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OF WILD FAUNA AND FLORA

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TRADE STUDY OF SELECTED EAST AFRICAN TIMBER PRODUCTION SPECIES

This document has been submitted by Germany* in relation to agenda items 62, 77 and 88.

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Handelsstudie zu ostafrikanischen Holzarten

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Cover picture: A worker of a sawmill in front of *Dalbergia melanoxylon* logs in Montepuez/Mozambique (A.B. Cunningham)

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1 Executive Summary

Building on previous studies on the timber trade, this study aimed to get a more complete understanding of the conservation status of *Afzelia quanzensis, D. melanoxylon* and *P. angolensis* in three neigbouring countries (Kenya, Mozambique and Tanzania).

While none of the three species (*Afzelia quanzensis, D. melanoxylon* and *P. angolensis*) is under the immediate threat of extinction, all of them are under severe pressure of international and domestic demand. There is strong evidence that if the current rate of harvest continues, populations of the species will severely decline and a viable timber production of these species will no longer be possible on the short to medium term. Based on field observation over many years, coupled to a thorough review of other studies, it is clear that the existing system of regulation of the harvesting of wood from miombo woodlands is not workable. A workable sustainable management system needs control at the point of harvesting. This is not possible due to the remoteness of the remaining resource-rich areas, under-resourced conservation and forestry services and the wide dispersion of cutting activities. In addition, timber supply chains are "slippery" and oiled by corruption. Elite capture of valuable timber concessions and exports by powerful, well connected individuals poses a practical challenge, including to "participatory forest management" by local communities who are expected to face overwhelming imbalances in power. Consequently, continuing to try to attain sustainable management under the current system is not a sensible option. The costs far outweigh the benefits. What is practical is support for controls higher up the supply chain (for example through Revenue authorities and customs and shipping container companies, coordinating with national forestry authorities and international conservation agencies). A coordinated approach through the International Consortium on Combating Wildlife Crime (ICCWC), formed in November 2009 by representatives from the CITES Secretariat, the International Criminal Police Organization (INTERPOL), the United Nations Office on Drugs and Crime (UNODC), the World Bank and the World Customs Organization (WCO) could have a real impact.

National parks and Forest Reserves remain as an important tool for conserving tree species. At the same time, private enterprise and national forestry departments need to improve the management of softwood plantations and expand on them.

All three focal species would meet the CITES Appendix II criteria of Res. Conf. 9.24 (Rev. CoP16). Firstly, it can be inferred that major population declines have occurred the past three generations of these long-lived species. There also is compelling evidence that in many Range States, current harvest levels from wild populations are unsustainable. If the current levels of exploitation continue, then commercial logging of *A. quanzensis, D. melanoxylon* and *P. angolensis* is likely to become non-viable from a commercial perspective in the future. Secondly, from a policy perspective, given that the purpose of the CITES Strategic Vision is "*to ensure that no species of wild fauna or flora becomes or remains subject to unsustainable exploitation because of international trade*", cases where unsustainable harvest occur need to be considered, even where biological extinction is unlikely. Thirdly, there have been major declines in populations of these three species in the past through habitat loss due to clearing for subsistence and commercial agriculture, poor fire management and felling trees across a range of diameter size classes for domestic and export purposes. Fourthly, the "extrinsic" factor of climate change needs to be considered for all three species. This is best known for *P. angolensis*, where climate change predictions show that *P. angolensis* populations will be seriously affected in drier range States (such as Namibia and Botswana). In addition, in higher rainfall Range States, such as Zambia, South Africa and Zimbabwe, fungal wilt disease is also affecting *P. angolensis* populations. Based on field observations and available research, this report suggests that *Afzelia quanzensis* may be even more vulnerable than *P. angolensis* to climate

change. CITES Appendix II listing in this case links the nomination by Kenya (supported by Germany) in 1994 for *Dalbergia melanoxylon* to be included on CITES-Appendix II and to the recommendation by MILLEDGE et al. (2007) that both *Dalbergia melanoxylon* and *Pterocarpus angolensis* should be included on CITES Appendix II after their seminal study documenting illegal logging in Tanzania. And the situation facing these species has worsened since then, for a variety of factors, including large scale logging for export of logs from Mozambique to China. Based on official figures, over half the volume of the commercial species harvested in Mozambique is from three species (FAEF, 2013), two of which are Afzelia quanzensis and *Pterocarpus angolensis*, the third being *Millettia stuhlmannii*, which MILLEDGE et al. (2007) also suggested for CITES Appendix II.

Unsustainable and wasteful exploitation of valuable timber species is not just economically inefficient with negative outcomes for biodiversity. It also has social impacts that are poorly recognized. Poor rural households are vitally dependent on miombo woodlands because of their role as a safety net. These go beyond what effectively is the "export of local jobs" as logs are exported with minimal value-adding and job creation. There also are more subtle impacts. Most tree species commercially logged in East and southern Africa also have "non-timber" uses. This is a critical issue in sub-Saharan Africa, where food crops are particularly vulnerable to climate change and people commonly supplement their starchy staple diet with gathered foods and locally caught fish. Loss of this „green social security" due to deforestation or unsustainable logging puts additional pressure on public institutions that often are poorly equipped to handle the problem of rural poverty.

Logging for Asian markets also has other "ripple effects", as the same supply chains sometime involve trade in ivory from African elephants (CITES App. I), rhino horn (CITES App. I), a growing trade in scales from Cape pangolins (*Manis temminckii*, CITES App. II) and in Tanzania, export of East African sandalwood (*Osyris lanceolata*), listed in CITES App. II in 2013.

In terms of the political climate for CITES App. II listings, this is positive for *D. melanoxylon*, due to a much more supportive situation in Mozambique than in 1994 when App. II nominating was suggested by Kenya and Germany. Less political support may be expected for listing *A. quanzensis* and *P. angolensis*. That said, there are other practical measures that can be taken in regard to trade in these species even before CITES App. II listing is debated. Detailed recommendations are made in this report. These include implementing:

- A ban in Mozambique on the export of unprocessed logs, half-cut logs and rough cut timber >125mm thick;
- Improving timber trade tracking along supply chains and better use of tracking technologies;
- Strengthen ICCWC implementation through the World Customs Union (WCU), World Bank and national asset forfeiture and money laundering units in relation to environmental crime;
- Developing a more nuanced strategy and dialogue with the Chinese government (as the major timber importer from Mozambique) based on a better understanding of the roles of Chinese private enterprise, the Chinese national and provincial government in the logging trade;
- Supporting the revision of forest concession policies in Mozambique to deal with the "grey area" of Simple licenses and ensure fewer, larger concessions that have Annual Allowable Cuts (AACs) that are based on at least a 30 year rotation that are sufficient to support a viable industry in the long term.

In summary, while this report presents a compelling case that monitoring of trade in these three species through CITES Appendix II listing, it would be strategic to hold a workshop in East Africa prior to the CITES COP 17 meeting in Johannesburg, South Africa (24 September – 5 October 2016). If the workshop was held in the first half of 2016, with Range States given time to hold consultations before then, then a decision could be reached whether to only list *D. melanoxylon* at this stage or all three species.

