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Useful wild tree resources of southern Sudan: a review

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Abstract

Southern Sudan has a rich tree flora. Trees are important in the livelihoods of the numerous tribes of the region, who use them for shelter, fuel, food, fodder, medicine and income generation. The gallery and depression forests contain valuable timber trees. Other species provide non-timber forest products that are potentially tradable outside Sudan, particularly in African countries that have over-exploited their own forest resources. As the carrying capacity of the western and central areas of Sudan decreases, the pressure on the natural resources of the higher rainfall southern areas will increase. This in itself might initiate conflict, as various tribes compete over a relatively rich resource base. The recent peace established between the north and south could result in depletion of the forest resources of the south through commercial exploitation. This paper details and discusses the wild tree resources of southern Sudan, including many already threatened species.

Keywords: biodiversity; conflict; forests; non-timber forest products

Introduction

Sudan is Africa's largest country (*ca* 2.5 million km^2). It has a wealth of indigenous plant resources and associated traditional knowledge of their characterization and uses. Unfortunately, conflict and drought beset the country, which make life increasingly difficult for its population. The indigenous forest resources are vital for sustaining livelihoods in Sudan. In the largely agrarian societies of southern Sudan trees represent, among other things, shelter, fuel, food, fodder, medicine and income.

The recent peace established between the south and the north will not necessarily result in cessation of internal conflict and will not necessarily have a beneficial effect on the environment. If internal conflict drives people from the west and central regions southwards, the anthropozoic pressure on the vegetation of the south could increase. Southern Sudan increasingly represents the only part of Sudan where agriculture can be realistically practised. Bella *et al*. (2002) reported that tree species in Sudan are threatened by agricultural expansion, overgrazing, illicit cutting and inadequate conservation measures. He highlighted a gap in the knowledge about most of the food tree species in the country, stating that although many species might be protected through local rules, national legislation aimed at preventing loss of genes or extinction was in its infancy. Peace in the country could allow uncontrolled exploitation of forests where war kept it at bay. With a greater proportion of displaced people than any other country on earth (Suliman, 1999), 1.5 million from Darfur alone, and a prediction that worse is yet to come (Anon., 2004, 2005a, b, c), the ecosystems of southern Sudan could come under increasing pressure.

This paper details the occurrence and use of a range of indigenous tree species of southern Sudan, and discusses their prospects in light of the changing political and environmental forces operating in the country.

The environments, livelihoods and conflict in southern Sudan

Environments

Southern Sudan (below 8°N) has borders with the Central African Republic, the Democratic Republic of Congo, Uganda, Kenya and Ethiopia (Fig. 1). Tropical rainforest

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(lowland/derived forest) occurs along the border with the Democratic Republic of Congo, tropical moist forest on the border with the Central African Republic to Uganda, and tropical dry thorn savanna in the northern areas. Tropical scrubland is present along the Kenyan and southern Ethiopian borders. Tropical mountain forest up to 3000 m a.s.l. is present in the Imatong and Dongotona mountains and Didinga hills on the Uganda border. Gallery/cloud forest occurs along rivers, there are some areas of depression forest and swamps occur around the Nile (Fig. 1). Andrews (1948), and more recently Wickens (1991), described the natural vegetation of the region. The climate ranges from humid and tropical rainy to tropical wet–dry with annual rainfall from over 1300 mm to about 600 mm per annum. About 200 plant species not found elsewhere in Sudan grow in the Imatong mountains (Wickens, 1991), including about 10–15 endemics (Friis, 1994). Limited forest conservation has been done in the area and there has been felling of *Podocarpus milanjianus* Rendle, *Podocarpus gracilor* Pilger and replanting with *Pinus* and *Cupressus* species (Wickens, 1991). Little information on the status of the Imatong forest has been received since the north–south conflict erupted anew in 1983 (Friis and Vollensen, 1998). Wickens (1991) indicated that the Talanga forest in the Imatongs (part of a small area of relic lowland forest, which in total occupies about 36,000 km^2) was threatened by exploitation of its valuable timber.

