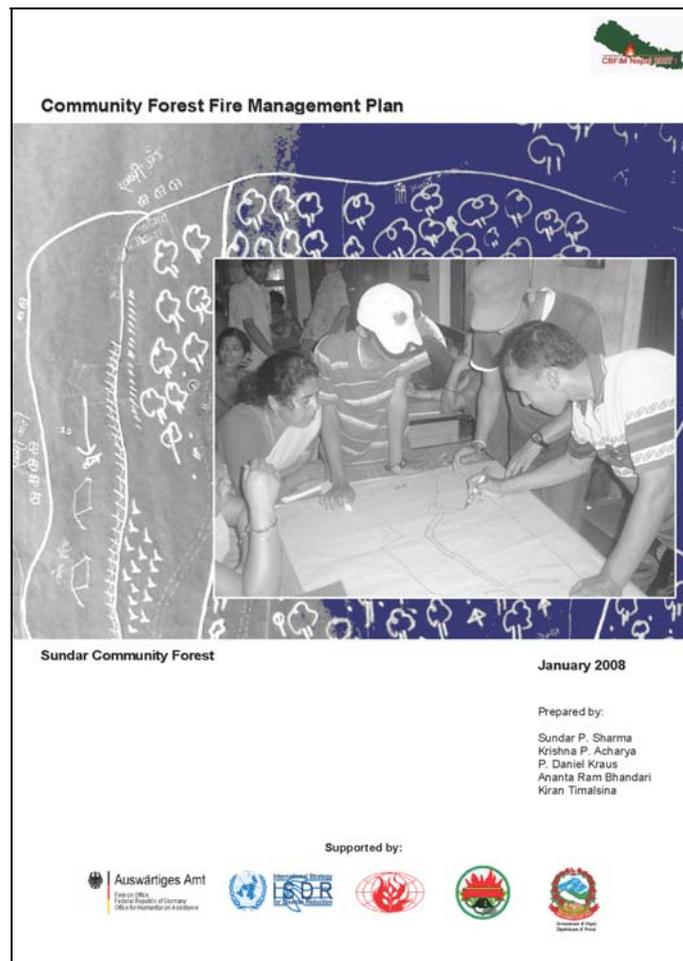
## Outputs

The process aimed to:

- To identify users, expectations and needs of users and planning area
- To identify physical features, conditions, zones, changes and contrasts in the village environment (transect walk)
- To present and analyze information on land use, forests, water and other resources and risk zones (participatory resource mapping)
- To prepare a 5-year action plan



**Figure 2.** Participatory Resource Mapping by local community



**Figure 3.** Cover page of the Community Forest Fire Management Plan<sup>3</sup>

<sup>3</sup> See full text of the Plan (PDF 1.8 MB):

[http://www.fire.uni-freiburg.de/GlobalNetworks/South\\_Asia/Community-Level-Fire%20Management-Planning.pdf](http://www.fire.uni-freiburg.de/GlobalNetworks/South_Asia/Community-Level-Fire%20Management-Planning.pdf)

### 3.3 District Forest Fire Management Planning (DFFMP)

#### Introduction

A systematic forest fire management is not practiced in Nepal. There is no management plan in a single district. In government managed forest, some steps taken by the Department of Forests even though at an indicative level are positive steps in this direction. So, it is necessary to develop district level forest fire management plan to initiate to address the forest fire problems at district level in the country.

Participatory approach to include all concerned stakeholders in the district was the main principle for the preparation of District Forest Fire Management Plan of Makawanpur district of Nepal.<sup>4</sup>

#### Objectives

The objectives of the development of a prototype District Forest Fire Management Plan include:

- To develop a model district with a proper forest fire management practices
- To recommend the Government of Nepal to implement the plan in the district concerned and replicate the planning process throughout the country
- To encourage the government to prepare national level strategic forest fire management plan



Figures 4 and 5. Elaboration of the prototype District Forest Fire Management Plan

### 3.4 Round Table Meeting for the Development of a National Strategy for Wildland Fire Management

#### Introduction

The National Round Table for Wildland Fire Management in Nepal was held in Kathmandu, Nepal, 16 December 2007. The meeting brought together 52 participants including national fire scientists, professionals, policy makers and expatriate experts, representing government organizations, international and regional non-government organizations, local non-government organizations and civil society from all over the country, and the Embassy of the Federal Republic of Germany and other international organizations.<sup>5</sup>

#### Objectives

The main objective of the meeting was to find out the direction by bringing together fire communities to discuss on global, regional as well as national level issues and concerns of wildland fire paradigms and build a national strategy for sustainable wildland fire management in the country in accordance

<sup>4</sup> See full text of the plan, PDF (1.7 MB):

[http://www.fire.uni-freiburg.de/GlobalNetworks/South\\_Asia/District-Level-Fire-Management-Planning.pdf](http://www.fire.uni-freiburg.de/GlobalNetworks/South_Asia/District-Level-Fire-Management-Planning.pdf)

<sup>5</sup> See for details: [http://www.fire.uni-freiburg.de/GlobalNetworks/South\\_Asia/Meetings\\_activities/Round-table\\_Nepal.html](http://www.fire.uni-freiburg.de/GlobalNetworks/South_Asia/Meetings_activities/Round-table_Nepal.html)

with the objectives of the UNISDR Global Wildland Fire Network (GWFN) / Global Fire Monitoring Center (GFMC) and the Regional South Asia Wildland Fire Network (RSAWFN).

**Outcomes**

The participants of the meeting presented the state-of-the-art of the fire situation and of fire management capabilities in the country and discussed international cooperation in fire science. The participants of the meeting identified five issues, namely, (a) National Assessment - Wildland Fire Management, (b) Human Resources Development, (c) Legal, Institutional and Policy Frameworks, (d) Research and Development, and (e) International Cooperation.

The participants worked in two groups and came up with common conclusions agreed a resolution of the meeting contributing towards development of national strategic plan for sustainable wildland fire management.<sup>6</sup>

**3.5 Production and Distribution of Extension Materials**

The main objective of the development and distribution of extension materials – posters and brochures – was to raise awareness among people in rural communities towards forest fire disaster.

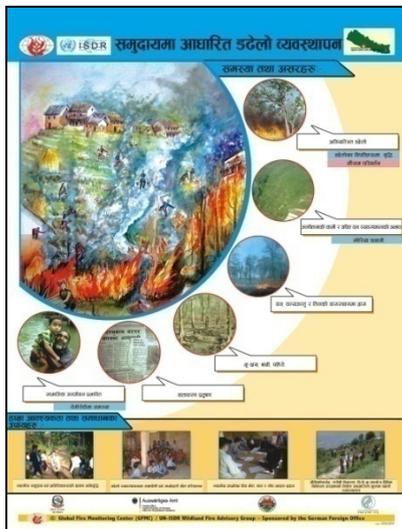


Figure 6. Poster<sup>7</sup>

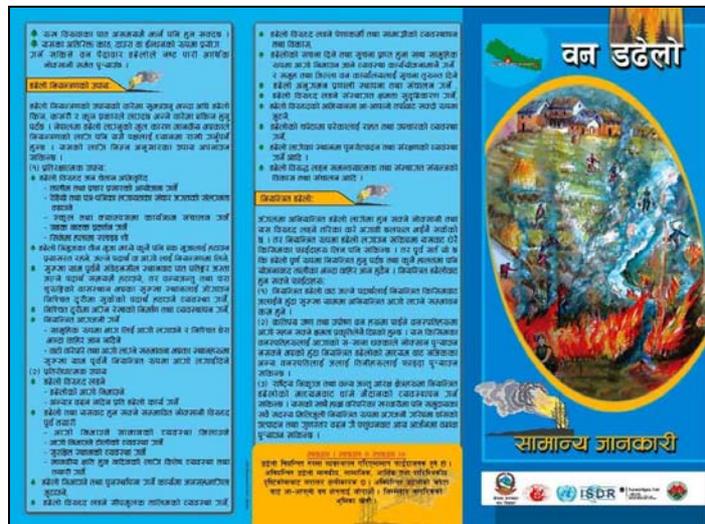


Figure 7. Brochure<sup>8</sup>

**4. The Way Forward**

For the future it is important to develop a Policy, a Strategy and Building Capacities in Local, National and Transboundary Forest Fire Management in Nepal, particularly to:

- Strengthen local communities coping with wildfires and aiding them in addressing the consequences of climate change and fires and the effects on their livelihoods;
- Assist in fire management planning and program implementation, enhancing institutional and technological capabilities and developing synergies through coordinated and collective action both within the region and internationally;
- Emphasize the improvement of participatory multi-stakeholders/fire management involving local community approaches and institutional and technological capabilities at all levels;
- Promote education and awareness-raising programmes on wildfire prevention; and

<sup>6</sup> See the resolution of the round table meeting at [http://www.fire.uni-freiburg.de/GlobalNetworks/South\\_Asia/Meetings\\_activities/Resolutions\\_RT.pdf](http://www.fire.uni-freiburg.de/GlobalNetworks/South_Asia/Meetings_activities/Resolutions_RT.pdf)  
<sup>7</sup> High-resolution version: [http://www.fire.uni-freiburg.de/Manag/poster\\_CBFIM\\_Nepal\\_nep.png](http://www.fire.uni-freiburg.de/Manag/poster_CBFIM_Nepal_nep.png)  
<sup>8</sup> High-resolution version: [http://www.fire.uni-freiburg.de/GlobalNetworks/South\\_Asia/Backgrd\\_materials/brochures.html](http://www.fire.uni-freiburg.de/GlobalNetworks/South_Asia/Backgrd_materials/brochures.html)

- Enhance and strengthen bilateral/multilateral and international cooperation in wildland fire management for creating synergies and sharing knowledge and technical and human resources among countries in the region by accepting and promoting principles, norms, rules, and decision making procedures within a guiding framework that individual countries agree on.
- Ensure participatory multi-stakeholders involvement including local communities and the activities will be implemented, monitored and evaluated together with the local communities.
- Adapt forest fire management to existing systems of sustainable forest management (SFM) with careful attention to the way forward to the REDD mechanism.

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[www.fire.unifreiburg.de/GlobalNetworks/South\\_Asia/Meetings\\_activities/Southasia\\_meeting\\_foundation.html](http://www.fire.unifreiburg.de/GlobalNetworks/South_Asia/Meetings_activities/Southasia_meeting_foundation.html)

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## **Development of a Policy, a Strategy and Building Capacities in Local, National and Transboundary Forest Fire Management for Nepal**

### **1. Introduction**

Forest fire is considered as a major cause of forest degradation in Nepal. About 400,000 hectares (ha) forest area burned annually. About 90 percent of the forested area in the plain was burnt annually. Moreover, there are regular winter fires affecting the coniferous forests in the high mountains of Nepal. Humans cause most of the fires. At least one hundred villages are burned annually by wildfires in Nepal. Wildfires do not only contribute to the degradation of forest ecosystems and the environment, but also lead to deterioration of social and economic conditions in some land-use systems and natural vegetation types. Fires result in losses in regenerative capacity of the forest (ca. 90% regeneration of *Shorea robusta* is completely damaged by fire). Fire-induced loss of soil cover negatively affects hydrological regimes and soil properties, leading to severe erosion and loss of productive topsoil, also resulting in flooding, landslides and debris-flows. High economic losses are caused by damaging valuable timber and non-timber resources, natural regeneration, and planted forests.

Major issues with respect to wildland fires in the country are:

- National wildland fire management assessment
- Human resources development
- Legal, institutional and policy frameworks
- Research and development
- International cooperation

### **2. Footprints Behind**

#### **2.1 Establishment of Regional South Asia Wildland Fire Network (RSAWFN)**

An increasing frequency and destructive force of unwanted wildfires worldwide – including the excessive use of fire in the conversion of forests into other land uses in the tropical countries – is affecting human lives, health and well-being, economic assets, property, biodiversity, water resources, soil, atmosphere and climate.

Fire management solutions and strategies, which include preparedness and early warning, cannot be generalized due to the multidirectional and -dimensional effects of fire in the different vegetation types and the large variety of cultural, social, and economic factors influencing them. However, unlike the majority of the geological and hydro-meteorological hazards, wildfires represent a natural but predominantly human-influenced hazard, which can – to a certain extent – be predicted, controlled and prevented.

The current state of wildland fire science and atmospheric sciences research of the last two decades potentially provide sufficient knowledge for fire management decision support and development of policies affecting the occurrence and consequences of human-caused fires. However, in many countries or localities, the requisite knowledge is either lacking or is not readily accessible for developing adequate measures in fire policies and management.

In response to the strategic goals of the UN Convention on Combat of Desertification (CCD), Convention on Biological Diversity (CBD), and the UN Framework Convention on Climate Change (UNFCCC), the Ramsar Convention on Wetlands the UN Forum on Forests (UNFF), the Millennium Declaration of the UN General Assembly, and the objectives of the work of the Global Fire Monitoring Center (GFMC) and the World Conservation Union (IUCN), the UN-ISDR Inter-Agency Task Force for Disaster Reduction in 2001 of the United Nations International Strategy for Disaster Reduction

(UNISDR) established a Working Group on Wildland Fire (WG-4). This Working Group was coordinated by the GFMC.

One of the priority fields addressed by the Working Group on Wildland Fire was the establishment of, and operational procedures for, a global network of regional- to national-level focal points and network structures for early warning of wildland fire, fire monitoring and impact assessment, aimed at enhancing existing global fire monitoring capabilities and facilitation of a global fire management working program or network.

At the second meeting of WG-4 (3-4 December 2001) it was decided to give priority to the establishment of a "Global Network of Regional Wildland Fire Networks", which finally was entitled "Global Wildland Fire Network". At the same time the WG-4 transitioned to the newly formed UNISDR Wildland Fire Advisory Group (WFAG). GFMC is serving as Secretariat of both the GWFN and WFAG.