2 Introduction

Between 2008 and 2013, the tenth European Development Fund (EDF) allocated €22.7 billion in funding for Africa (EUROPEAN COMMISSION, 2013). Most of this focussed on poverty alleviation, with some also spent on environmental sustainability. Despite hopes that European tax-payer's funds spent on development aid will deliver real and lasting results, there are many examples where this is not the case. Hopes for sustainable timber harvests and efficient generation of revenue to the forestry sector are one such example. The case where around 50% of the US$ 60 million of Norwegian aid funds allocated to a major natural resources programme in Tanzania over a 12-year period were lost through corruption and mismanagement is an example of the scale of the challenge (JANSEN, 2009). So is the example of Mozambique, where during 2013, 93% of logging was illegal (EIA, 2014a). In fact if both domestic and international demand for timber are taken into account in Mozambique, then the quantities harvested far exceed the annual allowable cut (AAC) (FAEF, 2013). A decade ago, INDUFOR (2005) summed up a similar situation with respect to Tanzania:

> *"There are strong grounds for believing that the current system of regulation is actually unworkable. The central problem is a mismatch between the regulatory regime and the system it is to regulate on the ground. The regime was devised for an industrialised timber production system, dominated by the public sector, where a few large capacity, stationary sawmills formed the backbone of production. Regulation of this type of production system is relatively straightforward. The production units are easily traceable and production volumes easily monitored. The hardwood production system operating now is very different. The bulk of production is from a large number of small units operating over a very wide expanse of territory. Forest officers cannot regulate the extraction of timber because of insufficient resources. The costs of proper monitoring of the felling of trees would be enormous and far outweigh the benefits. … In addition, we have shown that the supply systems are flexible, so that agents can quickly switch channels and routes on tightening of regulation. One could say that the wood supply system is ‚slippery'. It is difficult to get hold of for regulation purposes. What looks like a good intervention point for regulation of the dispersed, multi-channel and complex system, ‚slips away' as the regulation is applied. But as well as cheating by the pit-sawyers and dealers there is also corruption in the forest service, on the railways and in the police force. Many of the people in a position to apprehend and convict those trading without licenses can be 'easily silenced with a bribe', a fact openly acknowledged by all respondents".*

This situation still applies widely in the region today. This is worsened by a combination of three main factors. Firstly, the 1998 logging ban in China, which brought positive environmental benefits locally, but "externalized" the logging problem by shifting demand for hardwoods to the rest of the world, including to Africa. Secondly, the widespread availability of chainsaws, that are now used by tens of thousands of small-scale loggers (WIT et al., 2010). Thirdly, the involvement of powerful elites in commercial logging. As a result, there are major challenges to the European Union's (EU) Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan, which aims encourage legal and sustainable forest management.

2.1 International, national and regional demand for East African hardwoods

Compared with tropical moist forests, the miombo woodlands of East and southern Africa that are the source of the focal species of this report have a relatively low biomass of high quality commercial timber species. Yet some of these timbers are very valuable. Plant biodiversity is low compared to tropical forests, yet is high compared to temperate forests in Europe, as miombo woodlands contain about 8,500 plant species, 54% of which are endemic to this woodland type, 300 of which are tree species (WHITE, 1983), including a range of species commercially logged for timber (Appendix 1).

Building on previous studies on the timber trade, this report focuses on the current conservation status of *Afzelia quanzensis, D. melanoxylon* and *P. angolensis* in the three countries (Kenya, Mozambique and Tanzania). To give a better context for these widely distributed species, this study also discusses the impacts on these three species across their wider geographic range in Africa. This report would not have been possible without building on the excellent studies conducted in the region over the past decade on the extent of legal and illegal logging from eastern Africa. With its focus on international policy tools such as CITES, EUTR and FLEGT, this report pays more attention to exports of timber, logs and carvings. It is crucial, however, for policymakers to also appreciate the extent of domestic timber demand. An excellent FLEGT funded study recently estimated that in Mozambique in 2012, domestic wood consumption was about 414,000 m³ of logs equivalent per year, 257,000 m³ of logs equivalent of this for urban timber demand, with 7,000 m³ for carpentry from local sawmills, plus an additional 150,000 m³ logs equivalent used in rural areas (FAEF, 2013).

Based on official records of Mozambican timber exports, the total consumption of timber domestically and for export was 727,000 m³ of logs equivalent in 2012 (FAEF, 2013). Based on the extent of illegal logging in Mozambique, this total is likely to be much higher. Both MACKENZIE (2006) and MACKENZIE & RIBIERO (2009) have drawn attention to the extent of illegal logging for export to Asia and how dysfunctional forestry concession licences processes can be. More recently, EIA (2013) showed that in the same year as the FAEF (2013) study, Chinese companies imported between 189,615 m³ and 215,654 m³ of timber that was unlicensed, so was illegally exported from Mozambique (48% of total imports). What previous studies have not taken into account is the illegal export of timber (mainly *Pterocarpus angolensis* and *Afzelia quanzensis*) across the Rovuma river from Niassa province in northern Mozambique to Tanzania (Figure 1).

Over half the volume of the commercial species harvested in Mozambique is from three species (FAEF, 2013), two of which are the focus of this report: *Afzelia quanzensis, Pterocarpus angolensis* and *Millettia stuhlmannii* (all Fabaceae). The third species on which this report concentrates, *Dalbergia melanoxylon*, considered to be one of the most valuable timbers in the world (Table 7), is also logged in significant quantity for export to Europe and Asia. Between 80–90% of the exported Mozambican timber is shipped as logs to China, primarily through the ports in Guangdong, Jiangsu, Shanghai and Zhejiang. In 2000 the proportion of Africa's timber exports to China was 35%. By 2009, this proportion had grown to 78%, making timber Africa's third largest export commodity after oil and mineral ores (HUANG et al. 2013). In Tanzania, a seminal study by MILLEDGE et al. (2007) documented the extent of illegal logging in Tanzania, recommending that Tanzania consider CITES-listing for several internationally traded timber species as a tool for a more sustainable trade: *Osyris lanceolata, Dalbergia melanoxylon, Millettia stuhlmannii, Swartzia madagascariensis* and *Pterocarpus angolensis*.

In terms of feedback into policy from field studies on the ground, this report is timely for four main reasons. Firstly, while the surge Chinese demand for *hongmu* (*hong*=red, *mu* =wood) has drawn attention to a "*Dalbergia* conservation crisis" (EIA, 2013), it is important

not to forget the impacts that this demand is having on other species in addition to *Dalbergia*. The "rosewood plunder" in Guinea Bissau (ANON., 2014) certainly involved significant quantities of *Pterocarpus erinaceus*. Across the tropics, *P. angolensis, P. santalinoides, P. santalinus, P. soyauxii* and *P. erinaceus* are all in high commercial demand. One of these *Pterocarpus* species (*P. angolensis*) is a focal species in this study, but it is likely that the red timber of *Afzelia quanzensis* is also marketed in China as *hongmu*.

Secondly, this study describes the many ways in which logging impacts wildlife in eastern Africa, showing that links between logging and influences on wildlife are more diverse and more nuanced than previous studies have indicated. In contrast to the Congo Basin, where the associations between logging concessions and bush meat consumption are well known (BENNETT et al., 2002; POULSEN et al., 2009), far less attention has been given to bush-meat in East Africa. Far more CITES-listed species are impacted by the "ripple-effects" of logging in East Africa than is usually appreciated, as logging for Asian markets not only involves timber, but also trade in ivory from African elephants (CITES App. I), rhino horn (CITES App. 1), a growing trade scales from Cape pangolins (*Manis temminckii*, CITES App. II) and in Tanzania, export of East African sandalwood (*Osyris lanceolata*), which was suggested for CITES App. II listing at CoP 16. The combination of timber, ivory and pangolin scales also occurs in West Africa. The extent of trade in all four African pangolin species should not be underestimated. In June 2014, for example, 3 tonnes of pangolin scales worth HK$ 17 million were seized by Hong Kong customs in two shipping containers, one exported from Uganda via Kenya and the other from Cameroon (LO, 2014). And although the South African abalone (*Haliotis midae*) only occurs in cold water inshore marine areas off the West Cape province, South Africa, customs records include seizures of illegally traded South African abalone in Kenya, Mozambique, Swaziland and Zimbabwe, in some cases in conjunction with ivory.