Livelihoods

Tothill (1948), de Schlippe (1956) and Dickie (1991) described agricultural systems of southern Sudan. They are complex and differ according to site and tribe. There are numerous Nilotic, Nilo-Hamitic, Bari-speaking,

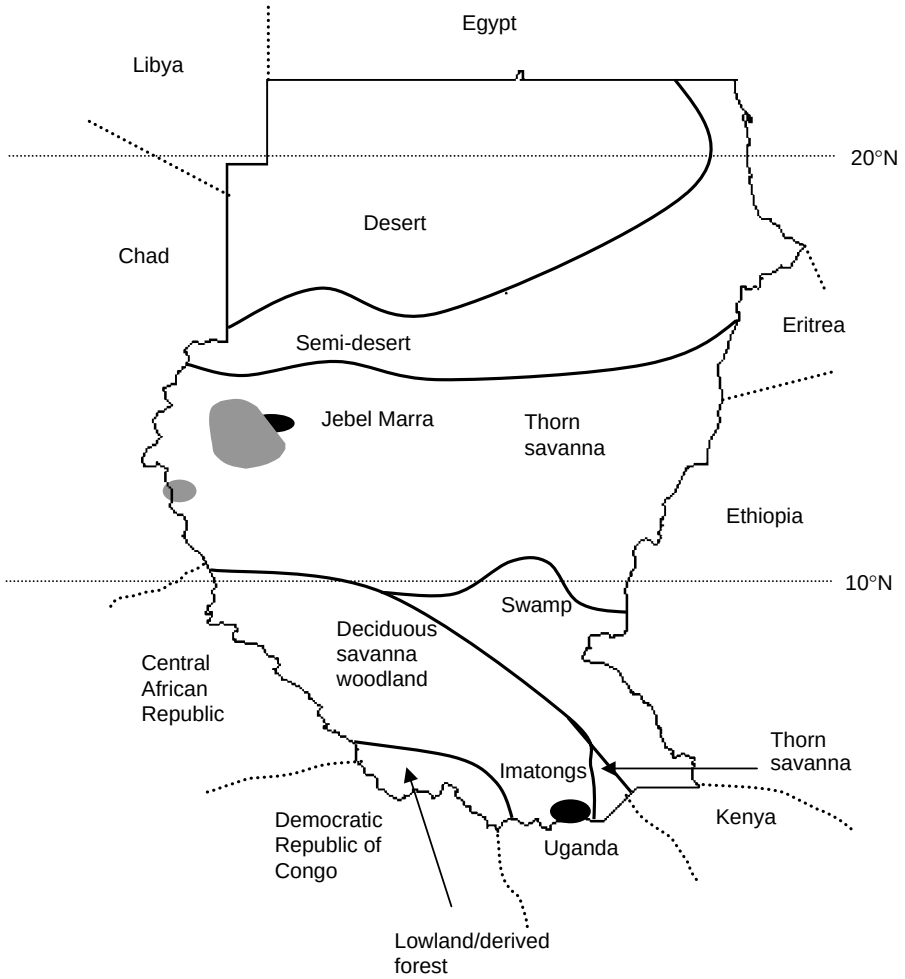

Fig. 1. Map of Sudan indicating vegetation types and neighbouring countries. The two black areas represent montane forest of Jebel Marra in the west and the Imatong mountains (with Dogotona mountains and Didinga hills) in the south. The two grey areas represent deciduous savanna woodland. The region discussed in this paper lies below 8°N.

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Moru-Madi and Bantu tribes in southern Sudan, and consequently there are many tribal languages spoken. Cattle are a major feature of the Dinka, Nuer and Shilluk farming systems in the northern areas of southern Sudan, while towards the southern areas agriculture is crop based and is of the smallholder, subsistence, shifting-cultivation type. The Zande occupy the south-western area and are a major tribe whose agriculture was reported on in detail by de Schlippe (1956). The trees dominating the vegetation (often *Combretum* spp., Zande *tabo* and *Terminalia* spp., Zande *bakpua*) are cut and some are used for house (*tukl*) construction (poles from introduced teak, *Tectona grandis* L., are also used for house construction). A wide range of crops is sown in the opened land to meet needs of food security and income generation. Robinson (2004) described the range of wild and domesticated plant genetic resources of southern Sudan. Trees are a major feature of the environments of southern Sudan and supply the communities living there with a wide range of products. The forests also represent the natural habitats of wild animals that are hunted for meat.

Conflict

Civil conflict between north and south Sudan started immediately following independence of Sudan from Egypt and Great Britain in 1956. Salopek and Olson (2003) described it as the oldest civil war in the world. Hostilities have continued over the past 47 years, with only a respite between 1972 and 1983. Recent peace negotiations indicate that current hostilities will cease, but the problem remains of how to distribute benefits derived from natural resources of the south. Not only is land an issue, but water and oil also feature in the dispute. Moreover, in addition to its own conflict, southern Sudan has suffered from conflicts along the borders of its neighbouring countries, and has been used as a safe haven for various guerrilla groups, which has made the entire southern border area unstable and unsafe.