These decisions were endorsed by the International Wildland Fire Summit (Sydney, October 2003), which elaborated a "Strategy for Future Development of International Cooperation in Wildland Fire Management", in which the following statement was included:

*"The Regional Wildland Fire Networks will be consolidated, developed and promoted through active networking in information sharing, capacity building, preparation of bilateral and multilateral agreements, etc. This process will be facilitated through regional wildland fire conferences and summits in cooperation with the International Liaison Committee and the UNISDR Working Group on Wildland Fire".*

At the first meeting of WFAG / GWFN in December 2004 it was recommended to instrumentalize the networks as effective platforms for dialogue and communication to achieve a level of mutual cooperation and synergy within regions, between regions, as well as between UN agencies and programmes including the secretariats of the "Rio Conventions" (UNCCD, UNCBD, and UNFCCC), and to support the Regional Wildland Fire Networks.

The Regional South Asia Wildland Fire Network was established in line with several declarations made in international conferences/ summit *inter alia* the Declaration of the 10<sup>th</sup> SAARC Summit Colombo 1998 on Environment and the decisions made in the meetings of UNISDR WG-4, WFAG and GWFN since 2002. The foundation of the regional network intended to bring together both the technical members of the fire community and the authorities concerned with policy and national practices in wildland fire management to realize their common interests of fire risk management and disaster reduction at global scale.

The foundation meeting was funded by GFMC, cosponsored by the International Centre for Integrated Mountain Development (ICIMOD) and assisted by the Nepal GIS Society (NEGISS), Agro-Farm Foresters Association Nepal (AFFAN) and the Center for Biological Conservation Nepal. It was held in the premises of the International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu, Nepal, 2-3 April 2007.

It brought together international and regional wildland fire scientists, professionals and managers to discuss global, regional as well as national level issues and concerns of wildland fire paradigms and build a common consensus for sustainable wildland fire management in the South Asia region by providing a regional platform within the GWFN, called Regional South Asia Wildland Fire Network. The report of the Foundation Meeting of the Regional South Asia Wildland Fire Network can be accessed on the Regional Website.<sup>9</sup>

<sup>9</sup> [http://www.fire.uni-freiburg.de/GlobalNetworks/South\\_Asia/Meetings\\_activities/Southasia\\_meeting\\_foundation.html](http://www.fire.uni-freiburg.de/GlobalNetworks/South_Asia/Meetings_activities/Southasia_meeting_foundation.html)



The participants of the foundation meeting recommended to governments, international organizations, non-government organizations and civil society the following action plan for cooperation at bilateral and multilateral levels on wildland fire research and management in South Asia, among other:

- Stress on national focus and technical resource development for wildland fire management programmes
- Stress on national policy development and institutional set up for dealing with all wildland fire issues
- Stress on strategy formulation, fire management plan development and programme implementation
- Conduct assessment and research on wildland fire
- Stress on development and improvement of national legal frameworks, resource generation and allocation and law enforcement
- Stress on strategy formulation, fire management plan development and programme implementation
- Give emphasis on improvement of community-based fire management and institutional and technological capabilities at all levels
- Enhance cooperation amongst the countries for sharing technology and data

## **2.2 Round Table for the Development of a National Strategy for Wildland Fire Management in Nepal**

After the foundation of the Regional South Asia Wildland Fire Network under the UNISDR Global Wildland Fire Network the **3-level Wildland Fire Management Project for Nepal** was approved and funded by the German Foreign Office, Task Force for Humanitarian Assistance, and was implemented by the GFMC in close collaboration with the Department of Forests (Ministry of Forests and Soil Conservation, Nepal), the United Nations Development Programme (UNDP) Nepal and the International Centre for Mountain Development (ICIMOD). The main components of the project were:

- Community Forest Fire Management Planning: Development of a model
- District Forest Fire Management Planning: Development of a model
- National Round Table meeting for the development of a National Strategy for Wildland Fire Management in Nepal

The main objective of the meeting was to find out the direction by bringing together fire communities to discuss on global, regional as well as national level issues and concerns of wildland fire paradigms and build a national strategy for sustainable wildland fire management in the country.

The National Round Table was held in Kathmandu, Nepal, 16 December 2007. It brought together 52 participants including national fire scientists, professionals, policy makers and expatriate experts, representing government organizations, international / regional non-government organizations, local

non-government organizations and civil society from all over the country, and the Embassy of the Federal Republic of Germany and other international organizations.



The participants recommended, among others, the following road map:

- To formulate and improve legal, institutional and policy frameworks, build sustainable fire management capabilities;
- To conduct national fire assessment and research on wildland fire outbreaks, suppression, ecology and management;
- To develop fire management plans and human resources at all levels;
- To give emphasis to community-level fire management planning approaches and institutional and technological capabilities at all levels;
- To enhance cooperation among countries within the region and at inter-regional levels, aimed at sharing technology, expertise and data in fire management;
- To support wildland fire management activities by national agencies and international donors aimed at fostering international cooperation in fire management, including collecting and disseminating fire information, arranging and enhancing international policy dialogue, and support of projects;
- To create an enabling environment from all possible donors including national, international, bi-lateral, multi-lateral and private foundations for financial, technical and other resource support for sustainable fire management in the country;
- To seek support from all possible donors including national, international, bi-lateral, multi-lateral and private foundations for financial, technical and other resource support to accomplish the above tasks.

The report of the Round Table can be accessed at the GFMC system.<sup>10</sup>

### 3. Objective of the ITTO Project

The proposed project is to meet the rationale and requirements to be sponsored in accordance with the International Tropical Timber Council (ITTC) decision ITTC (XXXIII)/27 of 9 November 2002 and to request the services of a forest fire expert to assist Nepal by:

- Evaluating the country's forest fire situation
- Evaluating the current fire management capabilities
- Identifying pragmatic options / proposals that would be incorporated in the development of a national fire management policy, a strategy and action for implementation, including transboundary cooperation with neighbor countries, and
- Developing a project proposal for their implementation

<sup>10</sup> [http://www.fire.uni-freiburg.de/GlobalNetworks/South Asia/Meetings activities/Round-table Nepal.html](http://www.fire.uni-freiburg.de/GlobalNetworks/South%20Asia/Meetings_activities/Round-table_Nepal.html)

Based on the authorization by the Ministry of Forests and Soil Conservation of Nepal, transmitted to ITTO on 10 December 2008, GFMC and ITTO agreed to prepare, organize and implement an ITTO Mission over a period of 6 months to assist the Government of Nepal to undertake a review of the current status of forest fires and fire management in Nepal and to develop a Fire Management Strategy for Nepal, with emphasis on cooperation with neighboring countries (both ITTO member and non-member countries) and community participation in fire management.

In order to implement the mission a consultative round table meeting was scheduled for March 2009 in which all stakeholders concerned including national fire scientists, professionals, academicians, administrators, policy makers, and international institutions and NGOs / Community Forest User Groups (CFUGs) members, media etc. attended.

#### 4. The Round Table Meeting “Development of a Policy, a Strategy and Building Capacities in Local, National and Transboundary Forest Fire Management for Nepal”

The consultative multi-stakeholders Round Table meeting was held in Kathmandu on 11 March 2009. Participants included national fire scientists, academicians, professionals, policy makers and expatriate expert, representing government organizations, international / regional non-government organizations, local non-government organizations and civil society from all over the country and other international organizations. The participants presented the state of the fire situation and fire management capabilities and discussed for international cooperation in fire science, fire management and fire management training in the country. Five thematic papers were presented by the fire scientists and recommended enhancing international cooperation; creating an enabling environment and stressing proactive actions for wildland fire management.



Opening of the multi-stakeholders Round Table meeting – Lighting the *Panas* by Uday R. Sharma, Secretary, Ministry of Forests and Soil Conservation, and Sundar P. Sharma, coordinator of the Regional South Asia Wildland Fire Network.

The participants proposed the elements determining wildland fire management strategy for Nepal, and recommended implementation of priority elements of the Forest Fire Management Strategy for Nepal, with emphasis on regional cooperation as follows:

##### 1. Assessment of the national fire situation and fire management capabilities:

- Fire is used by the rural population as a traditional tool for clearing and managing agricultural and pasture lands. It is also used to facilitate the gathering of non-timber forest products, hunting and herding. Uncontrolled fires are common in the country, with a long and intense dry season. Many of these fires have the potential to cause major damages;
- Consequences of uncontrolled fires in country, *inter alia*, lead serious degradation of forests, ecological changes, as well as deterioration of social and economical conditions in some land-use systems and regional climate (e.g., the *Asian Brown Cloud*) and natural vegetation types;
- Nepal has diverse ecosystems, socio-economic and cultural settings and vegetation types resulting from a wide range of land-use systems and climatic conditions, consequently having diverse fire regimes and vulnerabilities;
- Fire management can be an essential part in ecosystem management (not all fires are destructive);
- There is a lack of existing local and national capability in fire research and management, including monitoring, early warning and ecological and socio-economic impact assessment, and facilitating international cooperation in fire management;

- There is increasing interest in Community-Based Fire Management (CBFiM) and the need for institutional and technological capability development at all levels;
- Sustainable management and protection of vegetation cover, which provides goods and services including non-timber forest products and recreation, maintain biological diversity, mitigates the consequences of climate change, conserves watersheds, improves air quality and helps to reduce poverty through livelihood support to rural populations;
- Implementation of the plans, which are prepared with support from the Foreign Office, Federal Republic of Germany, Office for Humanitarian Assistance, implemented by the Global Fire Monitoring Center (GFMC), is crucial to test for a replication in other parts of the country under similar fire regimes.

## 2. Conclusions and Strategic Recommendations:

- There is a lack of legal, institutional and policy frameworks dealing with wildland fire management building sustainable fire management capabilities;
- There is a lack of fire management plans and human resources at all levels;
- There is a need to conduct national fire assessment and research on wildland fire outbreaks, suppression, ecology and management;
- There is a lack of fire management guidelines at all levels;
- Education and awareness are vital to minimize the adverse impacts of wildfires at all levels including incorporation of wildland fire management courses in disaster management curricula at school and college level education specially in natural resource management courses;
- There is an acute need of an enabling environment from all possible donors including national, international, bi-lateral, multi-lateral and private foundations for financial, technical and other resource support for forest fire management in the country;
- There should be an emphasis on multi-stakeholders and community-based fire management (CBFiM) approaches and institutional and technological capabilities at all levels;
- There should be an enhancement of cooperation among countries within the region and at inter-regional levels, aimed at sharing technology, expertise and data in fire management to deal with transboundary wildfires and haze pollution;
- The country should encourage the endorsement and use of international instruments (e.g. Hyogo Framework for Action, Kyoto Protocol 2005, United Nations Framework Convention on Climate Change (UNFCCC), the ITTO Action Plan, Bali Action Plan and Reducing Emissions from Deforestation and Degradation in Developing Countries (REDD), the objective of work of UNISDR- Wildland Fire Advisory Group / Global Wildland Fire Network and Global Fire Monitoring Center, the SAARC Declarations on Environment and Natural Disasters, the Millennium Declaration, Implementation of the World Summit on Sustainable Development, the Yokohama Strategy, Fire Management Guidelines (ITTO, FAO) etc.; and
- There is a recognition of the UNISDR Global Wildland Fire Network, the Regional South Asia Wildland Fire Network and its National Chapter and the Secretariat of the Global Wildland Fire Network (Global Fire Monitoring Center) at fostering international cooperation in fire management, including collecting and disseminating fire information, arranging and enhancing international policy dialogue, and support of projects.

It was felt by all participants of the national consultation that the timeframe and the limited resources of the pre-project would not allow to develop a comprehensive national fire management strategy. Instead, the conclusions and recommendations would be addressed in the follow-up project to be developed by the Government of Nepal. Experience gained within the project would be used to develop a consolidated national fire management policy and an implementation strategy based on realistic and implementable approaches.

## 5. The way ahead

Altogether the community of foresters and fire managers in Nepal underscored the need for

- Strengthening local communities coping with wildfires and aiding them in addressing the consequences of climate change and fires and the effects on their livelihoods
- Emphasizing the improvement of community-level fire management planning approaches and institutional and technological capabilities at all levels
- Assisting countries in fire management planning, enhancing institutional and technological capabilities and developing synergies through coordinated and collective action both within the region and internationally
- Promoting education and awareness-raising programs on wildfire prevention; and
- Establishing Regional Fire Management Center aiming at enhancing existing regional capability in fire management, including monitoring, early warning and impact assessment, and facilitating international cooperation in wildland fire management

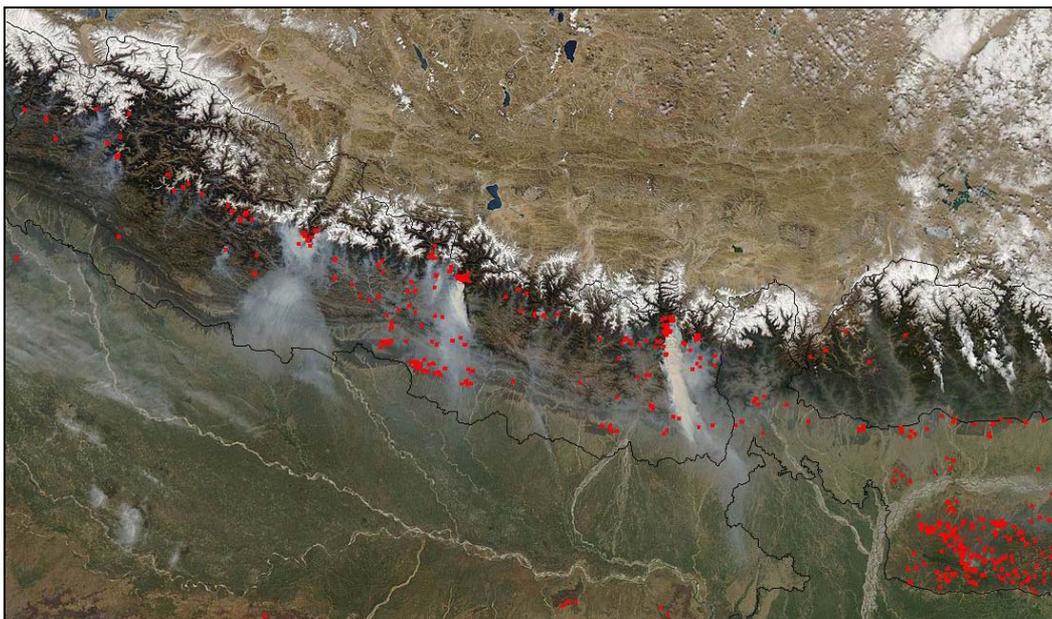
Based on these earlier recommendations the stakeholders involved or potentially to be involved in fire management in Nepal are now fully aware and ready to develop a national fire management policy, a strategy and appropriate action to implement the strategy.