Lastly, in terms of "ripple effects" on CITES listed species, is the link between poaching of large mammals (such as elephant or buffalo) and deliberate poisoning of vultures (GROOM et al., 2013). In some cases this is done to avoid early detection of carcasses (SMILLIE, 2014). In other cases this is to get the vulture's heads, which are traded for traditional medicine in Mozambique and are exported from Mozambique to South Africa (CUNNINGHAM, 1990; MANDER et al., 2007).

Thirdly, this study is relevant to four global policy initiatives and at least one regional forum related to the East African timber trade. The global initiatives are the European Union Timber Regulation (EUTR), the EU's voluntary agreement process on Forest Law Enforcement, Governance and Trade (FLEGT), the Green Customs Initiative (GCI) (http://www.greencustoms.org/) and the International Consortium on Combating Wildlife Crime (ICCWC). While the GCI was established in 2001 and FLEGT in 2003, both the ICCWC (November 2009) and EUTR (March 2013) are more recent. By bringing together EU member states, the United Nations Environment Programme (UNEP) and representatives from the CITES Secretariat, the International Criminal Police Organization (INTERPOL), the United Nations Office on Drugs and Crime (UNODC), the World Bank and the World Customs Organization (WCO) offers an opportunity to take a coordinated approach to dealing with forest and wildlife crime. The regional initiative is the East Africa timber trade forum, which has recently organized several annual multi-stakeholder meetings to try to coordinate solutions to the illegal and unsustainable timber trade in Tanzania, Kenya, and Mozambique and is organized by TRAFFIC, WWF Tanzania and the Tanzania Natural resource Forum.

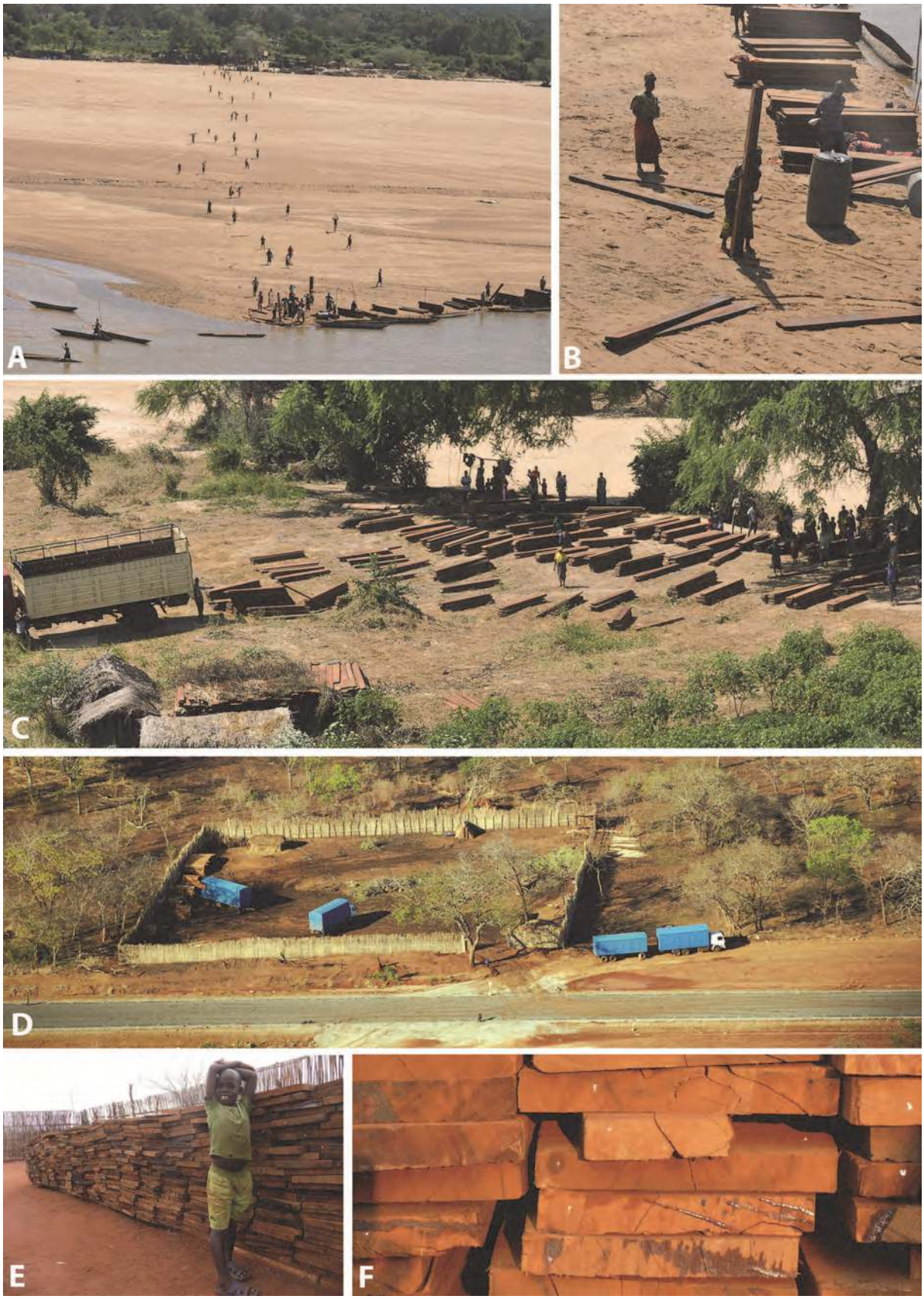

Figure 1

Figure 1. Large scale "leakage": illegal export of sawn timber from Niassa province, northern Mozambique to southern Tanzania. **A.** Women carrying sawn planks to dugout canoes on the Mozambican side of the Rovuma river (2009). **B.** Planks ready for loading. **C.** *Pterocarpus angolensis* planks on the Tanzanian side being loaded, probably for sale in the domestic market. **D.** Covered trucks loaded with illegally cut planks on the Tanzanian side of Negamano border post. **E.** and **F.** Confiscated timber at Negamano (2010). Photos: W. Ebersohn (A-D), A.B. Cunningham (E, F).

Fourthly, this report suggests a set of practical approaches that are needed to address the problem. What is needed are country-specific approaches, as different types of logging need to be differentiated into more than just "legal" vs. "illegal" logging. To develop coherent, practical policy responses, the interplays between domestic demand for local construction timber, carpentry enterprises, charcoal and the international trade in commercial woodcarvings and legal and illegal logging for commercial timber need to be understood. In Kenya, for example, the commercial woodcarving is not a small-scale artisanal production system that has negligible impacts. The 60,000 Kenyan woodcarvers are highly organized, using 52 tree species in an export business worth US$ 20 million per year that is growing at 1.8% per year (MUGA et al., 2014). Since the 1950's, commercial carvers in Kenya have had a significant impact on populations of several tree species, including *Dalbergia melanoxylon* and *Brachylaena huillensis* (CHOGE et al., 2005). They also use *Afzelia quanzensis*, but unlike carvers in Tanzania and throughout southern Africa, do not use *Pterocarpus angolensis*, firstly because it does not occur in Kenya and secondly because Kenyan carvers prefer to import *D. melanoxylon* and *B. huillensis* from Tanzania.

2.2 Drivers of demand: history of the "trade package"

The reason why it is important to understand the history of the trade package of timber, ivory, pangolin scales and other valuable natural resources is simple: it is widely accepted that to effectively plan for the future, it is crucial to understand the past. This applies as much to trade policies and rural development as it does to conservation and sustainable use. What is much less widely appreciated is how past histories resonate into the future. China's current "One belt, One road" (OBOR) policy, initiated in 2013, at the same time as the EUTR, is one such example. Based on the political resonance of the historical "Silk Road" across East Asia through Central Asia to Europe and China's proud history of a maritime trade that stretched from East Africa and into SE Asia, OBOR (in Mandarin, 带 路 and in pinyin, *yídài yílù*) has two modern components. The "Silk Road Economic Belt (SREB) and the Maritime Silk Road (MSR). East Africa is included in the MSR component of OBOR, with a focus on upgrading East African ports constructing a modern standard-gauge rail link between Nairobi and Mombasa.