Trees and their uses

Table 1 provides details on a selection of important tree species of southern Sudan. All species are found in other areas of tropical Africa. Table 2 provides vernacular names of many of the species listed in Table 1. The information derives from a variety of referenced and unreferenced sources (*inter alia* Tothill, 1948; Andrews, 1950–1956; Sommerlatte and Sommerlatte, 1990; Mahmoud *et al.*, 1995). It does not provide complete coverage of the vernacular languages of the two regions, but includes several of the major ones. For most species and most languages, including Arabic, there are numerous names for the same species and they have not all been listed. The importance of the mobola plum (*Parinari curatellifolia* (Planch.) Hiern.), a small tree of Equatoria (the southernmost province of Sudan: *ca* 4–10°N, 24–36°E), to the Zande, is demonstrated by it being given at least four vernacular names: *bandeni*, *banyikoro*, *vuruma* and *zambara*. Added complications are that the tribal languages of the region are not written, there are numerous dialects and the transliterations of Arabic can vary. The same name can also be used for different species in the same and in different languages. However, the vernacular names remain a very useful addition to the Latin, trade and common names provided in Table 1.

Several of the trees listed in Table 1 are internationally threatened according to Oldfield *et al.* (1998) and *Prunus africana* is listed in CITES Appendix II. Other species have been classified as endangered in Sudan by the Sudan Ministry of Agriculture (Warrag *et al.*, 2002) and some represent priority species in Sudan (Bella *et al.*, 2002).

Timber

Wood is used for building houses and grain stores in southern Sudan. The major criteria for the species used are that they are relatively durable (termite resistant) and easily available: *Combretum* and *Terminalia* species are often used. In addition to wood for hut construction, wood is cut from larger trees for making doors, frames, furniture etc. *Combretum hartmannianum* occurs in southern areas and is a threatened species that is cut for timber. There is a wide range of tree species that supply timber (Table 1), including several species that are traded internationally.

Carbon sequestration is usually attributed to organic carbon storage in trees. Iroko, *Milicia excelsa*, a major timber species, however has been shown to be a substantial mineral carbon sink, storing calcium carbonate when growing in ferralitic soils. Cailleau *et al.* (2004) suggested that conservation of iroko trees is crucial to maintenance of the mineral carbon sink.

Fuel

The rural populations of southern Sudan depend almost entirely on trees, either as wood or charcoal, for their energy requirements. Several fuelwood species are listed in Table 1. Fuelwood supply in southern Sudan is largely plentiful and does not currently represent a problem for conservation of the environment, but with

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Table 1. Important tree species of southern Sudan, indicating status, common and trade names, height, growing environment, distribution and uses