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### Postscript

On 12 March 2009, the day after the Round Table meeting, the MODIS instrument on NASA's satellite Terra depicted the active fires burning in the high altitudes and lowlands of Nepal and neighboring India:



Active vegetation fires (red dots) in Nepal and neighbouring India depicted by the MODIS instrument of NASA's satellite Terra depicted on 12 March 2009 (Courtesy: MODIS Rapid Response System).

## The Situation of Forest Fires in Guatemala

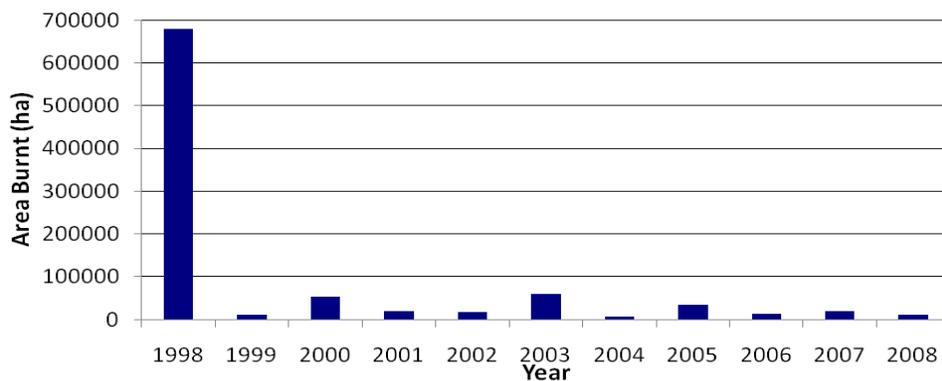
### 1. Introduction

Guatemala is a complex country and has a very diverse mix of ecosystems, including forests of broadleaves, conifers, mixed forests, dry forests and swamp, as well as a diversity of wild fauna, floor types and climatic variables and conditions. It has an approximate territory of 108,889 square kilometers of which 39.9% of this is covered by forests, equivalent to 4.3 million hectares (ha) (System of Geographical Information of the National Institute of Forests, 2001).

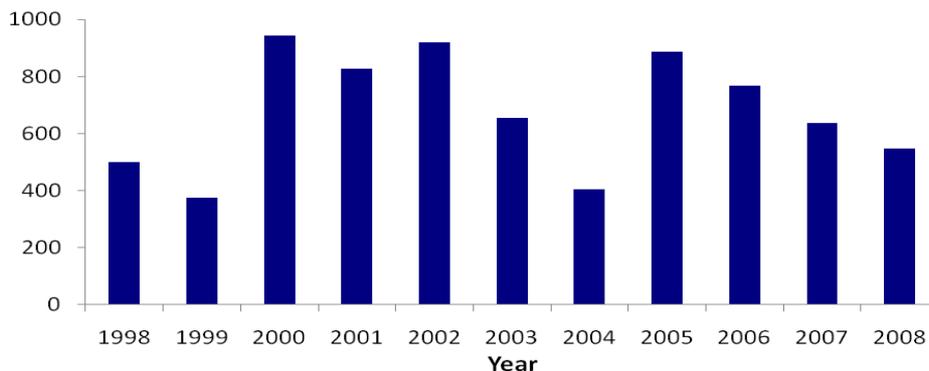
The incidence and the behavior of the forest fires vary from one geographical area to another. There is also very high cultural and social diversity in the communities that hinder the implementation of general strategies of prevention and control of forest fires. As such, it is necessary to establish strategic actions which are situation specific and long term in order to be able to impact on the processes of the residents' sensitization, generating changes of attitude, for the benefit of Guatemala and the Guatemalan people.

### 2. Forest Fire Situation 1998-2008

The following Figures 1 and 2 show the area burnt and number of fires per year for the period of 1998-2008 according the official statistics of the Government of Guatemala.



**Figure 1.** Annual area burned (ha) in Guatemala between 1998 and 2008.  
Source: Base Information Profor / INAB



**Figure 2.** Total Number of Fires per Year in Guatemala, 1998-2008  
Source: Base Information Profor / INAB

### 3. Causes of Forest Fires

One of the main causes of the forest fires is the use of the fire in the agricultural sector. Due to recent efforts to reduce the impact of agricultural fires it has been possible to reduce the proportion of agricultural fires of all wildfires in Guatemala from 40% to 24% from 1998 to 2008. However at the moment, the social inequity, not well guided politicians, weakness of the human capital, among other things, have contributed to an incidence of the forest fires of intentional character. Fire is used by local people to achieve different aims, such as land-clearing for agriculture and makes it more difficult to establish strategies of prevention, since many actions are not within reach of forest technical institutions, and they don't correspond to political decisions of high level. Looking at the smaller scale, causes of forest fires include use of fire by hunters, bonfires inside the forest that have not been properly extinguished, coal workers, the burning of garbage in areas adjacent to forests, and bee-keepers (*colmaneros*) that use fire to extract honey of wild honeycombs, among others.

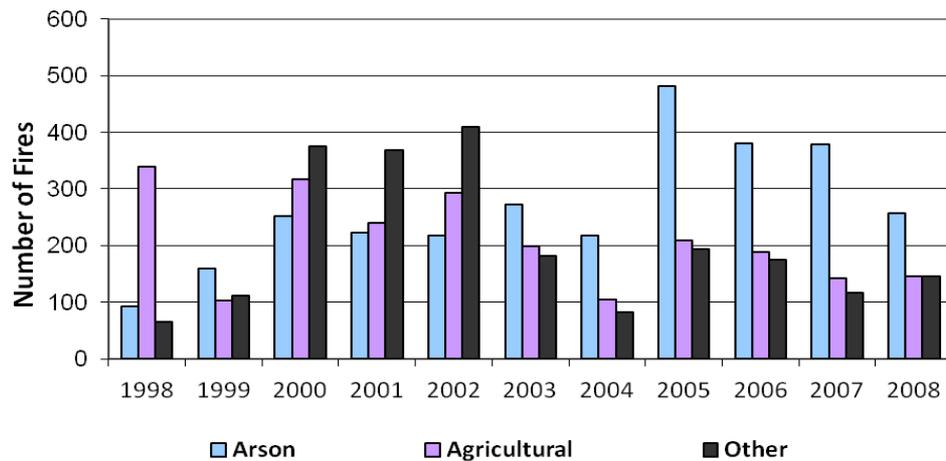


Figure 3. Causes of wildfires in Guatemala, 1998-2008

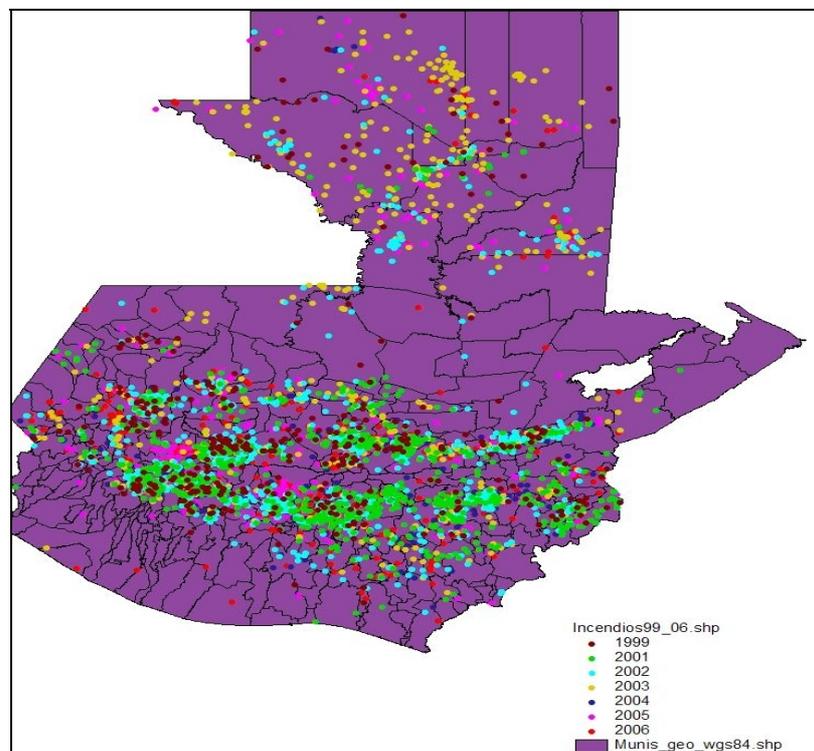


Figure 4. Location of landscape fires in Guatemala, 1998-2008.

**Table 1.** Summary of official wildfire statistics for Guatemala, 1998-2008

Years	Total No. Fires	No. Forest Fires	No. Fires (non-forest)	No. Mixed Fires	Total Area Affected by Fire (Ha)	Total Forest Area Affected by Fire (Ha)	Total Non-Forest Area Affected by Fire (Ha)	Principle Causes Of Fires
1998	498				678,795.00			Agricultural
1999	374				10,623.05			Meaningful
2000	944				53,404.80			Agricultural
2001	916	827	89		21,997.13	18,636.17	3,360.96	Agricultural
2002	992	920	72		22,467.37	18,007.80	4,459.57	Agricultural
2003	732	653	79		83,058.31	60,209.33	22,848.98	Meaningful
2004	443	404	39		7,462.73	6,702.67	760.06	Meaningful
2005	947	886	61		92,554.45	34,157.12	58,397.33	Meaningful
2006	831	767	64		14,407.24	12,408.41	1,998.83	Meaningful
2007	869	637	57	175	56,046.00	18,757.00	37,289.00	Meaningful
2008	747	547	57	143	28,837.50	10,972.90	17,864.60	Meaningful
<b>TOTAL</b>	<b>8293</b>	<b>5641</b>	<b>518</b>	<b>318</b>	<b>1,069,653.58</b>	<b>179,851.40</b>	<b>146,979.33</b>	

#### 4. Areas of Cultural and Ecological Importance Affected by Wildfires

Due to its recent ecological formation, the Department of the Petén is highly susceptible and sensitive to wildfires. The Department of the Petén has a surface of 35,854 km<sup>2</sup>, corresponding to approximately a third of the country. The surface is distributed this way: 146 km<sup>2</sup> of water bodies, 5,059 km<sup>2</sup> constitutes cultivations, grasses and low mounts, 1,500 km<sup>2</sup> are secondary forests, 27,477 km<sup>2</sup> natural broadleaf forest and 1,672 km<sup>2</sup> wetlands between the 50 and 600 meters above sea level. Petén is a forest refuge of an incalculable quantity of fauna and wild flora. The faunal diversity includes the jaguar, tapir or *danto*, *tigrillo* (*Leopardus tigrinus*), ocelot, white line deer, boar, howling monkey, monkey claws, birds like the red *guacamaya*, the *cojolita*, the pheasant or *pajuil* and endemic species as the turkey *ocelado* (or turkey of Petén), the crocodile *moreletti* and the white fish. The Department of the Petén has protected areas of excellent importance among them the Parks National Lagoon of the Tiger, Sierra of the Lacandón and Reservation of *Biósfera Mayan Montañas Chiquibul*. In their majority the orography of the department is plains being inside these, important sources of water among those that the saline rivers, Santa Isabel or Cancuén highlight, Machaquilá, San Pedro and Usumacinta that end likewise in the gulf of Mexico and the Deep or Blue rivers, San Pedro and Mopén that end in the sea of the Antilles, highlight the lake Petén Itzá, the lagoons Sacpuy, Yaxhé, the Lost One, the Tiger, Two Lagoons, the Repasto, Yaloch, Petexbatún, Long and the Puddles, besides the Lagunetas San Diego, the Gloria, the Mendoza, Macanché and Salt Petén. Located inside the department are approximately 2000 archaeological places, among the most important are Tikal, Mirador, the Peru, Black Stones, Altar of the Sacrifices, Ceibal, Aguateca, Two Piles, Yaxhá, Nahúm and Cancuén. The majority of these cultural heritage sites are located inside the protected areas and outside of the protected areas Ixcún, Ixtontón, The Shawl, among others.



**Figures 5 and 6.** Areas of cultural importance include heritage sites of ancient Mayan culture.

On the other hand Petén has a rate of demographic growth of 8.5%, the highest in Guatemala with a current population of 546,003 inhabitants. The majority of these people live in rural areas and they carry out activities of subsistence agriculture (such as sowing cultivations) which causes pressure on the natural resources of the area. Factors such as this exert pressure of the region, although it has been designated as a protection area. There have been a high number of forest fires incidents within Petén in recent years. Between 1998 and 2007 forest fires have affected more than 600,000 ha of forest. Among the main causes of the burns are agricultural, bonfires, and deliberate use of fire by users of the forest including *xateros*, hunters and beekeepers. These regular fires pose a danger to the flora, fauna, soils, and has severe repercussions for biodiversity and ecosystem function.

## 5. Economic and Ecological Damages Caused by Forest Fires

The economic damages due to wildfires in Guatemala are concentrated in the loss of products of the forest which are used by the population for obtaining economic revenues, these include timber and non timber forest products; wood, firewood, needles and pine fruits, *xate*, pepper etc. There are also agricultural losses and decline in food productivity as a consequence of the forest fires, either by direct contact of the fire or for the proliferation of plagues and later illnesses to the occurrence of these.