Trade in ivory and precious woods from East Africa is not new. In fact the earliest quantified trade in African timber and ivory dates back to over 4000 years ago, where "*ships loaded with ivory & hbny*[1]" and "*111000 men loaded with hbny*" recorded in a rock inscription by Amenophis II's vizier Weser-Satet at Kasr Ibrim (DIXON, 1961). From the early 10th century, ivory was being shipped from East Africa (the land of „Zanj") to Oman and then on to India and China (BEACHEY, 1967). Turtle shell (probably hawksbill turtles), mangrove poles and gold were also shipped from Sofala (near today's major timber shipping port of Beira) to the Arabian peninsula at this time (BIGINAGWA, 2012; HORTON & MIDDLETON, 2000). Historical Swahili-Arab alliances and trade routes were seriously disrupted during the Portuguese peri-

[1] ***Hbny*** in Egyptian tombs was confirmed as *Dalbergia melanoxylon* by KITCHEN (1971).

od in East Africa (1498 – 1750) but trade in ivory to Europe expanded and also continued to South-east Asia through Portugese trade networks.

Beginning in the United Kingdom, then spreading to Western Europe and North America, the Industrial Revolution started around 1760 and continued to the mid-19th century. Rising wealth and a growing middle-class were a consequence, generating demand for luxury products that signified the shift of the middle classes out of poverty. Piano recitals, billiards using ivory balls and ivory handled cutlery were all part of this European "conspicuous consumption". As a consequence, trade in ivory and ebony wood (including *Dalbergia melanoxylon*) increased. By the mid-nineteenth century, over 500 tons of ivory per year were being exported to Europe and the USA (HÅKANSSON et al., 2008). Based on 45kg per tusk, HÅKANSSON et al. (2008) suggest that this represented about 11,000 elephants per year. This level of elephant killing had several environmental effects, including spread of tsetse flies and expansion of woodlands (HÅKANSSON et al., 2008).

The main woodwind instruments manufactured also first appeared during the Industrial Revolution. The standard oboe first appeared in the mid-17th century, when it was called *hautbois*. This was the main melody woodwind used by early military bands, until it was replaced by the clarinet. The clarinet was also developed around 1740 in Nuremberg, Germany. Initially the baroque oboe was usually made of boxwood (*Buxus sempervirens*), but today, both the modern standard oboe and the clarinet are made from *Dalbergia melanoxylon*, which is preferred as it can be turned so precisely, is so stable, doesn't crack easily and due to the elegant black colour. Many of the well-known European manufacturers of clarinets and oboes that were established during the 19th century: Buffet Crampon (France, established in 1835), Martin Freres company (France, established, 1840), François Lorée (France, established 1881) and in the USA, Henri Selmer & Cie (later Conn-Selmer) which was established in 1902. Bagpipes were an earlier invention, however (COLLINSON, 1975), but also favour the use of *D. melanoxylon* (Figure 2).

Figure 2. Edinburgh bagpipe maker David Glen in his workshop, c. 1910, showing blanks of *Dalbergia melanoxylon* on the shelves behind him. These are virtually unchanged from blanks made today and are likely to have originated from Tanzania (what was German East Africa at the time).

Demand for fine-grained “tone-woods” continues to generate high prices for these species today. Where there is a need for greater clarity, however, is on how high these values can be. Table 7 shows comparative prices for instrument blanks from a reputable European supplier. By contrast, JENKINS et al. (2002) published prices that are many times higher.

During this period, trade opportunities stimulated the Sultan of Oman, Seyyid Said, to move his capital from Muscat (Oman) to Zanzibar. By 1835, he had ratified a trade treaty with the United States and by 1837 had taken control over Mombasa as a key trade port. Ivory, slaves and gum copal (from *Hymenaea verrucosa*) were exported in return for „Marekani“ industrial products (beads, cloth guns and metal wire). This enabled Zanzibar to become the base of an Omani trade hub for international export of East African products, including to the USA and Europe. Sultan Seyyid Said highly valued *Dalbergia melanoxylon* as a timber, bringing in artisans from India to carve intricate furniture for his palace (Figure 3).

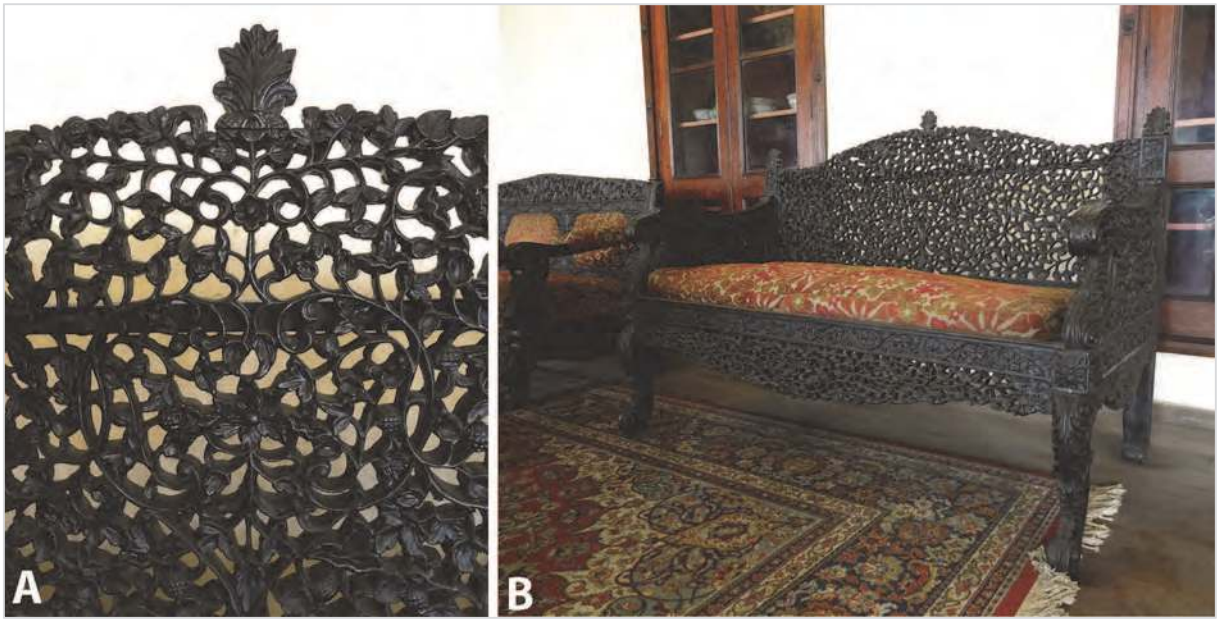

Figure 3. Blending Africa, Oman and India: **A.** detail of carving and **B.** the furniture belonging to Sultan Seyyid Said, ruler of Oman, who in the 19th century established his commercial capital in Stone Town, Zanzibar and had Indian artisans carve this intricate furniture from *Dalbergia melanoxylon* brought from mainland East Africa to Zanzibar. Photos: A.B. Cunningham.