Species	Comments[e]	Distribution in Sudan[f]	Uses[g]
Acacia senegal (L.) Willd.[a]	*Gum-arabic acacia*. (<12 m) Major cash crop. Short grass savanna. Thorn fences (*zareiba*).	Widespread	Ex, Ti, Fu, Fd, Ta
Adansonia digitata L.[a]	*Baobab*. (<20 m) Sandy soils, short grass savanna. Multi-purpose. Water storage.	Widespread (not Equatoria)	Fo, Fi, Me, Ta, Ex
Afzelia africana Sm.[b]	*Pod mahogany*. (<30 m) Dry forest. Seeds used for decoration.	Equatoria	Ti, Ex, Po
Balanites aegyptiaca (L.) Del.[ad]	*Desert date*. (<10 m) Short grass savanna and clay plains.	Widespread	Fo, Fu, Me, Ti, Fd, Ta, Ex
Baphia abyssinica Brummitt[b]	*Camwood*. (<10 m) Moist highland forest.	Equatoria	Ti
Beilschmiedia ugandensis Rendle[b]	*Mwasa, mukarata*. (<30 m) Gallery forest.	Equatoria	Ti, Fu
Borassus aethiopium Mart.[a]	*Fan palm, palmyra palm*. (<15 m) Silty soils, near riverbanks. Multi-purpose.	Central and south	Ti, Fi, Fo, Ex
Boswellia papyrifera (Del.) Hochst.	*Frankincense tree*. (<10 m) Rocky ground in savanna. Bark for paper.	Central and south	Ex, Me
Calotropis procera (Ait.) Ait. f.	*Sodom apple*. (<6 m) Indicator of exhausted land.	Widespread	Fi, Fu, Me
Canarium schweinfurthii Engler.	*Incense tree*. (<40 m) Gallery and depression forest.	Equatoria	Ex, Fo, Ti
Combretum hartmannianum Schweinf.[b]	(<10 m) Tall grass savanna. Solitary trees.	Central and south	Ti, Fu
Cordyla richardii Planch. ex Milne-Redh.[b]	*Wild mango, cordyla*. (<20 m) Alluvial soils near rivers.	Equatoria	Ti, Fo, Ex
Dalbergia melanoxylon Guillem. & Perrott.[bd]	*Mpingo, ebony*. (<15 m) Tall grass savanna and clay plains. Carving. Large trees rare.	Central and south	Cr, Ti, Me
Entandrophragma angolense (Welw.) C. DC.[b]	*Wooden banana, budongo mahogany, gedu nohor*. (<50 m) High rainfall savanna. Major source of mahogany.	Equatoria	Ti
Erythrophleum guineense Don.	*Ordeal tree, sasswood, missinda*. (<30 m) Gallery forest.	Equatoria	Ti, Po, Fu, Ex
Faidherbia albida (Del.) Chev.	*Apple-ring thorn*. (<20 m) Major component of agroforestry systems in west. Various habitats including savanna and alluvial soils. Bark for bee hives, trunks for mortars.	Widespread	Fd, Fu, Me, Ex
Hallea stipulosa (DC.)[b]	*Nzingu, abura*. (<30 m) Over-exploited swamp forest species.	Equatoria	Ti
Irvingia gabonensis Baill.[b]	*Bush mango, oba*. (<25 m) Gallery forest. Lost through logging. Canoe wood.	Equatoria	Fo, Ti
Isoberlinia doka Craib & Stapf.	*Abogo*. (<25 m) Savanna forest.	Equatoria	Ti, Ex
Khaya senegalensis (Desr.) A. Juss.[b]	*Small leafed mahogany*. (<25 m) Riverbanks and gallery forest. Medicinal bark.	Equatoria and Darfur	Ti, Me, Ex
Khaya grandifolia C. DC.[b]	*Large leafed mahogany*. (<30 m) Gallery forest. Imatongs.	Equatoria	Ti, Ex
Kigelia africana (Lam.) Benth.	*Sausage tree*. (<15 m) Savanna, often by rivers.	Central and south	Me, Fo, Ti
Lophira alata Banks ex Gaertn. f.[b]	*African oak, ironwood, azobé*. (<60 m) Over-exploited, slow-growing pioneer timber of high rainfall savanna. Mature trees rare.	Equatoria	Ti, Me
Milicia excelsa (Welw.) C. C. Berg[b]	*African teak, iroko, mvule*. (<50 m) Heavily exploited. Gallery forest and savanna.	Equatoria	Ti
Ocotea kenyensis (Chiov.) Robyns & Wilczek[b]	*Stinkwood*. (<20 m) Superior hardwood. Imatongs.	Equatoria	Ti

Table 1. *Continued*

Species	Comments[e]	Distribution in Sudan[f]	Uses[g]
Parinari excelsa Sabine	*Guinea plum, mubura.* (<50 m). Imatongs.	Equatoria	Ti, Fo
Phoenix reclinata Jacq.	*Wild date.* (<8 m) Near water. Aphrodisiac from roots.	Central and Equatoria	Ti, Fo, Fi
Pouteria altissima (A. Chev.) Baehni[b]	*Milkplum, osan.* High rainfall savanna, Imatongs. Over-exploited, general purpose timber.	Equatoria	Ti, Fo
Prunus africana (J. D. Hook.) Kalkman[c]	*African prune, red stinkwood, mueri.* (<40 m) Over-exploited for medicinal bark, timber. Imatongs, Itobol.	Equatoria	Me, Ti
Sclerocarya birrea (A. Rich.) Hochst.[d]	*Marula.* (<15 m) Lighter savanna soils.	Central and south	Fo, Me, Ta, Ex
Sterculia setigera Del.[bd]	*Star chestnut, kataya.* (<15 m) Tall grass savanna.	Central and south	Ex, Me
Syzgium guineense (Willd.) DC.	*Eramori.* (<35 m) Streams and wadis. Subspecies in highland and lowland forest.	Central and south	Ti, Fo
Tamarindus indica L.[a]	*Tamarind.* (<15 m) Tall grass savanna and near water and termite mounds.	Central and south	Fo, Ti, Me, Ex, Ta
Vitellaria paradoxa C. F. Gaertn.[ab]	*Shea butter, karité.* (<15 m) Dry savanna woodland.	South	Oi, Ti, Fu, Ex
Zizyphus spina-christi (L.) Desf.[a]	*Jujube, Christ's thorn.* (<5 m) Short grass savanna and silty soils. Brush hedges (*zareiba*).	Widespread	Fo, Ti, Fu, Fd, Me, Ta