Furthermore, there is also evidence of the loss of revenues from visitors to the wild areas for recreation and tourism because during the fire season the scenic beauty is diminished and the airports occasionally close as a consequence of the smoke caused by the forest fires. Effects include direct losses in the population's income due to the decrease of tourists. Smoke from the fires can have perverse outcomes on human health, causing respiratory illnesses with children and elderly people most vulnerable. The impact of smoke on health has an economic impact also, as victims have to appeal to economic payments on the part of the population to heal these ailments.

From the ecological and environmental point of view the damages are similar to those seen in neighboring countries include fragmentation of the forest, soil erosion, loss of habitat for wildlife, nutrient depletion and other harmful effects on forest soils, changes in forest structure with the consequent invasion of other exotic species into the area, desertification of lands, contamination of sources of water, and of the atmosphere, proliferation of plagues and illnesses in the forests, death and emigration of wild animals, and pressure on native flora, among others.

**Table 2.** Estimates of economic losses in 2003 due to forest fires

	<b>Value</b> (in millions of Quetzales)	<b>Value</b> (in millions of US Dollars)
Timber	82.8	11.4
Non-timber forest products	20.8	2.77
Emissions CO <sub>2</sub>	43.3	5.77
Value of Existence	359.8	47.97
Total	506.7 Million Quetzales	67.91 million \$US

Source: Consultancy CATIE/INAB/CONAP

## 6. Prevention of forest fires

Several institutions collaborate together as the National System for the Prevention and Control of Fires Forest (SIPECIF) to execute diverse actions in Guatemala in an attempt to counteract the incidence and effects of the forest fires. Such preventative actions include:

### *Detection*

National level journeys using pickup vehicles or motorcycles are implemented for fire detection. Air journeys using airplanes or helicopters are also occasionally used, although due to the high cost these are made with little frequency. Another detection form is a stationary one using observation towers in diverse areas with protection priority. Finally fire detection by satellite has been introduced in Guatemala, with the National Commission for Biodiversity with headquarters in Mexico sending Guatemalan officials daily information regarding heat and fire observations, which are verified with field observations.

### *Analysis of risk*

The objective is to prepare personnel to have a direct contact with the population mainly community leaders, such as mayor. Through an analysis of the environmental situation in the community, municipality or region, and through the graphic representation of the area, the designated leader can analyze risk and prepare a plan of prevention and control of forest fires. This is to be done collaboratively with different stakeholders and with shared responsibility and involvement on the part of the community.



**Figure 7.** Community members preparing a fire prevention plan

### *Training of forest fire fighters*

With a duration of three days, it is a course that consists of 11 theoretical-practical lessons and a field phase using the interactive method and participative teaching with the objective of forming forest firemen able to direct and to execute tending actions to control and to extinguish the forest fires in a sure and effective way.

### *Management of forest fuels*

Training has been conducted for locals to learn how to create firebreaks which impede the advancement of a fire. This practice is implemented by foresters, community member, and proprietors of state-led projects, among others. Another practice of handling of fuels is prescribed burning, which consists on making a plan of fire management for the area to work using parameters of relative humidity, wind direction and speed, topography, fuels, etc. The objectives of prescribed burning range from the reduction of fuels, to propitiate natural regeneration, but also for the elimination of plagues and illnesses. With regard to the black lines their application is not still significant.

### Awareness rising

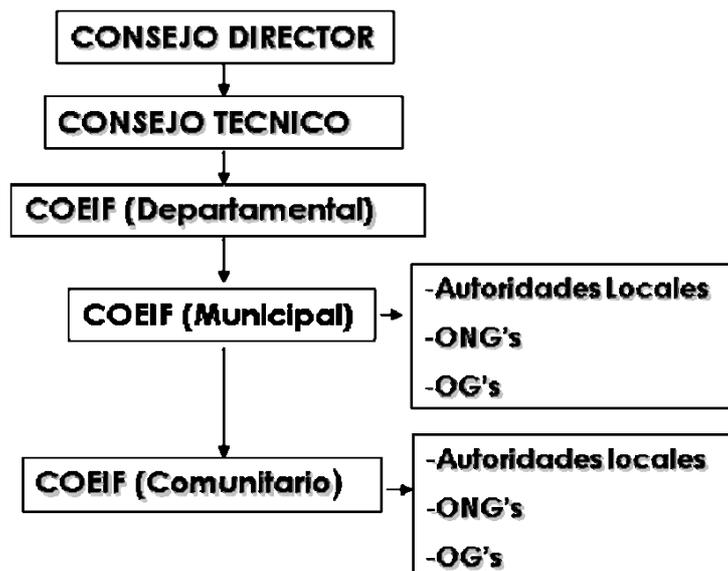
Guatemala has 23 languages so the task of spreading a national message on the management of forest fires is a difficult one. It is mainly attempted using different means such as radio, television, posters, calendars and pamphlets.



**Figure 8.** Promotional material intended to raise awareness and educate people about forest fires and their control and prevention.

## 7. Organization for Forest Fire Control

At national level, there are 20 Emergency Operation Centres (COEIF), who manage forest fire incidents. These they are led by the departmental governor and worked by the institutions that together form the SIPECIF. This system employs approximately 30 forest fire brigades in the whole country who, with the supported of community volunteers and technical personnel, control and liquidate the catastrophes that happen inside their designated areas.



**Figure 9.** Chain of command for forest fire management

### *Integrated Fire Management*

Currently an integrated fire management plan is being employed in a little more than 1400 ha of mixed forest in the National Forest Property of San Jerónimo in Low Verapaz. Two prescribed burns have been implemented under this plan, with the objective of reducing forest fuels and encouraging natural regeneration. Having planned for the year 2008 the execution of this plan includes prescribed burns in critical areas, black lines, definition of protection areas and areas of forest handling, among others.

## **8. National Cooperation in Fire Management**

Everything related to the topic of the management of wildfire is executed by applying the governmental agreement 63-2001. The national forest fire fighting capacity (the prevention and control of fires) is based on SIPECIF. This agency works together with the National Institute of Forests, the National Council of Protected Areas, the Ministry of Atmosphere and Natural Resources, the National Coordinator for the Reduction of Disasters, the Ministry of the Defense and the Secretary of executive Coordination of the Presidency, institutions that work on the whole to lessen the impact of forest fires on the environment and the economy.

## **9. International Cooperation in Fire Management**

The international support of organizations such as TNC, CCAD, AECI, FAO, OFDA-LAC, SEMARNAT, AID, DOI and GTZ (among other) has strengthened the aspects of prevention and control of forest fires. With the help of these international partners at national level elaboration and execution of plans of integrated fire management, handling of fuels, personnel training, improvement of fire detection abilities, among other things, have been achieved.

## **10. Analysis and Recommendations**

- A high proportion of all forest fires are deliberately lit. These are the result of various forest users in the pursuit of forest products for subsistence and economic gain.
- The introduction of the concept of good fire has caused divergences of opinions in the population for the repetitive slogan that 'all fire is bad'.
- The investigation has been very scarce regarding the integrated handling of the fire, as well as in aspects of valuation and environmental restoration.
- The budgets are guided in way in which more is allocated to fire control and less to fire prevention. Both are needed for sound management to minimize the impact of forest fires.
- It is necessary to implement a national system for dealing with forest fires that serves as a guide for the execution of tending actions and for the appropriate handling of fire incidents.
- Although there are 23 specific technicians on the topic of forest fires hired at national level, technical invigoration is necessary for the application of the system of command of incidents, in the attention of big catastrophes.

### **IFFN contribution by**

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## Fire on Mount Cameroon Forest

### Abstract

Fire is the greatest threat to forest conservation in the Mount Cameroon area, with the potential to detrimentally affect different human activities such as tourism, farming, harvesting of fuel wood, and honey and non-timber forest products for local and economic development.

About 300,000 people are living in villages around Mt. Cameroon and depend solely on forests for their livelihood, using fire as a cheap means of labor and to clear forest land for agriculture, this significantly harms the forests, hydrology, soils, wildlife and human environment and property.

A participatory rapid assessment survey was used to survey about 1,200km<sup>2</sup> of forest land that is in use. Two experiments were conducted, the first concerned sampling of three areas in the region in which three plots were selected with each plot made up of twin adjacent plots measuring 500m<sup>2</sup> each. One of the plots was affected by fire and the other not affected by fire. Inventory was conducted in the plots to evaluate the effects of fire and the overall biomass loss. The second dealt with testing the productivity of a burned piece of land and an unburned one on which a leguminous crop *Egusi* was planted and produce collected each harvesting season for a period of four years and weighed.

Overall analysis shows that about 88% of activities on forest are by use of fire with an increasing impact on biodiversity and ecosystems, with population increase and poverty being the major driving force. Results from this study have been used to develop management strategies for conservation purposes, land use planning to ensure food sufficiency for long term, economic, political, social and cultural values of indigenous Bakwerians and others.

Cameroon is one of many countries in Africa facing a litany of environmental problems. Presently, food and water shortages are on the rise, drastic climatic changes, diseases increase, biodiversity loss, modification of species and vegetation cover and landscapes, depletion of soils and strong pressure placed upon ecosystems. A fire management scheme and framework with mitigating solution is put in place to *kill the fire use habit* and to save Mount Cameroon Forest for posterity.

### Introduction

Mount Cameroon region covers about 4,500 km<sup>2</sup>, with Cameroon Mountain the highest point at 4,095m above sea level. It is an active volcano with rich volcanic soils and forest being the main attraction to many scientists, economists, sociologists, educationist, tourists, farmers, etc. It is one of the world's natural heritages with large areas of continuous forest cover, from the coastal region with marine forests to the hinterland with tropical evergreen forest, up the slopes of the mountain with sub montane and montane forest to the apex with high altitude grassland.

About 300,000 people are living in the area and fire is commonly employed by the users of these natural resources while carrying out different activities of subsistent farming and cash crop plantation and agriculture dominating. Inappropriate and excessive use of fire is causing perverse outcomes for the forests and is the underlying reason for the present study. There is an urgent need to remediate the situation.

The climate is tropical equatorial having high rainfall and average temperatures conducive for agriculture and high levels of biodiversity. The area has very high levels of species endemism and richness, in part due to the great altitudinal range and the resulting diversity of habitats. Details on the evaluation of forest fires have been recorded, and the significant loss of biodiversity confirmed through studies. Mt. Cameroon has about 42 endemic plant species, 8 species of rare mammals, 8 threatened bird species and many butterflies.

The study area covers about 2,800km<sup>2</sup> from west coast, upper villages on the mountains slope, Bimbia-Bonadikombo, Bomboko forest reserve and adjoining forest and Southern Bakundu forest area. Field survey assessment methods observed that about 1,200km<sup>2</sup> of forest land has been used up for various activities and farming taking the highest portion with slash and burn as the main method of farmland preparation.

The study has also elaborated reasons why people in Mt. Cameroon area use fire, its effects on the forest and land forms and environment, and has proposed recommendations towards *killing the forest fire use habit* for sustainable management of the forest and resources.

### **Objectives and Method of a Fire Study**

A fire study was implemented in order to

- Evaluate the causes and effects of forest fires on the Mount Cameroon region for reasons of conservation and sustainable development.
- Develop monitoring and management mechanisms for forest fires in the region for necessity of intervention and defense.
- Establish regulatory and collaboration framework for local people and organizations for information sharing.
- Estimate the value and quantity of biomass burned and the amount of CO<sub>2</sub> emissions in the region

The field survey and assessment, inventory and interactive interviews and collection of data were made as well as analyses on the effects of fire on affected areas compared to chosen non affected standing forest land.

First, the sample areas in the region were selected and comprised two sub-plots of equal sizes measuring 500m<sup>2</sup> and adjacent to each other. One has to be on an area affected by fire and the other on a non-affected area:

- Plot I: Lava flow track in the upper villages on the Western side of the mountain along a lava flow track
- Plot II: Bomboko forest reserve area on the eastern side of the mountain
- Plot III: Kendongi camp in the southern Bakundu forest reserve along the Buea-Kumba road near Mbalangi village.

Analyses of Plot I on the lava degraded area after the last eruption 9 years ago (in 2000) has not got a single shoot of grass. Fuming steam can still be found on some portions of the lava. Compared to the non-affected area with high vegetation cover, it is estimated that it will take about 100 years for the lava to regain total vegetation cover.

Plots II and III where slash and burn is highly practiced has very unhealthy crops and no vegetation cover, an indication of loss of fertility over the years. When compared to the non-affected plots is a direct opposite of the situation. It is estimated that over 25% carbon dioxide (CO<sub>2</sub>) is emitted in the atmosphere. A good quantity of incompletely burned wood is abandoned and finally shall be wasted. In fact, some portions are left completely bare by fires which are very prone to severe erosions.

Random sampling tree count of timber species, non-timber forest product species, lianas, shrubs, other plant species and animal species was enumerated on each of non-affected plots to estimate the average biomass loss on the affected plots.

About 500 effects could be numerated from plant and animal loss including (microorganisms, soil food nutrients, animals and plants in aestivation or hibernation, plants seeds and seedlings, eggs of animals and birds on incubation, young tender newly born living organisms), vegetation cover, soils and soil structure, climate, and hydrology.