2.3 From music to Ming furniture: international timber trade in the 20th and 21st centuries

As discussed in the previous section, 19th century industrialization and an emerging middle-class in western Europe and North America stimulated "conspicuous consumption". Displays of new wealth that signified a move into the middle classes included demand for mahogany furniture, pianos and ivory products (from billiard balls to combs). Similar social trends occur in China and Vietnam today, following rapid industrialization and rising wealth. This includes rising demand for fine furniture made from precious *hong mu* woods, ivory and rhino horn. In China, prior to the early 1400's, when Zheng He was sent by Emperor Zhu Di to explore the Western Ocean (South and south-east Asia), only Asian timber species were used for furniture. During the Ming dynasty (1368–1644), precious hardwoods such as *Pterocarpus santalinus* started to be imported from beyong the borders of China (LIU et al., 2013). Due to the scarcity of *Pterocarpus santalinus*, between the 17th and 19th century only the imperial household was permitted to use this wood in China (KANER et al., 2013). One of the major differences between the "conspicuous consumption" trends in 19th century Europe and 21st century China is the scale of demand. In 1850, the total population of Europe was 213 million (GRIGG, 1980), with the Industrial Revolution primarily influencing western Europe. In 1850, the population of the USA was 23.1 million[2]. In total, in 1850, the total size of the emerging middle-class generating demand for fine timber and ivory in Europe was about 20% of the population[3] (c. 40 million people). In contrast, in 2015, the total population of Chi-

[2] see: en.wikipedia.org/wiki/1850_United_States_Census

[3] see: www.historydoctor.net/Advanced%20Placement%20European%20History/Notes/rich_poor_and_middle_class_life.htm

na is 1.4 billion[4], with as many as 680 million people moving out of poverty between in 1981 and 2010 (ANON., 2013).

Table 1. The eight genera in two plant families (five genera and a total of 32 species) listed in China's National Hongmu Standard (GB/T18107-2000[5]), translated for this study. Botanical names in the official standard need to be updated and have been corrected here. For example, *Cassia* is now *Senna*, and *Pterocarpus cambodianus* is now considered to be equivalent to *P. macrocarpus* (see www.ipni.org) despite the different Chinese names for these species. *Dalbergia melanoxylon* from East Africa is on the official standard, but *Pterocarpus angolensis* and *Afzelia quanzensis* are not. It is possible, however, that the red-brown timber from both *P. angolensis* and *A. quanzensis* is being substituted for official *hongmu* species (such as *P. indicus*) and that *Millettia stuhlimannii* from East Africa is substituted for official "chicken wing woods" (a name given due to the characteristic grain of the *Millettia* woods, *M. laurentii* and *M. leucantha*).

FABACEAE	***Pterocarpus***	紫檀木类 (*zi tang mu)*	檀香紫檀 (*tang xiang zi tang*) *Pterocarpus santalinus*
		花梨木类 (flower pear wood)	越柬紫檀 (*yue jian zi tang*) *P. cambodianus,* 安达曼紫檀 (*an da mang zi tang*) *P. dalbergioides,* 刺猬紫檀 (*ci wei zi tang*) *P. erinaceus,* 印度紫檀 (*yin du zi tang*) *P.indicus,* 大果紫檀 (*da guo zi tang*) *P. macrocarpus,* 囊状紫檀 (*lang zhuang zi tang*) *P. marsupium,* 鸟足紫檀 (*liao zu zi tang*) *P. pedatus*
	Dalbergia	香枝木类 (incense branch wood)	降香黄檀 (*jiang xiang huang tang*) *Dalbergia odorifera*
		黑酸枝木类 (black rosewood class)	刀状黑黄檀 (*dao zhuang hei huang tang*) *D. cultrata,* 黑黄檀 (*hei huang tang*) *D. fusca,* 阔叶黄檀 (*kuo ye huang tan) D. latifolia,* 东非黑黄檀 (*dong fei hei huang tang*) *D. melanoxylon,*卢氏黑黄檀 (*lu shi hei huang tang*) *D. louvelii,* 巴西黑黄檀 (*ba xi hei huang tang*) *D. nigra,* 亚马孙黄檀 (*ya ma shun huang tang*) *D. spruceana,* 伯利兹黄檀 (*bo li zi huang tang*) *D. stevensonii*
		红酸枝木类 (red rosewood class)	巴里黄檀 (*ba li huang tang*) *D. bariensis,* 赛州黄檀 (*sai zhou huang tang*) *D. cearensis,* 交趾黄檀 (*jiao zhi huang tang*) *D. cochinchinensis,* 绒毛黄檀 (*rong mao huang tang*) *D. frutescens* var. *tomentosa,* 中美洲黄檀 (*zhong mei zhou huang tang*) *D. granadillo,* 奥氏黄檀 (*ao shi huang tang) D. oliveri,* 微凹黄檀 (*wei ao huang tang*) *D. retusa*
	Millettia and ***Senna*** *(formerly Cassia)*	鸡翅木类 ("chicken wing wood")	非洲崖豆木 (*fei zhou ya dou mu*) *Millettia laurentii,* 白花崖豆木(*bai hua ya dou mu*) *M. leucantha*, 铁刀木(*tie dao mu*) *Senna siamea*
EBENACEAE	***Diospyros***	乌木类 *wu mu* (the ebony class)	乌木 (*wu mu*) *Diospyros ebenum,* 厚瓣乌木 (*hou bang wu mu*) *D. crassiflora,* 毛药乌木 (*mao yao wu mu*) *D. pilosanthera,* 蓬塞乌木 (*peng sai wu mu*) *D. poncei*
		条纹乌支木 (black striped *wu mu*)	苏拉威西乌木 (*su la wei wu mu*) *D. celebica,* 菲律宾乌木 (*fei lv bin wu mu*) *D. philippensis*

[4] see: www.worldometers.info/world-population/china-population/

[5] see: www.chinesestandard.net/PDF-English-Translation/GBT18107-2000.html

Figure 4. There is a need to consider more species than just *Dalbergia, Pterocarpus* and *Afzelia*. A. Logging trailers with massive *Colophospermum mopane* logs felled from "gallery mopane" woodlands in the Zambezi valley, ready to off-load at Tian Yang logging yard near Dondo, Sofala, Mozambique. **B.** Entrance gate of the massive Tian Yang logging yard (c. 600 m long, 200m wide). **C.** *Pterocarpus angolensis* on a logging truck on the Inchope-Beira road. **D.** Standing dead *Combretum imberbe* trees are centuries old and an important habitat for birds and some rare reptiles, but are logged for their dense timber. **E.** *Millettia stuhlmannii* logs on a logging truck at Inchope on its way to Beira from the Cheringoma plateau. *M. stuhlmannii* is an unofficial substitute for two other official *Millettia* species (*M. laurentii* and *M. leucantha*) on the "*hong mu*" list. Photos: A.B. Cunningham.

Today, five genera in two plant families (a total of 32 species) are listed in China's national Hongmu Standard (GB/T18107-2000[6]). Despite the „Red wood" (*hong mu*) name, this includes woods ranging from pitch-black (*D. melanoxylon*) and brown (*Pterocarpus indicus* and *Dalbergia cultrata*) to red (several *Dalbergia* species) (Table 1). Historically, the second-most valuable species in the *hongmu* trade categorization was *Pterocarpus santalinus* (檀香紫檀 [*tang xiang zi tang*]), with the most valued species being Asian *Dalbergia* species (*D. odorifera*, 降香黄檀 [*jiang xiang huang tang]*). NELLEMANN et al. (2014) suggest that prior to 2005, *Dalbergia odorifera* was being sold for US$ 15,000 per m³, but by 2006 had increased to over US$ 100,000 and by 2007 was being sold for US$ 500,000 per m³ with prices up to US$ 1.5 million per m³ being paid today.

There certainly is a pan-tropical *Dalbergia* crisis. Asian demand and rising prices are driving the exploitation of *Dalbergia* species in places as far apart as Belize (ZEMPEL, 2014), Madagascar (PATEL, 2007; SCHUURMAN & LOWRY, 2009), the Mekong region of SE Asia (EIA, 2014b) and northern Mozambique (MACKENZIE, 2006; MACKENZIE & RIBIERO, 2009).