[a] Priority species in Sudan according to Bella *et al.* (2002).
[b] Listed in *The World List of Threatened Trees* (Oldfield *et al.*, 1998)—directly threatened, environment degraded or important in neighbouring country.
[c] Listed in CITES Appendix II.
[d] Endangered in Sudan according to the Sudan Ministry of Agriculture (Warrag *et al.*, 2002).
[e] Common and trade names for species and products.
[f] Central includes western and eastern Sudan.
[g] Cr, crafts; Ex, exudate; Fd, fodder; Fi, fibre; Fo, food; Fu, fuel; Me, medicine; Oi, oil; Po, poison; Ta, tannin; Ti, timber.

Table 2. Vernacular names of important tree species of southern Sudan listed in Table 1 (Arabic dialects are generally used more in the west; Bari, Acholi and Zande are major languages of the southern areas of southern Sudan; Dinka and Nuer are spoken in the more northern areas)

Species	Arabic	Bari	Acholi	Zande	Dinka	Nuer
Acacia senegal	*Hashab*	*Kadab Kadofi*	*Owak*		*Atitak Chiandok*	*Bam*
Adansonia digitata	*Tebeldi Humeira*				*Dunyud Zuony*	*Geinen Kusha*
Afzelia africana		*Berlingi*	*Beiyo*	*Kpawe Pai Pawe*	*Biling Riang*	
Balanites aegyptiaca	*Heglig Lalob*	*Lallok Lugwati Lumili*	*Logwat*		*Thou Thoa Eduti*	*Tau Fiath*
Borassus aethiopium	*Doleib Zaf*	*Injir Wawuti*	*Tugo*	*Okwa*	*Akot Akan Touk*	*Akot Nurr Giat*
Boswellia papyrifera	*Terakterak Bakhur*					
Calotropis procera	*Ushar*	*Pudentut*			*Apabuong*	
Canarium schweinfurthii				*Abanga Mbele*		
Combretum hartmannianum	*Sobakh Habil*					
Cordyla richardii					*Celoc Donjijual*	
Dalbergia melanoxylon	*Babanus*	*Faiti*			*Errit Rit*	*Larr Gel Did*
Erythrophleum guineense		*Kolute*	*Akwir*	*Gero Irrik*	*Kuru Thiepagor*	
Faidherbia albida	*Haraz*					
Hallea stipulosa				*Kopo*		
Irvingia gabonensis				*Taba Nzerri Kuvondoro*	*Daritar*	
Isoberlinia doka				*Vuba*	*Erianga Kobu*	
Khaya senegalensis	*Muraya Mur*	*Bierr*		*Bogu Baggu*	*Teet Tinliap*	
Khaya grandifolia		*Kir*	*Teedo*		*Teet*	*Nak Luel*
Kigelia africana	*Abu shatur*	*Kubuli Wunguli*	*Yako*	*Rangbarangbo*	*Ruwal*	
Lophira alata	*Zawa*			*Zawa*	*Tanga*	
Milicia excelsa		*Doro*	*Pwoiyo*	*Bema*		
Phoenix reclinata	*Nakhla*		*Otit*	*Kinge Sikisa*		
Sclerocarya birrea	*Homeid*	*Lukwok Mat*			*Akamil Gummil*	*Kameli Omei*
Sterculia setigera	*Tangaruru Umm tali*		*Obinyo Asaru*	*Kossawro*	*Adhiak Bogo*	
Syzgium guineense	*Kulet*	*Kulupu*	*Lugwaya*	*Bumbisso Sendembiri*	*Juw Kuom*	*Joic*
Tamarindus indica	*Ardeib*	*Kitei Showi*	*Kwa*	*Abanza*	*Kwai*	*Kwat Koatch*
Vitellaria paradoxa	*Lulu*	*Kumur*	*Yaa*	*Kpakari*	*Rak Enguratoi*	*Riek*
Zizyphus spina-christi	*Nabaq Sidr*		*Lango*		*Lang*	

increasing population pressure from the west and central areas fuelwood collection might not remain sustainable.