**Table 1.** Biodiversity inventory of the research plots

<b>Faunal Diversity</b>			
<b>Species / Plot</b>	<b>Plot I</b>	<b>Plot II</b>	<b>Plot III</b>
Monkeys	06	08	Non
Chimpanzees	03	06	Non
Bush buck	12	16	20
Porcupine	36	22	16
Bush goat	12	16	22
Crocodiles	0	01	03
Snakes	38	26	23
Cane rats	66	54	46
Elephants	6 footprints and droppings	6 footprints and droppings	None
Birds	362	346	296
Butterflies	226	320	232

<b>Tree Species (Common Names)</b>			
<b>Timber and non timber forest products (common names)</b>	<b>Plot I</b>	<b>Plot II</b>	<b>Plot III</b>
Frake	06	18	22
Bete	04	03	39
Aiele	02	08	14
Ayous	12	14	36
Bilinga	06	03	12
Doussie	13	18	14
Dibetou	04	03	09
Bubinga	08	12	18
Kossipo	11	12	18
Sipo	06	14	20
Dabema	13	16	14
Acajou	03	12	22
Iroko	12	09	10
Moabi	01	04	08
Iron wood	10	14	26
Tiama	03	02	04
Padouk	05	04	26
Pygeum	22	18	0
Tetra pleura	02	05	02
Cola lateritia	02	03	02
Bitter kola	03	02	08
Bush pepper	12	22	26
Njansang	22	34	66
Voacanga	10	14	03
Yohimbe	03	09	01
Bush mango	03	02	15
Quinine Stick	12	18	03

### **Fire Occurrences in Rainforests of Mount Cameroon**

Natural occurrence of fire on Mount Cameroon is noticed during volcanic eruptions, since it is an active volcano and each time it erupts, as was the case on 29 March 1999, there was emissions of very hot and flammable lava that flowed down slopes towards the western coastal side of the mountain in Bakingili. I was there myself amongst the friends of the Limbe Botanic Gardens in the forest at Bakingili when a huge hill of moving hot burning lava of height of about 5m and 200m wide, engulfed, ravaged, and quickly dried up vegetation of both large and small trees alike, wildlife of different varieties plus those that could not escape were in a few seconds burned up into ashes. This

process continued for about three weeks, leaving the entire area completely transformed into a smoky desert. The landform and vegetation cover is degraded, destroyed, displaced and fragmented. In fact hundreds of hectares of forest, biodiversity, ecological habitats and water sheds have gone forever.

Very few cases of fire ignition from lightning have been recorded as was the case in 1996 in Bimbia Bonadikombo in the forest along the Limbe-Ombé road. An accident occurred when a transformer carrying high tension cables that passes through the forest along the Tiko-Douala road exploded in 2002 and caught fire and burning a rubber plantation and the surrounding forest.

Intentional situations frequently occur here where forests are burned for farming purposes. Already mentioned is slash and burn practice of agriculture which is very significant in the area common among subsistent farmers who lack knowledge and means for sustainable alternatives. Local people use fire for harvesting fuel wood and charcoal. Dry woody material and leaves are gathered round the tree and set on fire. When the tree falls, wood and charcoal is collected for household use and for sales. This is done and left overnight and because it is not supervised has the potential to escape and get out of control, burning huge portions of forest. Use of fire for honey harvesting is an old phenomenon here which sometimes results in destruction of forest and bee swamps. A whole tree is set on fire to collect a few liters of honey and the fire ends up consuming large portions of forest.

Fire incidences have been recorded each year during touristic activities and Mount Cameroon race. It is an annual event where the race track is cleared using fire especially on the savannah. When fire is set here due to high wind speed at this altitude fire is carried to distant areas and by virtue of the dryness of the grass, quickly picks up and burns more than the intended portions. Animals escape and move down slopes into the forest where local hunters use this opportunity to trap the animals. Other montane organisms are displaced and lost.

Some tourist, visitors and users of the mountain are careless in the way they handle fire especially cigarette smokers who drop lighted cigarette butts along their path which may pick up fire and grow wild in the forest. Cases of severe harm, deaths and biodiversity loss were recorded on the mountain in 1996, and 1999.

Occasional fire incidents have occurrence from high tension electricity lines that pass through the forest. Fires are caused by explosion of transformers that sets the forest on fire.

Most forest users especially farmers use fire to clear and prepare their farmlands at the beginning of the farming season. Owners of cash crop plantations of rubber, cocoa and palms, use fire as a cheap tool to clear old plantations or burn already cleared material to prepare the land for new planting and it is done without proper demarcation of the plantation boundaries. These fires eventually connect into neighbouring forest as was the case in Munyenge, Tiko and Idenau on the foot of the mountain. Farmers consider fire to be the easiest, cheapest, and readily affordable alternative for farmland preparation. To do this an average farmer places himself at a very poor position arguing that if he wants to clear and prepare a farm land normally for a piece of land say about 2 hectares, he would require a labor force of about 100 men including saw men and if he has to pay each worker about 4,000 CFA per day, he will be spending a total sum of 400,000 CFA which he cannot afford. It will be very cheap for him to buy a box of Match for 25 CFA, and use just a single stick to light the entire area. He believes this will do the clearing better and quicker and will save hundreds of thousand expenditure compared to having to employ labor.

Another argument raised here is that they have an immediate problem which is that of putting food on the table and will not want to wait for such a long time to go through the normal process of land preparation and planting. Some commonly grown crops especially subsistence crops such as *egusi*, maize, yams, plantains etc. are seasonal that must be cultivated at particular periods of the year for them to do well. This is the reason why farmers would prefer to use fire as a quick means to meet with this cultivation cycle.

Farmers also believe very strongly that crops like *egusi* will do very well with high yields on burned land than in a normal worked land. To investigate this fact, a 1.2km<sup>2</sup> area at Mbalangi was selected demarcated, and plotted out into six farm plots of 200m<sup>2</sup> each. Three of these plots were slashed and burned, while the other three were cleared and tilled and cropped with *egusi*. Harvesting was done at the end of the season and produce weighed for each of the plots. This process was conducted in the same conditions for four years and data imputed as on the table:

**Table 2.** Comparative *egusi* crop yield on burned and unburned plots for a period of four years

Plot (size: 200 m <sup>2</sup> )	Crop yield for 1 <sup>st</sup> year (kg)	Crop yield for 2 <sup>nd</sup> year (kg)	Crop yield for 3 <sup>rd</sup> year (kg)	Crop yield for 4 <sup>th</sup> year (kg)
Plot 1 (burned)	362	360	348	342
Plot 2 (unburned)	242	235	246	248
Plot 3 (burned)	366	368	350	325
Plot 4 (unburned)	240	244	242	248
Plot 5 (burned)	364	366	358	345
Plot 6 (unburned)	244	285	296	312

Quantitative and qualitative analyses of data on table shows that an average yield of unburned plots for 4 years period is 256.83kg while that of burned plots is 354.5kg. These figures reveal that there is an average yield during the 4 years period, whereas for the burned plots, the yield is very high during the first 3 years and falls sharply in the fourth year.

The results confirm the arguments raised by the local people, a scientific hypothesis for this phenomena is outlined as follows; ash from burned wood in the presence of rain water through its siltation process increases the basic mineral content of soils which is readily absorbed by leguminous species. More so, it also increases the cation exchange capacity of the soil. However, leguminous plants such as *egusi* have root nodules that contain nitrogen fixing bacteria which facilitate the plant's nutrition. The symbiotic relationship between the *egusi* plant and the N-fixing bacteria allow the plant to survive in nutrient poor soils. *Egusi* is also a creeping plant so will prefer clean and bare ground through which to creep and implant its root to absorb food nutrients directly to feed the rest of the stem since it will grow to a length of about 20-30m long during its life span. Absorption of food substances will reduce if it had to climb on trees or rough terrain not in contact to the soil and to depend on a single root for main means of nutrition that cannot completely support the whole plant length throughout its life span. It is also believed that soil diseases and pest such as tuber and root gangrier or panama, black soldier ants known here as *blackmans injection* are killed during burning process rendering the land safe for cropping. Also the fire will burn stumps and loosen the soil facilitating free infiltration and circulation of water and air in the ground for easy penetration of roots of crops and for absorption of food substances.

### **Average Biomass Loss and Volume of Biomass Burned in the Mt. Cameroon National Park**

Huge quantities of biomass are burned each year in the region of Mt. Cameroon National Park. The worst affected areas are the top montane and grassland region of the mountain and foothill forest. Remote sensing images have provided information on open areas of slash and burn, but have not estimated the exact quantity of biomass loss in the entire area since some of the burning is done in the forest understory without necessarily felling down the trees. This has created a sparse environment in the understory while the upper canopy appears covered. Authentic estimates can only be made through physical assessment and worth noting is that greater amounts of tropical forest biomass are found in the understory ground cover. Prominent in this observation is that fire is a big threat to some montane forest and grassland on Mt. Cameroon and that on the Eastern side of Mt. Cameroon it has been estimated that up to half of the forest cover is already lost (1). Considering that the lost portion is about a third of the Mt. Cameroon area together with the other portions assessed during the research survey, amounts to about 1200 km<sup>2</sup> giving an average annual volume of biomass burned to 14,400,000 m<sup>3</sup> taking an average vegetation forest height of 12m.

Wild bush fires are recorded on grassland savannah each year from above Hut 1 to the top close to the summit of Mt. Cameroon. These fierce and frequent fires since 1964 led to the enactment of the prohibition of fires regulation of 1964, applying particularly to high altitude areas at and above 1,220m). At such heights, the recovery of vegetation after a fierce fire is very doubtful and frequent fires at short intervals will quickly create a desert condition with attendant dangers (Bulletin of the Ministry of Natural Resources, 3 June 1965). This is exactly the situation on Mt. Cameroon with completely bare mountain tops. This desert conditions are causing serious erosions after rainfalls, carrying runoffs, large rocks freely trooping down slope in to the Buea municipality causing blockage and enormous damages each season. It is an indication of sparse vegetation cover. Fierce fires at this

altitude of the national park not only increase the amounts of CO<sub>2</sub> and other greenhouse gas emissions but amounts to cruelty to animals and against the law of conservation of wildlife.

Volume of biomass burned can be approximately estimated at this portion of the mountain as follows: The elevation of Hut 1 at 04°10.551' N and 009°12.257' E is 1,858 m, while the elevation of the summit at 04°13.081' N and 009°10.802' E is 4,041 m. The difference in elevation from these points gives the perpendicular height of 2,190 m. Mt. Cameroon is a vast dome extending over 45km, meaning radius of 22.5 km and slant distance from Hut 1 to the summit is 22.6 km and the surface area of savannah grassland up to the summit forms a cone with a surface of 3,190 km<sup>2</sup>. The average annual volume of biomass burned at the top grassland savannah taking average vegetation height of 3 m gives 9,569 m<sup>3</sup>. Putting these two average volumes together gives a total biomass loss of about 23,969 m<sup>3</sup>. Projections made over a period of 50 years will mean that all vegetation and biodiversity will be lost by this time if dispositions are not made to put in place a good fire management scheme and strict fire policy.

### Effects of Fire on Montane and Rainforest of Mount Cameroon

Fire effects in the area are enormous, spanning from forest, climate, hydrology, soils and wildlife, along volcanic lava flow paths, farmlands etc. The soil potential is observed to have been greatly affected and large areas show significant soil degradation. Soils are the most important asset of a nation. Vegetation cover of affected areas here is destroyed, and lost value as over 80% of soil nutrients depends on the forest, reported in (2). Poverty has increased with fall in standards of living as local people now have to go long distances in the neighborhood to collect fire wood for local use and farmers abandoning depleted farms, and opening new farms in the forest reserves.

Frequent volcanic eruptions with lava flows with fire have destroyed very large portions of forests and buried soils leaving entire environment bare. A case study of the 1999-2000 eruption revealed lava flow down slopes in to the Coastal village of Bakingili in the West coast. This caused wild bush fires that burned and ravished large portions of forest on the upper slopes with *Prunus africana* amongst other important forest plants and organisms and large hectares of palm oil plantations on the lower slopes. It also dried up every living thing and melted every non-living thing along its path as it flowed through. Lava height was about the height of an electricity pole. It almost crossed the road just barely about 500m into the Atlantic Ocean. Imagine the distance from the top of the mountain to this point and quantity of biomass consumed. The government of Cameroon intervened with a human rescue, evacuation and resettlement of affected populations at Moliwe, a village in the outskirts of Limbe towards Buea. Through the collaboration efforts of the CDC (Cameroon Development Corporation), resettlement camps were constructed. Some of the villagers resisted and refused to move away from their affected Bakingilli village and that their ancestors will take care of them because their shrines are there buried in the village. They cannot afford to go and abandon these shrines. This seems to have worked as chiefs of this area met together prayed to appease the gods of the mountain *Epassa moto* before the lava could stop at this point immediately at the main road. Serious danger was envisaged if the lava had to enter in to the Atlantic Ocean.

The touristic potentials of the area have dropped compared to the past years. Important caves that used to be habitats of endemic Mt. Cameroon bats have been exposed through constant fires and have lost great numbers of these bats. Habitats for mountain bats that are found only between these the two peaks of Mt. Cameroon and Fernandopo have been lost. Some of these caves were used by native Bakwerians as important traditional ritual sites (performance of traditional rights, the gods of the mountain *Epassa moto*) and as hide-outs and strategic ambush points/warfare tactics for traditional Bakweri Army during the Bakweri-German struggle of 1884 have been exposed. If any of such events occur today, the Bakweri man will not have a hiding place to carry out its activities.

Climatic conditions have changed from the usual cool, foggy, fresh climate of Mount Cameroon area that used to prevail in the past 20 years to higher temperatures and less rainy seasons. Increased scarcity of bush meat and formally common non timber forest products have also been reported as well as important wildlife and plant species have been lost while rendering others endemic such as the Mount Cameroon Francolin (*Francolinus camerunensis*) and the African Elephant (*Loxodonta Africana*) from Mount Cameroon especially on the eastern side of Mount Cameroon (Collar and Stuart, 1988). Landslides, floods and erosions have occurred here especially in the coastal region of Limbe in 2002 causing serious damages of property and loss of human lives. Fire greatly damages the savannah and the forest, a major source of food for animals. These food shortages affects some

animal reproductive and life cycles such as the Mount Cameroon elephant whose reproductive cycles last between 18 to 22 months. The big question is whether there will be enough food to sustain these reproductive cycles if fire occurrences are at high rates as calculated above. This will lead to an eventual decline of numbers of animals and other endemic species.