With the same drivers also affecting other genera in the national Hongmu Standard, it is important to also assess trade in those species as well, including *Baphia kirkii, Khaya antotheca, Milicia excelsa* and *Millettia stuhlmannii* all of which have become commercially extinct in parts of their East and southern African range due to unsustainable logging. In addiiton, impacts on habitat also need to be considered, even where widespread tree species are concerned. Logging of unusually tall *Colophospermum mopane* woodlands in the Zambezi valley is a good example. In Zambia, the Chinese "Fly Dragon Wood and Lumber Company" was prevented from logging *C. mopane* in the Mutulanganga Forest in 2010 because this was recognized as an Important Bird Area (IBA) by the Zambian Ornithological Society (ZOS) and a significant habitat for the African Pitta, Barred Longtailed Cuckoo, Thrush Nightingale and River and Marsh Warblers. In addiditon, logging was stopped to protect the Namoomba Elephant Corridor (ZOS, 2011). On the Mozambican side of the Zambezi valley, however, where „gallery mopane" habitat is just as important for birds and elephants, logging has been taking place on a massive scale.

3. Objectives and methods

3.1 Objectives

The primary objective of this study was to assess the conservation status and trade in three commercially exploited species in East Africa: *Afzelia quanzensis, Dalbergia melanoxylon* and *Pterocarpus angolensis*, and whether they fulfill the criteria for CITES Appendix II listing as laid down in Res. Conf. 9.24 (Rev. CoP16), compiling information for a possible listing at CoP 17 in 2016. A secondary objective was to assess the influence of trade regulations such as the European Union Timber Regulation (EUTR) and the EU's Forest Law Enforcement, Governance and Trade (FLEGT) process on these three focal tree species and their trade. A further secondary objective was also to investigate the possible consequences of the timber trade in East Africa for other CITES-listed species (e.g. African elephant).

3.2 Methods and approach

Due to the short period for this contract, this study combined four approaches: (a) a thorough literature review combined with (b) the extensive experience of the contractor in China and in the remote areas of East and southern Africa where logging takes place; (c) a meeting

[6] see: www.chinesestandard.net/PDF-English-Translation/GBT18107-2000.html

at the Bundesamt für Naturschutz (BfN) in Bonn to discuss preliminary results (on 2 September 2014) and (d) field visits to the study region (Kenya, Tanzania and Mozambique) by the contractor. These took place in late September and October 2014, followed by a visit to northern Mozambique (Cabo Delgado) with Dr D. Wolf (BfN) and two representatives of a European company, that imports wood from Mozambique and an exporting company (Pingo Madeiras) in Montepuez, Mozambique (May 2015).

It was during this field component that the contractor met with Kenyan authorities concerned about hardwoods such as *Dalbergia melanoxylon*. In May 2015, discussions were also held with the Mozambican CITES Scientific Authority (SA) and representatives of the Mozambican Management Authority.

4. Results

The primary objective of this study was to assess the conservation status and trade in three commercially exploited species in East Africa: *Afzelia quanzensis, Dalbergia melanoxylon* and *Pterocarpus angolensis*. In summary, none of the three species is in any immediate danger of biological extinction, although signiifcant population declines have occurred over the past three generations of these long-lived species. If the current levels of exploitation continue, then commercial logging of *A. quanzensis, D. melanoxylon* and *P. angolensis* is likely to become non-viable from a commercial perspective in the future. Major factors for past populations declines have been habitat loss due to clearing for subsistence and commercial agriculture, poor fire management and felling trees across a range of diameter size classes for domestic and export purposes. In addition, climate change predictions show that *P. angolensis* populations will be seriously affected in drier range States (such as Namibia and Botswana). In higher rainfall Range States, such as Zambia, South Africa and Zimbabwe, fungal wilt disease is also affecting *P. angolensis* populations. Based on field observations and available research, I suggest that *Afzelia quanzensis* may be even more vulnerable than *P. angolensis* to climate change. For *D. melanoxylon* to reach the minimum DBH of 24 cm takes 133 years (S. Ball pers. comm, 2014) and it takes *P. angolensis* between 90-130 years to get the minimum DBH of 35cm (THERRELL et al., 2007). Growth rates of *Afzelia quanzensis* (GAUGRIS et al., 2008) and *A. xylocarpa* (BAKER et al., 2005) both range from 2-3mm/yr. Few studies have been done on population structure of *A. quanzensis*, but GERHARDT & TODD (2009) showed that few seedlings made the transition to the juvenile tree stage. In the case of *A. xylocarpa*, the oldest trees were at least 257 yrs old and that no *A. xylocarpa* in the populations studied were less than 135 yr old. Summaries for each of the three species are given below to support decisions on whether these species comply with the criteria for CITES listings in Appendix II for a possible listing at CITES the forthcoming CoP 17 meeting in Johannesburg, South Africa (24 September to 5 October 2016).

4.1 Harvest and trade in *Afzelia quanzensis, Dalbergia melanoxylon* and *Pterocarpus angolensis*

There is extensive international trade in all three species, particularly from Mozambique and Tanzania. In Kenya, Mozambique and Tanzania, there is widespread recognition of unsustainable logging, limited value-adding to potentially high value indigenous hardwoods and the need to address illegal logging. The recent Kenya Forest Policy (REPUBLIC OF KENYA, 2014) summed up the situation well:

> *"A key challenge facing the wood products sub-sector is unsustainable extraction, which exceeds production, leading to degradation of forests particularly in community and private lands. Other challenges include inefficient conversion, low value addition methods leading to waste*

and thereby exacerbating the unsustainable wood supply scenario. Therefore, there is need to invest in improving wood based technologies and capacity to diversify into high value products. In order to address illegal trade in wood and wood products, a forest certification and a chain-of-custody system will be developed to ensure legal compliance and sustainability of the source of material".

Whether these goals are achieved remains to be seen. The challenge is certainly as daunting as the "implementation gap" between policy aspirations and practice. In Mozambique, the highest volume of all three species exported is in the form of unprocessed logs, as the 2002 forestry legislation requiring processing before export has not been enforced (SUN et al., 2008). In Tanzania, the Forest Regulations (2004) on "*Regulation on the Export of Forest Produce*" (Part XV) also required that "*No logs of any tree species shall be exported*" and this is now followed. This has added value to timber within Tanzania, but it has not stopped over-exploitation. The gap between intent and practice when it comes to forestry laws applies to commercial timber harvests throughout the region. In Kenya, a decade long partial logging ban applied nationally, until it was lifted under the new Forest Policy (2014). The ban was partial because it still allowed selected companies to continue to harvest wild populations of hardwood species in natural forests.

In Mozambique, both the land and the forest resources on that land are owned by the State. Forest policy is determined primarily through the Land Law and Forestry and Wildlife Policy (1997), the Forestry and Wildlife Law (1999) and the Regulations to the Forest and Wildlife Law (2002) as summarized by SUN et al. (2008). Access rights to harvest forest resource are either obtained on through longer term, renewable Forest concessions, or as for short-term annual simple licenses. Fees for different timber species are set according to the five different timber classes in REPÚBLICA DE MOÇAMBIQUE (2002). Precious timbers include *D. melanoxylon*, while *A. quanzensis* and *P. angolensis* are considered First class timbers. Unfortunately, abuse of the Simple Licencing system is a major problem, with local people logging to fulfill orders for logs that are exported. HANLON (2015) gives the case of Tete province, Mozambique, as an example, where in 2003, the Simple licence allocation was 3,000 m³ which by 2013 had increased to 47,000 m³.