Food

Numerous non-domesticated trees of southern Sudan produce edible fruits and leaves, which represent both important nutrition and variety in diets. Attempts have been made to domesticate some species, including *Sclerocarya birrea* (Nerd and Mizrahy, 1993) and bush mango, *Irvingia gabonensis* (Ladipo *et al*., 1996), and others such as tamarind (*Tamarindus indica*), although not domesticated, are well known and distributed widely (Gunasena and Hughes, 2000).

Given that many domesticated fruits are grown in southern Sudan (Robinson, 2004), it is difficult to estimate the contribution wild species make to the diets and nutrition of the populations that gather them. In times of famine, fruits produced by *Balanites aegyptiaca*, *Borassus aethiopium*, *Grewia* spp. (Arabic (Ar.) *bashem*, *gadeim*, *tukko*), *Ximenia americana* L. (Ar. *umm dika*) and *Zizyphus* spp. (Ar. *nabq*, *sidr*, *tuqr*), among others, are crucial to survival. In southern Sudan, if commercial exploitation of forest resources increases unsustainably, many fruit-bearing trees will disappear as the environment is altered. The gallery forests contain, for example, wild mango, *Cordyla richardii*, which is also used for timber and produces an exudate, African locust bean, *Parkia filicoidea* Welw. ex Oliv. (Ar. *umm rashad*, Zande *abanga*, Bari *ru*), African breadfruit, *Treculia africana* Decne. (Zande *puso*), African nutmeg, *Pycnanthus angolensis* (Welw.) Exell. (Bari, *gbongo*) and calabash nutmeg, *Monodora myristica* (Gaertn.). African peach (*Nauclea latifolia* Sm. Ar. *karamododa*, Zande *dama*), wild custard apple (*Annona senegalensis* Pers., Ar. *gishta*) and black plums (*Vitex doniana* Sweet. [Ar. *gulgul*] and *Vitex madiensis* Oliv.) grow in the central and southern savanna areas along with the shea butter tree, *Vitellaria paradoxa*, a source of valuable and nutritious oil. *Monodora myristica* and *Afzelia africana* seeds were shown by Oboh and Ekperigin (2004) to be good nutrient sources for human and livestock diets.

Exudates and tannins

One of Sudan's major export commodities has been gum arabic produced from *Acacia senegal*. The gum has medicinal properties in addition to industrial uses. It mainly comes from the gum gardens of central Sudan, Kordofan and Darfur, which have been in decline due to unfavourable socio-economic relationships that have been exacerbated by drought in the region (Jamal and Huntsinger, 1993). *A. senegal* grows in the south also. Mahmoud *et al*. (1995) listed over 120 indigenous gum-producing plant species, including many from trees of southern regions. Among these are the frankincense tree, *Boswellia papyrifera*, and the incense tree, *Canarium schweinfurthii*. Mahmoud *et al*. (1995) also listed about 40 plant species, mostly trees, that are used in Sudan to produce tannin, including 11 *Acacia* species, some of which grow in southern Sudan and most of which are useful for other purposes.

Fibre

In the absence of man-made fibres in the rural areas of western and southern Sudan, natural fibres are very important. Mahmoud *et al*. (1995) listed about 30 fibre-producing plants in Sudan, some of which are indicated in Table 1, but also including *Piliostigma reticulatum* (DC.) Hochst. (Ar. *karob*), *Dombeya multiflora* (Endl.) Planch. (Ar. *gergedan*) and *Grewia mollis* Juss. (Ar. *basham*).