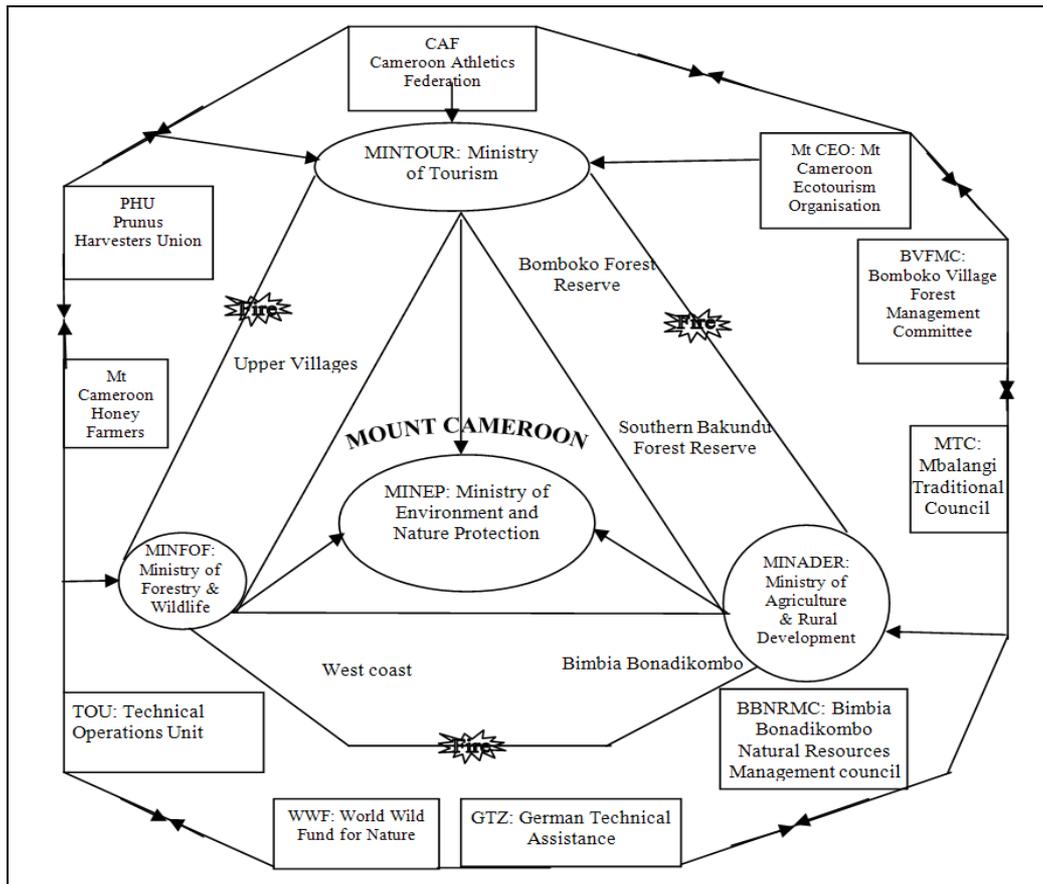
Water crises and food shortages have been noticed especially around Buea, a cosmopolitan town on the slopes of Mount Cameroon. Most of the water sheds and plant-animal habitats have been lost due to forest fires over the years. For example, Mosole stream which used to flow through the town has been lost completely. Water rationing is the order of the day now in town. Food supplies are increasingly becoming short each year as cultivable areas have been cleared by means of burning and have lost its fertility. Threats of encroachment in to the montane and tropical forest reserve of Bomboko on the eastern slopes of the mountain are ongoing.

In the Mt. Cameroon region frequent fires are caused by hunters who use fire for hunting by setting the bushes and forest on fire. The rising smoke affects the animals and at a certain threshold, will move to the East and West directions. Animals perceive this as danger and moreover, smoke is allergic to animals and will force them to run away. The upward direction is preferable but it is most difficult path to take, so obviously they will prefer the downward perpendicular direction and tracks i.e. “transversal flight”, and this is often towards human habitation and hunting trap zones. Hunters take advantage to hunt them and those that are not hunted escape invading the area causing animal- human conflicts. Eventually the competent authority usually will resolve these conflicts by ordering the killing of these animals.

### **Mitigation of Forest Fires on Mount Cameroon**

It has become a common and hardened habit for many years to clear the race track by use of fire during the annual event of the *Mount Cameroon Race of Hope*. Mountain can be observed alight especially the montane forest, grassland savannah and sub alpine forest. The Cameroon Athletics Federation in charge of organizing this event is required to introduce a fire management committee in its collaboration framework involving other government agencies and NGOs in the planning such as the Ministry of Tourism, Ministry of Forestry and Wildlife, Ministry of Environment and Protection of Nature, Mount Cameroon Ecotourism Organization, local stakeholders and community groups.

Other highly affected areas is the Southern Bakundu and Bomboko forest reserves where the local population use slash and burn as a quick means of clearing to encroach into the reserves to open new farms. The bush is usually set on fire overnight and allowed to burn with no control, thus very difficult to track down the culprits. Vigilante groups of forest management committees and traditional councils such as the Bomboko forest management committee and the Mbalangi traditional council have been identified among other community members to collaborate with the government service in charge of forestry and environment, who will make necessary dispositions as required by the law as stipulated in the 1964 law in the prohibition of fire (3). It is stipulated that heavy fines of up to 34,600 CFA or imprisonment for six months or both fine and imprisonment shall be meted on any defaulter. This regulation has been amended and included in the provisions of the present Forestry Law no 94-01 of 20 January 1994 (4) and Environmental Law No. 96/12 of 5 August 1996 (5) of Cameroon.



**Figure 1.** Fire Monitoring Network on Mount Cameroon Region: Circled loops are hunting horns indicating responsible decision making government agencies to which fire information is directed for necessary action. The square boxes are local Institutions and organizations working in the environment and forestry sectors that collect information and feed the ministries concerned. Lastly the arrows show information flow within the management authorities in place.

Modern methods and training for honey collection through production of modern bee hives that do not need use of fire have been programmed to be introduced in communities of the Mount Cameroon area. This however will require some funding and it is envisaged that the ministry of forestry and wildlife will produce low cost hives and distribute to local people. Massive sensitization and training on fire management and its effects on the environment is conducted in academic institutions, community associations and local communities in villages as a means of education because it has been realized that forest users lack good knowledge and have stereotyped belief on use of fire. The sensitization is done through field visits and organization of workshops in the communities and villages concerned and affected in a participatory manner.

It was observed that poverty, population growth and limited resources, is a big drive to forest fires in the area. Government needs to subsidize incomes of local people through operation of micro finance schemes making them readily available and at affordable rates. Also improved varieties of indigenous crop species should be multiplied and given free of charge to increase agricultural production so that in this way household incomes can increase.

### **Fire Management Scheme as a Solution to Fire Problems in the Area**

A fire management scheme is an important, immediate and long term solution to the fire problems that would help to reduce the number and impact of fires on Mt. Cameroon forest. The immediate impact is that the scheme is an integral fire management unit that brings on board all elements, parties and stakeholders within and beyond the Mt. Cameroon National Park area in a participatory manner to curb excessive carbon loss, rehabilitate and restore degraded forests and give the biodiversity of the

region a chance to recover. Through the scheme, water catchments in the region shall be protected thereby resolving water crises plaguing the area. The scheme will provide a sustainable supply source of non-timber forest products (NTFPs), food supplies to local communities, reducing food shortages and improve livelihood standards.

It will provide a forum, an opportunity for all stakeholders in the Mt. Cameroon National Park area to come together to discuss common issues of natural resources management, awareness of forest fire problems, impacts and solutions, and make common decisions that will lead to the formulation of a national fire management policy. This policy will reflect their daily lifestyles, cultures and traditions that will contribute to local and global life support systems. Through the establishment of community tree nurseries and enrichment planting activities will increase the resource base of medicinal plants for traditional and pharmaceutical purposes. Some of the NTFPs and medicinal plants are highly valued by villagers and if encouraged to plant on their farms along with their traditional food crops will prevent them from the use of fires on their farms and neighbouring forest. Some indigenous trees of economic importance including fruit trees, and fast growing timber used by local communities for poles, domestic construction purposes and firewood are included in the scheme. The preferred method of application will be enrichment approach of agro-forestry systems of *Taungya* and mix-cropping on farms to take care of carbon leakage. It will assure local rights to access forests and utilize forest resources. The scheme will provide an opportunity to people of Mt. Cameroon region to fully participate in achieving the Bali Action Plan (1/cp.13), Para 1 (b) and Para (b) (iii) towards a comprehensive process enabling full effective and sustained implementation of the convention through long term cooperative action, now, up to 2012 deadline and beyond.

The scheme will re-awaken and strengthen government surveillance on wildfires and evoke a sense of responsibility and consciousness to all concerned. The scheme provides for on-farm and off-farm activities which are alternative income generating to the benefit of rural living standards, create employment and contribute to the community and village development. The scheme will improve and increase ecosystems services of the National Park, increasing tourist potential and aesthetic value. Hopefully this will generate more revenue through tourism, education and research and employment to fringe village dwellers as porters, guides, bring projects and other activities that will be implemented in the area.

Mt. Cameroon is the identity of the Bakweries, thus, the scheme should enable the indigenous people to promote and maintain culture, spiritual, traditions and customs. Fire is used in agriculture as drivers and a cheap means of encroachment, in to the National Park and other protected areas and reserves, so the scheme will fill these gaps and prevent further encroachment, as well as land tenure issues and conflicts. The scheme will enable the rich biodiversity of endemic and endangered fauna and flora of the Mt. Cameroon National Park area to be conserved and managed sustainably.

Water erosions and accompanied forces will be prevented and protected through the maintenance and improvement of the vegetation cover on the slopes of the Mountain. The scheme will build the capacities through training of village communities and Mt. Cameroon National Park users to acquire knowledge about the effects and damages of deliberate use of fire in their forest. The scheme will improve understanding on the implication of forest fires and reduce excessive use of fire on forest in the region thereby protecting the entire mountain environment, natural resources, ecosystems/habitats for sustainable use and protection of humanity. It also pre-empts environmental health, human security against environmental risk and disasters as Mount Cameroon is an active volcano. The scheme will enable fire management or avoidance of bushfires to be treated as a REDD component on the development of a REDD project for the Mt. Cameroon area with the objective of secure long term financing of Mt. Cameroon national park management and leakage management in addition to the other two components already in existence including avoiding further encroachment by farmers and rehabilitation of already encroached areas.

## **Conclusions**

Preventing forest fire in this region is a very difficult task requiring the collaborative input of many stakeholders. Furthermore, there are several limitations to implementing a fire management plan including gaps in scientific knowledge, lack of personnel and training and monitoring equipment. There is also lack of fire information as there are no records or documents on fire study in the entire sub-region. When these gaps are finally filled, and conservation institutions prioritize fire in their agenda, it will commit everyone to act responsibly to save the Mt. Cameroon forest and beyond.

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## Analysis of Vegetation Fires in India Using Spatial Point Pattern Statistics

### Introduction

Understanding the impact of fires requires detailed knowledge about where fires occur, how they are influenced by landscape biophysical factors and precise calculations of fire regime parameters (Vazquez and Moreno, 2001). For the same, satellite remote sensing technology with its synoptic and repetitive coverage, provides valuable information on characterizing fires. For example, satellite images acquired by low spatial resolution sensors, such as the Advanced Very High Resolution Radiometer (AVHRR) and the Along-Track Scanning Radiometer (ATSR), provide information at a scale from regional to global and with a high temporal resolution, on fire timing, frequency and extent (Stroppiana et al., 2003). In addition to remote sensing technology, geographic information system (GIS) is used increasingly for fire management studies. Because most of the fires quantified from satellite remote sensing datasets quantify fires in the form of event data, spatial point pattern statistics can be effectively used to quantify some of the fire characteristics. To quantify spatial patterns in fire occurrences, statistical methods can be integrated with GIS to answer several important questions such as: (1) How are the fire events distributed across different vegetation types, topographic gradients and geographical regions? (2) Are the fire distributions random? If not, how are they different from random pattern? (3) What is the spatial scale at which fire events cluster? As each fire event is the result of the certain spatial process at a given time and in a given space, the above questions have important implications for fire management. We addressed the above questions in the Indian region using ATSR satellite datasets for the year 2006.

### Data

#### *Fire count data*

We used fire count datasets derived from Along Track Scanning Radiometer (ATSR) satellite for the year 2006 to characterize spatial patterns in fires over the Indian region. The ATSR channels are at wavelengths of 1.6 $\mu\text{m}$  (visible) and three thermal bands at 3.7 $\mu\text{m}$ , 11 $\mu\text{m}$ , and 12 $\mu\text{m}$ . These data sets were derived from night time passes with a single, rule-based threshold applied to band 5 (3.55–3.93 $\mu\text{m}$ ), where an active fire is detected if the land surface within a pixel was greater than or equal to 308 K. ATSR band 5 spatial resolution is 1 km, and it is probable that a small fire within a pixel (less than 1/10 of a pixel's area) is sufficient to produce a positive fire detection (Fuller and Murphy, 2006). This dataset provided active fire occurrences and basic information about the location of the fire events over the Indian region. We specifically aggregated the fire data from February to June, as this season represents the dry season in several states of the Indian region.

#### *Vegetation*

To infer the number of fire pixels in each vegetation type, SPOT satellite derived global land cover (GLC) 1km vegetation cover data over the Indian region at a scale of one kilometer has been used. GLC 2000 makes use of the VEGA 2000 dataset: a dataset of 14 months of pre-processed daily global data acquired by the VEGETATION instrument on board the SPOT 4 satellite. We specifically used the south central Asian regional product that covered the Indian region. Further, while assessing fires over different vegetation categories, we eliminated some of the non-vegetation categories such as water bodies, barren areas, etc.

#### *Topography*

We used GTOPO30 digital elevation model (DEM) with a horizontal grid spacing of 30 arc seconds (~1km) to extract slope and elevation values, corresponding to fire events.