In Tanzania, forest management is governed through the *Forest Act (No. 1, 4 of 2002)* (*Forest Act [Date of Commencement] Notice, 2004; Government Notice No. 160*) supplemented by *The Forest Regulations, 2004* (*Government Notice No. 153*) made under section 106(1) of the Forest Act (2002) (MILLEDGE et al., 2007). In 2006, changes to forestry laws occurred through the *Forest Amendment Regulations, 2006*. Regulations dealing with the harvest, trade and export of forest products are dealt with in the Forest Act (2002). In addition, Section 26 (Part V Forest Reserves) prohibits people from „cutting down, felling, digging up or removing any tree, wild plant or other forest produce within a national or local forest reserve without the necessary concession, licence or permit". The requirements for obtaining or revoking permits are specified in Section 49 of the Forest Act (2002) (Part VI Permits and Licences) and Part V of the *Forest Regulations (2004)* (Procedures and conditions for the application, grant, variation, refusal, extension or cancellation of licences, permits or certificates). Regulations covering the felling, removal and transportation of timber and other forest produce are covered in Part II of the *Forest Regulations (2004)*. Gaps between this legislation and what happens on the ground have been described by MILLEDGE et al. (2007) and more recently when the National Audit Office of Tanzania (NAOT) carried out an audit to determine the efficacy of forestry laws. Yet in December 2009, the Tanzanian Ministry of Natural Resource and Tourism (MNRT) reported that during the 2008/2009 financial year 57% of revenue from forest products was not collected (NAOT, 2012). In addition, during their audit, NAOT (2012) found that 96% of forest reserves were operating without any management plans and MNRT had no effective control over the issue of timber licensing at district level

and that in some districts harvesting licenses and transit passes were being issued without the required Forest Management Plans and annual harvesting plans in place. This situation occurred despite massive development aid spending. The Norwegain Management of Natural Resources Programme (MNRP), for example, spent US$ 60 million over a 12 year period in Tanzania, with up to half of these funds apparently lost through corruption and mismanagement (JANSEN, 2009).

Prior to 2003, when the Mkapa Bridge was completed in Tanzania, poor infrastructure "protected" stocks of valuable hardwoods in southern Tanzania. When the bridge was completed, this enabled a rush for the resource rich frontier, which was rapidly depleted (MILLEDGE et al. 2007). The same happened in 2010 when the Unity ("Umoja") bridge was completed across the Rovuma River, the international boundary between Tanzania and Mozambique (Figure 5). This worsened illegal logging occurs across a very porous border. As SULLE (2013) points out, over 40 unregistered entry points are used to smuggle illegal timber from Mozambique to Tanzania. These are mainly in the Masasi, Nanyumbu, Tunduru, Songea Rural and Nyasa districts of Tanzania. None of these transit points are gazetted. Nor do they have control by the Tanzania Revenue Authority (TRA), immigration, the police service or Tanzanian Forest Service. What makes the situation worse is that the timber trade between Tanzania and Mozambique "*falls partly under the control of a group of unscrupulous forest officials, traders and politicians*" (SULLE, 2013), resulting Tanzania is losing around US$ 4.2 million per year for these districts alone.

4.2 Domestic and cross-border trade

Although this report is focussed on international policy tools such as CITES, EUTR and FLEGT and on timber exports, it is crucial for policymakers to also appreciate the extent of domestic timber demand. An excellent FLEGT funded study recently estimated that in Mozambique in 2012, domestic wood consumption was about 414,000 m³ of logs equivalent per year, 257,000 m³ of logs equivalent of this for urban timber demand, with 7,000 m³ for carpentry from local sawmills, plus an additional 150,000 m³ logs equivalent used in rural areas (FAEF, 2013). Eighty-five percent of this domestic trade was due to trade in timber from *Afzelia quanzensis, Pterocarpus angolensis* and *Millettia stuhlmannii*. In Kenya, stocks of *A. quanzensis* have been heavily depleted to the point that carpenters in Lamu (near the Kenya/Somalia border) told me (in 2012) that when they could get *A. quanzensis*, it was coming from southern Tanzania and Mozambique. The scale of domestic demand in Mozambique was quantified by the recent FAEF (2013) study showing total domestic trade in timber in seven cities was a total of 123,000 m³/year (Figure 8). More than half of this quantity was consumed in Maputo and Matola. Informal sector markets were the points of sale for about 64% of this traded quantity (79,000 m³). Indigenous hardwoods are also extensively used for domestic purposes in Tanzania (Figure 9).

Figure 5. The Unity ('Umoja') bridge over the Rovuma river, looking towards Mtambaswala (Tanzania) from the Negamano (Mozambican) side. Photo: A.B. Cunningham.

During SULLE's (2013) field study, he recorded cases where timber that traders claimed to have originated from Mozambique was accompanied by fake documents supposedly issued by the Mozambique government. Some timber was also said from Mozambique, when in fact it was exploited in the Masasi, Newala and Tunduru districts of Tanzania. Trucks and boats are used at these illegal entry points to transport illegal timber from Mozambique to Tanzania (Figure 1 and SULLE, 2013).

Figure 6. Cross-border "leakage" despite the MOU between Tanzania and Mozambique: *Pterocarpus angolensis* sawn timber from Cabo Delgado being off-loaded from a dhow at Mtwara, Tanzania (Oct 2014). Photo: A.B. Cunningham.

This illegal timber trade is facilitated by corrupt Tanzanian officials, in particular officials involved in tax collection and forest products licensing and inspection (SULLE, 2013). And the financial incentives for illegal cross-border trade in timber are significant, with SULLE (2013) estimating an entrepreneur would earn over (US$ 3,688 [more than TZS 6 million]) in cash for a single truck-load of sawn timber. Some of this illegal cross-border timber trade is also

by sea (Figure 6). Although most of this sawn timber from Mozambique is transported to Dar es Salaam, Tanzania, for use in flooring and furniture, it is also shipped to Zanzibar or to international markets in Asia (India and China).

Figure 7. *Afzelia quanzensis*, Tanzania. **A.** Pitsawing, a laborious but efficient method of cutting planks, is widely used for the local commercial market. Use of chainsaws is far more wasteful. **B.** A small (c.60 yr old) *Afzelia quanzensis* of 33 cm DBH that is well below the minimum legal diameter (of 55 cm DBH) felled with a chainsaw near Sindano village, southern Tanzania (October 2014). Photos: A.B. Cunningham.

4.3 International trade

All three species are traded internationally, over 99% of this as uncertified timber. This is not surprising. Only 0.6% of global forest cover is FSC-certified, most of this in Europe and North America, with just a tiny proportion of this in Africa (GULLISON, 2003). *Afzelia quanzensis* timber is only FSC-certified from a single group certification scheme worldwide. These are the community-managed areas under the Mpingo Conservation and Development Initiative (MCDI) that are certified by the Woodmark (Soil Association) (FSC Licence Code FSC-C0126907). Far more businesses are FSC-certified to log, process or trade in *D. melanoxylon* (Appendix 3) and *P. angolensis* (Appendix 4), but the majority of these are not Range States. For *D. melanoxylon*, for example, only two of the eight countries for which some form of FSC certification is awarded are Range States (Mozambique and Tanzania). With *P. angolensis*, only a single group scheme (the MCDI in Tanzania) represents a Range State, yet there are FSC-certified companies as far apart as Bosnia-Herzegovina ((Jafa-Jase 4 d.o.o in Špionica-Srebrenik) and China (Macrola Home Furniture & Home Decoration (Fujian) Co., Ltd in Fuzhou) that are FSC-100% certified as primary processors (Appendix 4). It is admirable that companies are motivated to get some form of FSC certification. But to the general public, who see the FSC logo, but are not aware of the differences between FSC-100%, FSC-Mix, FSC-Recycled or FSC Chain of Custody (COC) licensing, this can be confusing. FSC certification of *D. melanoxylon* in two Range States provides a good example. In Mozambique, for example, SGS-Qualifor have certified that Mpingo Madeiras Lda fulfills FSC standards with regard to Chain of Custody (COC) under the FSC Controlled Wood certificate category. This specifies that the SQS certificate enables the company „*to process FSC products which are subject to full and complete controls and which originate from forests that are managed in accordance with the principles and criteria of the Forest Stewardship Council*

(FSC)". However, Mpingo Madeiras Lda do not manage any forest production areas. Instead, they purchase logs from Forest Concessions (such as Wood Exports Lda., Panga Lda and Macaloe Lda and from Simple Licence holders (SGS QUALIFOR, 2012). In contrast, the group certification certificate issued to the Mpingo Conservation and Development Initiative (MCDI) by Woodmark (Soil Association) certification represents a different type of certification (FSC-100%) for a group scheme FSC-certified to undertake logging (Appendix 3). But these differences pale into insignificance when non-FSC certified exports are taken into account.