Medicine

The vast majority of rural southern Sudanese have no access to modern medicine and rely heavily on traditional cures, mostly prepared from plants. A very large number of tree species are used in traditional medicine in southern Sudan. Many of the species are also used in other countries and there are actual and potential foreign markets for Sudanese forest products. The bark of *Khaya senegalensis* is an example. *Kigelia africana* is particularly well known as a medicinal tree, infusions of its bark being used to treat dysentery among other ailments. Bark of other trees, including *S. birrea*, *Sterculia setigera* and *B. papyrifera*, are used to treat diarrhoea, jaundice and bilharzia, while the latex of *Calotropis procera* is applied to scorpion stings and has anti-tumour properties (Van Quaquebeke *et al*., 2005). Hedberg *et al*. (1982) listed numerous medicinal uses for *T. indica*, *K. africana* and *A. senegalensis* in Tanzania, and Williamson (1975) for Malawian tree species, many of which also grow in Sudan. Tamarind fruits are used as a laxative and febrifuge for malaria in Sudan, in addition to being used to make a refreshing drink, and baobab fruits are used to cure stomach aches. *Rauvolfia vomitoria* Afz. (Zande *gbatunga*) is a small tree of Equatoria that has many local medicinal uses, but also contains several alkaloids, the derivatives of which are used as antihypersensitives and sedatives (Levingston and Zamora, 1983).

P. africana is one of the most well-known medicinal tree species and grows in southern Sudan. This species

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has been over-exploited in its West African range, including Cameroon (Schröder, 2000), where it earns the country about $700,000 p.a. (CIFOR, 2003). Its bark has been unsustainably harvested to extract a pharmaceutical for treating benign prostate cancer. In addition, the bark has been widely used throughout its range as a traditional medicine for treating a variety of other ailments. *P. africana* can be grown on a field scale and it might be that it and other useful species could represent new crops for the region, which might prevent erosion of genetic resources and offer protection to natural forest stands.

Many tree species that grow in Sudan have been screened for pharmaceutical properties. *Lophira alata*, which is internationally threatened, contains two compounds that inhibit Epstein-Barr virus, one of which blocked tumour promotion (Murakami *et al.*, 1992). *Erythrophleum guineense* bark contains an analgesic alkaloid that has been used in dentistry and is used locally (Davis *et al.*, 1994). Phenolic extracts from *Crossopteryx febrifuga* Afz. (Benth.) (Zande *gbugari*), a widespread tree of central and southern Sudan, were shown to exert antiamoebic and spasmolytic activity (Tona *et al.*, 2000). Sanon *et al.* (2003) demonstrated that extracts of *C. febrifuga* and *Terminalia macroptera* (Guillem. & Perrot.) (Ar. *darot*) had antiplasmodial properties, as also demonstrated for *K. senegalensis*, *Maytenus senegalensis* (Lam.) Exell. (Ar. *shagar el mortayin*, Bari *surreh*, Zande *abaya*, Dinka *awailwel*) and *Trichilia emetica* Vahl. (Ar. *umm hagri*, Bari *kurulengi*) by El Tahir *et al.* (1999). Furthermore, spasmolytically active compounds (Orisadipe *et al.*, 2001) and anti-ulcer agents (Njar *et al.*, 1995) were found in the bark of *Entandrophragma angolense*. *Hallea stipulosa* (*Mitragyna stipulosa*) was demonstrated by Fatima *et al.* (2002) to have terpenoids that functioned as natural inhibitors of phosphodiesterase I snake venom.

Additional uses

For the tribes living in the various vegetation zones the trees have intrinsic value. They have symbolic significance as landmarks that are used for navigation in the region and can be defining features of a community. In southern Sudan, *Synadenium grantii* Hook. f. and *Euphorbia* spp. are planted by cultivated areas as antidotes to evil (Tothill, 1948). *Phoenix reclinata* Jacq. roots, like those of *Anogeissus leiocarpus* (DC.) Guill. et Perrott., are purported to have aphrodisiac properties. *Strychnos spinosa* Lam. (Bari *kunduruk*, Acholi *kwalakwala*) wood is particularly suited to making musical instruments in addition to having anti-trypanosomal properties (Hoet *et al.*, 2004) and edible fruit (von Maydell, 1983), and *Dalbergia melanoxylon* wood is prized for carving, as well as being used as a fumigant against rheumatism (Mahmoud *et al.*, 1995). Nigerian ebony, *Diospyros mespiliformis* Hochst. Ex. A. DC. (Ar. *goghan*), a widespread species, provides an edible fruit and workable wood. *Afzelia africana*, in addition to being a primary timber species, bears seeds used as decorative beads. *Crateva adansoni* DC. (Ar. *dabkar*) is another medicinal species with edible fruit whose wood is suited to making mortars (*funduq*) for pounding grain in Sudan (von Maydell, 1983). *E. guineense*, the ordeal tree, is associated with traditional lore in many African countries, its poison being used in tribal courts to determine guilt and innocence (Palgrave, 1984).