### Spatial statistical methods

Fire ignitions detected from ATSR satellite data with the event location information (x and y coordinates) were assessed using spatial statistical tools. The simplest theoretical model for a spatial point pattern is that of complete spatial randomness (CSR) (Gatrell et al., 1996; Diggle, 2003).

Statistical tests of the CSR hypothesis can be based on the counts of events in regions (quadrats), or distance-based measures using the event locations. The first-order properties describe the way in which the expected value (mean or average) of the process varies across space, while second-order properties describe the covariance (or correlation) between values of the process at different regions in space (Gatrell et al., 1996).

#### *Quadrat analysis*

This method evaluates a point distribution by examining its density changes over space. The density measured by Quadrat analysis is then compared with the density of a theoretically constructed random pattern to see if the point distribution in question is more clustered or dispersed than the random pattern. As a process, a regular grid (hexagon in our case) is overlaid on the point pattern fire data, the numbers of fire pixels are counted and a frequency distribution is constructed based on those points falling in each grid. Then the frequency distribution is compared with that of a known pattern, generally a theoretically constructed random pattern to assess clustered or dispersed patterns.

#### *Nearest neighbor analysis*

Nearest neighbor analysis (Clark and Evans, 1954), is specifically designed for measuring pattern in terms of the arrangement of a set of points in two or indeed three dimensions. The nearest neighbor index is simply the observed mean nearest-neighbor distance divided by the expected mean nearest neighbor distance for a random arrangement. Different orders in the neighbor analysis refer to the different ways points are considered as neighbors with respect to the reference point.

#### *Ripley's K statistic*

The quadrat analysis and nearest neighbor analysis are the first order properties and attempt to offer overall descriptions (global pattern) of the point patterns being analyzed. However, the underlying spatial process may not be homogenous over the study region. For example, neighboring units may not cluster at the same magnitude across different parts of the region. For the same, Ripley's K function is quite useful (Ripley, 1976). The Neighborhood analysis of point patterns using 'K' statistic is based on distances between all pairs of points; it counts the number of points within a certain distance 't', of each point, with 't' taking a range of values. Commonly, K (t) is presented as the linearised L-function (Besag 1977).  $L(t) = 0$ ; if points are regularly dispersed,  $L(t) < 0$ . The higher values (positive) in this function indicate clustering at the corresponding spatial lag distance 't', and low values (negative) values indicate dispersion of points at that distance.

#### *Hierarchical clustering*

To detect active fires or areas where fire incidents are most prevalent, we used nearest neighbor hierarchical (Nnh) clustering technique (Levine and Kim, 1999). For detecting the clusters, Nnh uses a threshold distance and compares the threshold to the distances for all pairs of points. Only points that are closer to one or more other points than the threshold distance are selected for clustering. In addition, minimum number of ignition points to be included in a cluster can be specified using this technique. Only fire ignitions that fit both criteria, i.e., closer than the threshold distance and belonging to a group having the minimum number of fire ignition points, are clustered at the first level (first-order clusters).

## **Results**

Results from ATSR fire count data suggested total fire counts of 1279 during the dry season (February to June) for the year 2006 (Tab.1). Of these, nearly 1140 ignitions have been found in the vegetation categories (Table 2). The other fire signals were from gas flares from petroleum refineries and occurred close to Arabian Sea near Gujarat state. These fire counts were eliminated in the analysis. Of the different states, maximum number of fires was recorded in Madhya Pradesh (14.77%) followed by Gujarat (10.86%), Maharashtra (9.92%), Mizoram (7.66%), Jharkhand (6.41%), etc. (Tab.1 and Fig.1). With respect to the vegetation categories, highest number of fires were recorded in agricultural regions (40.26%) followed by tropical moist deciduous vegetation (12.72), dry deciduous vegetation (11.40%), abandoned slash and burn secondary forests (9.04%), tropical montane forests (8.07%) followed by others. Analysis of fire counts based on elevation and slope range suggested that

maximum number of fires occurred in very low and low elevation types and also in areas having very low to low-slope (Tab.2).

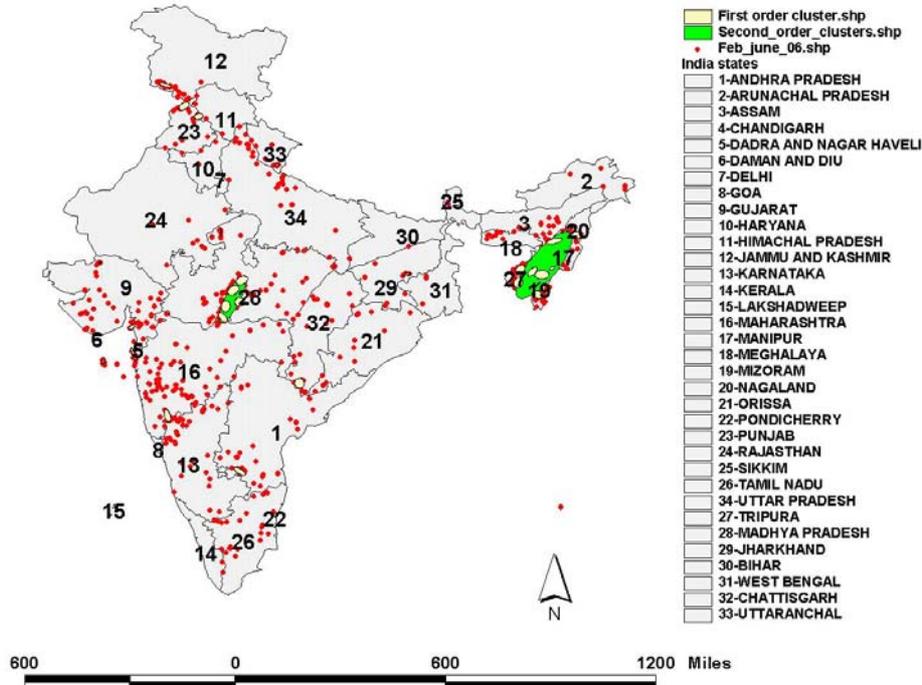
**Table 1.** Fire counts in different states of India derived from ATSR satellite data during the dry season (February – June 2006)

State	Fire counts	% Fire counts
Andhra Pradesh	42	3.283
Arunachal Pradesh	7	0.547
Assam	30	2.346
Gujarat	139	10.868
Haryana	2	0.156
Himachal Pradesh	4	0.313
Jammu And Kashmir	44	3.440
Karnataka	58	4.535
Kerala	1	0.078
Maharashtra	127	9.929
Manipur	39	3.049
Meghalaya	14	1.095
Mizoram	98	7.662
Nagaland	36	2.814
Orissa	33	2.580
Punjab	44	3.440
Rajasthan	8	0.625
Sikkim	2	0.156
Tamil Nadu	27	2.111
Tripura	49	3.8311
Madhya Pradesh	189	14.777
Jharkhand	82	6.411
Bihar	1	0.078
West Bengal	8	0.625
Chattisgarh	42	3.283
Uttaranchal	16	1.250
Uttar Pradesh	41	3.205
Other Ignitions	96	7.505
<b>Total</b>	<b>1279</b>	<b>100</b>

The results obtained on fire characteristics at state level and vegetation categories in our study should help resource managers and environmental scientists to identify potential critical areas where fire management efforts can be focused. Although, no attempt has been made to infer the causative factors of fires in this study, our previous studies suggest that, several of the agricultural fires were related to crop residue burning including slash and burning agriculture in different states (Kiran Chand et al., 2006). Also, dry deciduous forests are one of the most dominant vegetation types in India and fires in these forests are attributed to high level of anthropogenic activities, mainly due to dependence for fuel, food and fodder. Similar to dry deciduous forests, fires in the thorn forests are also attributed to anthropogenic disturbances including accidental fires. Information on fire events categorized based on topographic characteristics can be used in predictive modeling to assess potential fire 'hotspots'.

With respect to the spatial patterns, the three basic types of point pattern, namely random, clumped and uniform are well recognized in spatial statistical literature depending on the relative position of one point observation to another. There are driven processes that are responsible for the generation of those patterns (Upton and Fingleton, 1985). For instance, random patterns presuppose environmental homogeneity and non-selective processes while non-random patterns, either clumped or uniform indicate environmental heterogeneity and the existence of favorable and selective mechanisms as well as constraints that govern those processes (Ludwig and Reynolds, 1988). In our case, spatial analysis clearly suggested that fire events had a clustered / clumped pattern at 125 miles scale. This pattern implies some sort of environmental heterogeneity, which in turn can be effectively used to understand fire characteristics at landscape scale. Hierarchical nearest neighboring technique identified significant clusters of active fires in states pertaining to northeast and central India. These results imply that fire

management in these states should be given priority. We infer that use of spatial statistics is the first step in exploring patterns of point distributions. Since the basic fire patterns in the Indian region are detected, this information can be now effectively used to build models and hypothesis to explain the underlying causative factors of fire events. Such an attempt is underway through integrating biophysical as well as socioeconomic information covering highly diverse ecoregions of India.



**Figure 1.** Clustering of fire events in northeast and central India obtained from nearest neighbor hierarchical technique.

**Table 2.** Fire counts in different vegetation types of India derived from ATSR satellite data (February – June 2006)

Class	Vegetation Type	Fire Counts	% Fires
1	Tropical evergreen	24	2.11
2	Subtropical evergreen	2	0.18
3	Temperate broadleaved	4	0.35
4	Tropical montane	92	8.07
5	Tropical semi-evergreen	3	0.26
6	Subtropical conifer	5	0.44
7	Tropical moist deciduous	145	12.72
8	Tropical dry deciduous	130	11.40
9	Junipers	50	4.39
10	Degraded forest	50	4.39
11	Dry woodland	1	0.09
12	Thorn forest	65	5.70
13	Abandoned <i>Jhum</i>	103	9.04
14	Savannahs, grasslands, meadows	7	0.61
15	Agriculture	459	40.26
	<b>Total</b>	<b>1140</b>	<b>100</b>

**Table 3.** Fire counts in the Indian region aggregated according to elevation range (February to June 2006)

<b>Elevation range (m) and categories</b>	<b>Fire counts</b>	<b>% Fires</b>
0-218 (very low)	537	49.17
219-395 (low)	280	24.24
396-597 (medium)	205	16.97
598-938 (high)	95	6.30
938-1664 (very high)	66	3.29
<b>Total fires excluding other ignitions</b>	<b>1183</b>	<b>100</b>

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## Swissfire: A Centralized Fire Database for Switzerland

### Abstract

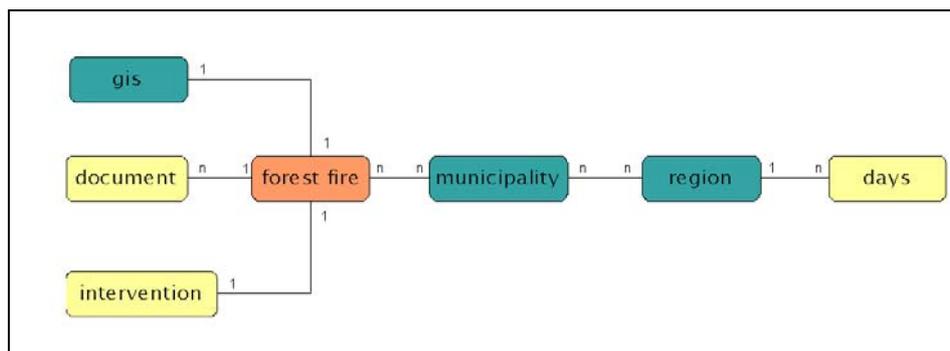
The Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) and the Swiss Federal Office for the Environment (FOEN) cooperated on organizing a centralized forest fire database for Switzerland. The database allows the officers of the 26 cantons to enter and manage their fire data through a web interface. The system makes it possible to enter and manage not only the information on fire events and related parameters, but also additional fire relevant parameters such as meteorology, land-use and land-cover information, and population on different spatial (from municipal to national level) and temporal (daily to yearly) scales. This will improve the potential for analyzing the fire occurrence with respect to the driving factors. A second web application enables single operators to easily produce the periodic standard fire statistics on their own.

### Introduction

Forest fire statistics are an important management tool for planning preventive technical (fire fighting facilities) and silvicultural activities and for optimizing fire-fighting strategies. In view of the ongoing climate change, it has become even more important to collect information on forest fires, even in regions where fires at present rarely occur. Only such a systematic approach will provide in the future the necessary data series to detect trends and changes in fire regimes in a consistent way. For this purpose the Swiss Federal Institute for Forest, Snow and Landscape Research and the Federal Office for the Environment FOEN started a joint project for implementing a centralized web-based national forest fire database – the *Swissfire* database in 2007.<sup>11</sup> This database is directly accessible to the cantonal forest services for data input, storage and analysis, including standard periodic reports.

### Database design

The database has been designed in order to assure a very flexible handling of data (e.g. tracking the fusions of municipalities), as well as storing data on different spatial and temporal scales (from the municipal to the national level, from days to decades). For this purpose, a list of relevant fire parameters was chosen representing a reasonable balance between the required level of detail to be informative and the need to ensure that collecting and handling the data can be done easily by the foresters concerned. The database structure consists of seven main tables (Fig. 1 and Table 1) and around 30 auxiliary tables.