Discussion and conclusion

Civil war in southern Sudan has had substantial adverse effects on livelihoods in the region. The plant biodiversity though has probably not been completely negatively affected by war. McNeely (2003) described both positive and negative effects of conflict on biodiversity of tropical forests, pointing out that peace can often be worse than war as it allows forests to be freely exploited. Draulens and van Krunkelsven (2002) reported that although many effects of war on biodiversity in the Democratic Republic of Congo were negative, collapse of the wood industry did have a positive impact.

In the absence of many sawmills and chainsaws in southern Sudan, and given the civil conflict, many timber species have been under relatively little pressure from commercial logging. However, following the recent peace in the region, it is possible that pressure will increase and the fragile and restricted environments in which timber trees grow will be damaged in the absence of any enforceable conservation. Species including *A. africana*, *Entandrophragma angolense*, *Erythrophleum guineense*, *L. alata*, *M. excelsa* and *Ocotea kenyensis* are internationally threatened (Oldfield *et al.*, 1998). These species, among others, have been overexploited in several African countries and Sudan's reserves represent an attractive and relatively untapped source of high-quality timber. Although illicit logging is no doubt taking place in southern Sudan, as indicated by Wickens (1991), if peace prevails in the region not only will the internal timber trade probably expand, but safe and well-maintained roads out of southern Sudan will expedite trade in general, including export of wood to Uganda and Kenya, among other neighbouring countries. Moreover, many of the forest products of southern Sudan, apart from high-value timber, are traded internationally. For example, a West African company advertises products of more than 20 tree species mentioned in this paper on the internet (http://sky.

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yage.net/ghana.html). As such forest products become less readily available in other countries, the trees of southern Sudan might be targeted.

One possible environmentally damaging scenario is that both displaced sedentary farmers from western and central Sudan will attempt to resettle further south, once hostilities cease in the west. If the cattle nomads do similarly, not only will this spread the environmental destruction, through overgrazing and uncontrolled agricultural expansion, but it might also lead to serious conflict between the western and southern tribes over natural resources. Relatively small-scale conflict has always been a feature of the tribal relationships between the west and the south, but the current unprecedented conflict in western Sudan could spread south and drag the environmental destruction with it.

Conservation of the forests of southern Sudan is essential to maintaining biodiversity and providing livelihoods for the peoples who depend on them. The gazetted forest reserves of Sudan covered over 1 million hectares in 1979, but were increased substantially after 1993 to 8 million hectares, nearly 3% of the area of the country (Warrag *et al.*, 2002). What this actually means in terms of conservation is difficult to gauge in a country that has suffered from internal conflict and poor communications. Southern Sudan is relatively isolated and enforcing legislation will be extremely difficult. An additional complication is that the Imatongs span the Sudan–Uganda border, and co-operation will be required to implement conservation. Important forest also occurs along the border with the Democratic Republic of Congo, which is suffering from its own internal conflicts.

Domestic demands for wood could be taken care of in southern Sudan through establishing plantations, as has been done for teak, pine and eucalyptus, among other species. However, establishment and management are demanding and the valuable timbers of the gallery and montane forests will always represent high income for those who fell them. The timber species are not generally suited to plantation production, although highly valuable medicinal trees, such as *P. africana*, are amenable to husbandry and can be managed sustainably to provide a constant supply of product (Schröder, 2000). Abu-Al-Futuh (1989) suggested that *B. aegyptiaca* might be grown commercially for drugs, food and feed.

Although Sudan is not a signatory of the Congo Basin Treaty, the first ever region-wide conservation treaty in Africa, the neighbouring countries of Chad, Central African Republic and Democratic Republic of Congo are. This could be of benefit in future conservation efforts in Sudan as important forest occurs on its borders with those countries. Conservation on one side of the border could be of benefit on the other (Sudanese) side and encourage co-operation. Rehabilitating agriculture, after war has disrupted social systems, is always difficult (Richards and Ruivenkamp, 1997), but when livelihoods depend to a large extent on trees and forest products, it is likely that rehabilitation will be much more difficult. Rehabilitation of forests and trees outside forests takes generations. With the prospects for peace between the north and the south looking favourable, now is the time to plan for conservation and sustainable use of the forests. Post-conflict periods represent particularly vulnerable times (Price, 2003).

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