**Figure 1.** Simplified structure for the main tables of *Swissfire*

<sup>11</sup> [www.wsl.ch/swissfire](http://www.wsl.ch/swissfire)

**Table 1.** A short definition of the 7 main tables of *Swissfire*.

<b>Main table:</b>	<b>Description</b>
Forest fire	<ul style="list-style-type: none"> <li>• Outbreak (place, coordinates, date and time, ...)</li> <li>• Fire parameters (cause, estimated burnt area according to land cover, type of fire, ...)</li> <li>• Forest parameters (type of forest, tree species, fuel type, damage, ...)</li> </ul>
Fire services	<ul style="list-style-type: none"> <li>• Fighting (start and finishing times, strategy, total manpower, ...)</li> <li>• Fighting costs (total costs, aerial fighting costs, ...)</li> </ul>
Document	<ul style="list-style-type: none"> <li>• Document types related to fire events, such as area burnt maps, pictures, reports, videos, ...</li> </ul>
GIS	<ul style="list-style-type: none"> <li>• Geo-referenced data (polygon, fire perimeter, calculated area)</li> </ul>
Municipality	<ul style="list-style-type: none"> <li>• Municipality data (coding (outbreak/affected), possibly a new municipality reference)</li> </ul>
Region	<ul style="list-style-type: none"> <li>• Municipality groups, validity reference for the daily parameters</li> </ul>
Days	<ul style="list-style-type: none"> <li>• Daily parameters (holidays, fire bans, helicopter and forest service standby service, drought periods, wind conditions (e.g. Föhn day), selected fire danger indices, ...)</li> </ul>

The database was implemented as an Oracle® Database. Fine-grained access to the own fire data for each canton is ensured using the Virtual Private Database (VPD) feature of Oracle®.

The main data-handling characteristics of the database are:

- Each type of fire that gets out of control may be considered as data (even very small wildfires are important for estimating ignition danger).
- Every fire event can be allotted to an outbreak municipality as well as to municipalities which have been affected.
- Multiple documents and document types can be stored and attached to each fire event, like images, videos, maps, reports.
- Changes in municipality attributes, such as fusions, may be easily updated every year from the newest data of the Swiss Federal Statistical Office FSO. All changes are tracked by a historical index allowing database queries on both options: current and historical municipalities.
- Municipalities may be grouped to *ad hoc* regions (meteorological regions, districts, macroregions such as Alps, Pre-Alps...).
- Relevant pyrological daily parameters, such as meteorological parameters, regional fire bans, cantonal holidays or celebration days, etc. can be easily defined and allocated to different regions. With this approach it is also possible to store many temporal municipality-related data, like population and land-use data. Through the date and the municipality, these parameters can be queried and related to each fire event.
- Through pl/sql routines, derived daily parameters, such as fire weather indices (e.g. Canadian Fire Weather Index and related sub indexes, Nesterov index, KBDI index), may be calculated for further processing.

### Data management

The database is centrally managed by WSL. The data collection is carried out by the cantonal forest services, and usually involves filling out a form. The cantonal representatives collect the forms, check them and enter the data into the database or send the forms to WSL. In the near future the option for foresters to directly enter the data into the repository will be implemented. Each canton has full right of access with query, insert and update authorization of their own data.

At the time of writing (31/12/2008) the database consists of 7359 fire events (4043 with starting coordinates and 2213 with digitalized perimeters) ranging from the 19th century to present. The registered events originate mainly from Ticino (5916), Valais (934) and Grisons (452), which are the cantons with the longer tradition of collecting fire data. For all the other cantons data collection has just started (62 fires). For these cantons we will encourage archive research in order to quickly enhance the dataset on past fires.

A multilingual (English, Italian, German and French) web application acts as the communication platform between database and end-user (Fig. 2a,b). Different forms allow input, selection, view and export of fire event and daily pyrological data.

Queries may be performed in two ways: by an interface-assisted approach that allows the search keys to be entered directly in the mask by specifying selection criteria such as ranges of values or logic operators, or by entering a SQL query (including a library with templates of the often used queries).

Figure 2a. Screenshot with an example of the English web application form for forest fire data

## Producing fire statistics

A second web application (Oracle<sup>®</sup> Apex, Application Express) allows the automatic generation of yearly or periodic standard statistics, either as ready-to-print graphs (Fig 3a) or as data tables for further analysis (Fig 3b-c). Data tables may be assembled according to the user needs, defining the region of reference (from municipal to cantonal or national level according to the access rights), the period, the parameter to be summarized (number of fires, area), the fire seasons (winter, summer, year), and the cause of the fire.

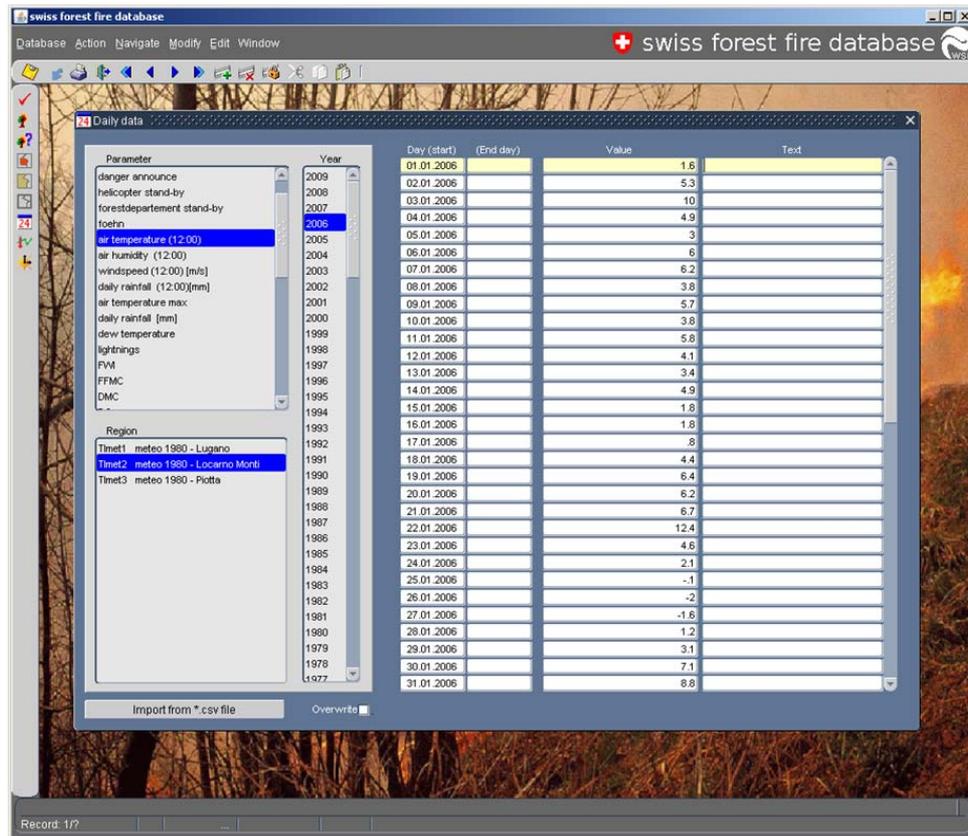


Figure 2b. Screenshot with an example of the English web application form for the daily pyrological parameters

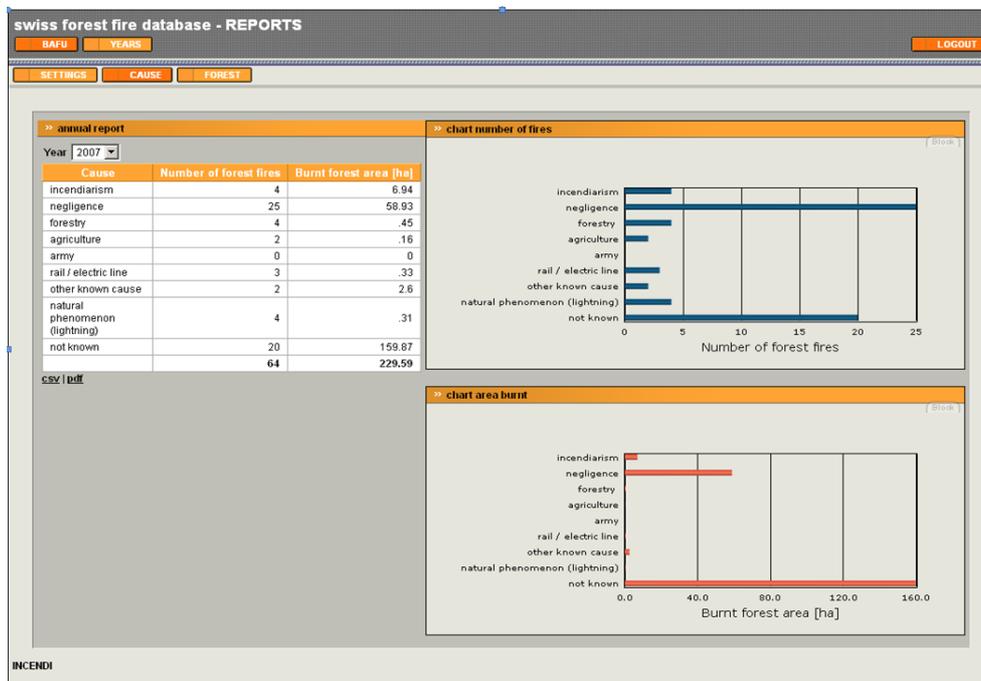


Figure 3a. Screenshot with an example of an English web application page for automatically generating fire statistic charts

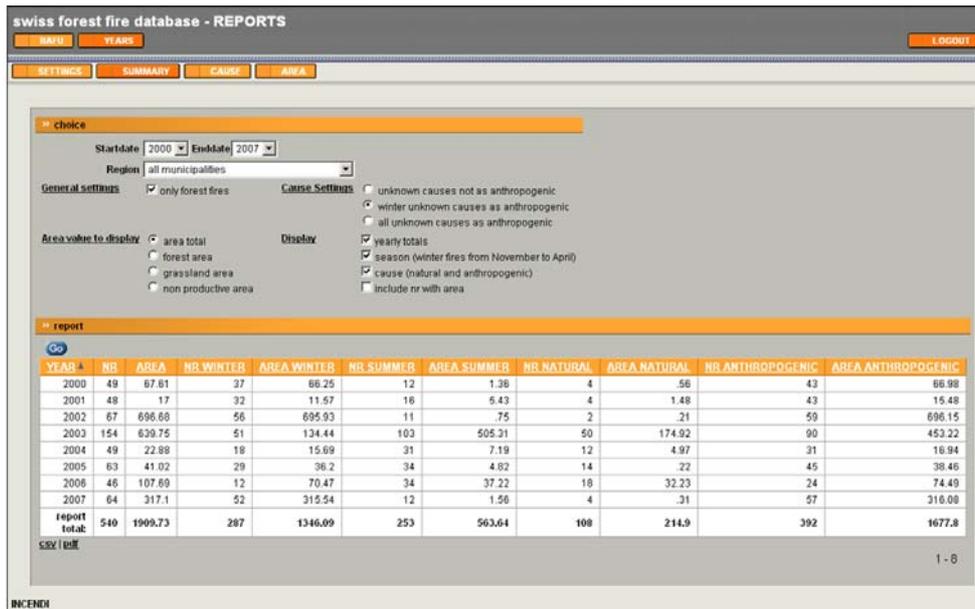


Figure 3b. Screenshot with an example of an English web application page for automatically generating exportable fire data tables

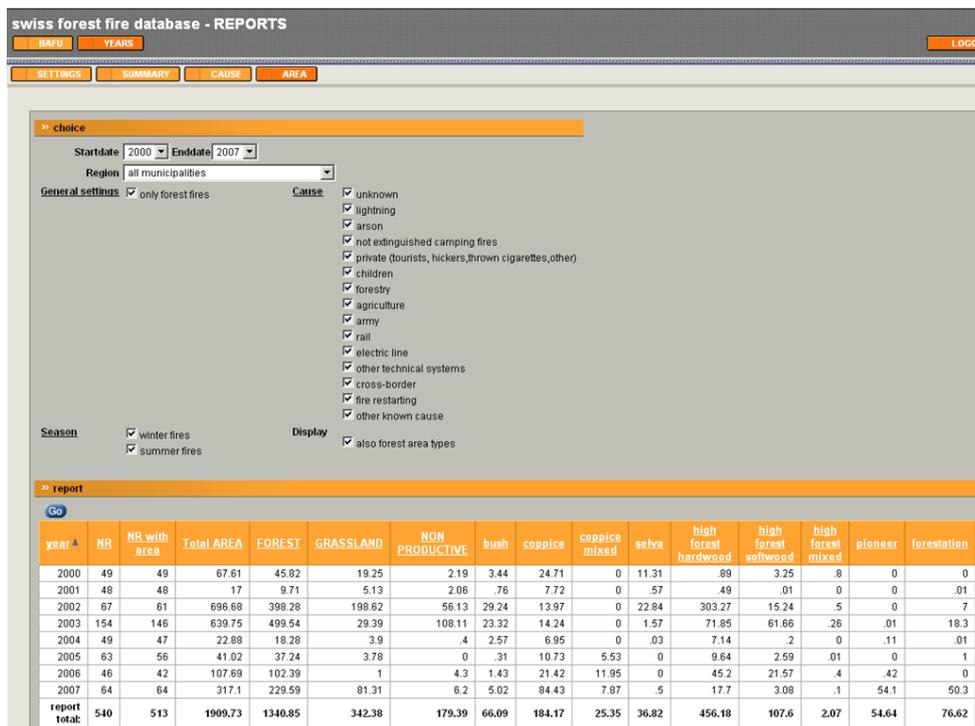


Figure 3c. Screenshot with an example of an English web application page for automatically generating exportable fire data tables

## Further applications

Consistent and geo-referenced fire data allow advanced spatio-temporal analyses of fire occurrence and fire related parameters, such as meteorology, ignition causes, socio-economic context, legislation or ecological and social consequences. Such approaches may be used for implementing fire weather danger rating systems (Mandallaz and Ye, 1997), identifying areas with a high fire danger and fire risk (Conedera et al., 2005), analyzing long-term fire regime evolution (Pezzatti and Conedera, 2005; Conedera et al., 2006), checking the long-term effect of fire legislation or preventive measures (Conedera et al., 2004), highlighting fire selectivity with respect to vegetation cover (Pezzatti et al.

2009), or evaluating the ecological impact of different fire regimes (Marxer, 2003; Moretti et al., 2004; Moretti et al. 2006a, 2006b).

## Conclusion

The new database is a flexible instrument which should help in future, to assure the homogeneity and completeness of Swiss fire data at the national level. With time, we expect to build a sufficiently large set of data for advanced statistics and analysis with a view to refine and optimize fire management strategies.

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