According to SULLE (2013), for example, until the mid-2000s, China's timber imports from Tanzania were mainly in the form of logs. This continued until 2004 when the Tanzanian government banned log exports in favour of value-added sawn timber. It is widely felt that Mozambique needs to do the same, including by Narciso Gabriel (Associacao de Industriais de Madeira de Cabo Delgado [AIMCAD]). Since the Tanzanian moratorium on log exports (Forest Regulations, 2004, Part XV, Section 50(1)), India, rather than China has been the major importer of Tanzanian timber. In 2011, for example, India reportedly imported over US$ 12 million in all wood products from Tanzania whilst China imported only US$ 2.7 million (SULLE, 2013). In contrast, in the same year, China imported over 12 times the value from Mozambique (US$ 154 million) than India did from Tanzania (SULLE, 2013). This is exported from Mozambique in log form or as sawn wood, flooring, veneers or railwaysleepers. Both MACKENZIE (2006) and MACKENZIE & RIBIERO (2009) have drawn attention to the extent of illegal logging for export to Asia and how dysfunctional forestry concession licences processes can be. More recently, EIA (2013) showed that in the same year as the FAEF (2013) study, Chinese companies imported between 189,615 and 215,654 m³ of timber that was unlicensed, so was illegally exported from Mozambique (48% of total imports). What previous studies have not taken into account is the illegal export of timber (mainly *Pterocarpus angolensis* and *Afzelia quanzensis*) across the Rovuma river from Niassa province in northern Mozambique to Tanzania (Figure 1).

Based on official figures, over half the volume of the commercial species harvested in Mozambique is from three species (FAEF, 2013): *Afzelia quanzensis, Pterocarpus angolensis* and *Millettia stuhlmannii* (all Fabaceae), the first two of which are the focus of this report. The third species on which this report concentrates, *Dalbergia melanoxylon*, is considered to be one of the most valuable timbers in the world. *D. melanoxylon* is also logged in significant quantities for export to Asia (mainly as unprocessed logs) or to a lesser extent, in processed form to Europe. Between 80 – 90% of the exported Mozambican timber is shipped as logs to China, primarily through the ports in Guangdong, Jiangsu, Shanghai and Zhejiang. In 2000, the proportion of Africa's timber exports to China was 35%. By 2009, this proportion had grown to 78%, making timber Africa's third largest export commodity after oil and mineral ores (HUANG et al., 2013). In Tanzania, a seminal study by MILLEDGE et al. (2007) documented the extent of illegal logging in Tanzania, recommending that Tanzania consider CITES-listing for several internationally traded timber species as a tool for a more sustainable trade. The species MILLEDGE et al. (2007) suggested for consideration for CITES Appendix II listing were *Osyris lanceolata, Dalbergia melanoxylon, Millettia stuhlmannii, Swartzia madagascariensis* and *Pterocarpus angolensis*. In all three countries, commercial woodcarvings are also an export commodity (Figure 10), as most carvings are exported either directly or by tourists, usually to Europe, North America and South Africa, so this is an interesting policy issue in relation to EUTR. In the USA, for example, it could bring the Lacey Act into conflict with the US governments African Growth and Opportunity Act (AGOA) trade agreement.

In Mozambique, due to the combination of growth in domestic demand for timber plus exports, the annually harvested volume has also shown tendency to increase from 413,000 m³ in 2007 to approximately 727,000 m³ of logs equivalent in 2012 (FAEF, 2013). Based on the extent of illegal logging in Mozambique, this total is likely to be much higher.

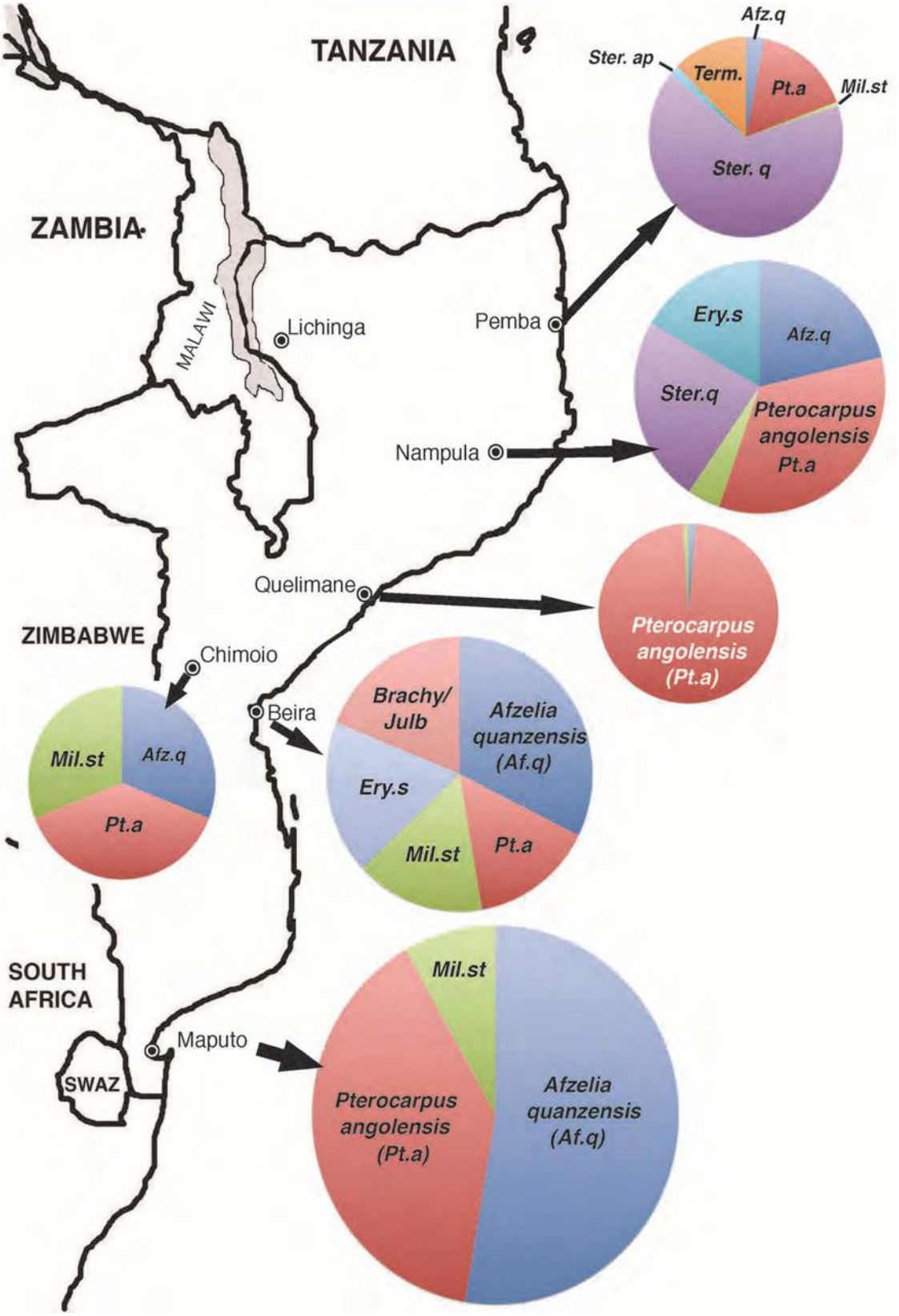

Figure 8. Domestic trade in timber at local marketplaces across Mozambique, showing the high proportion of *Pterocarpus angolensis* (*Pt.a*) and *Afzelia quanzensis* (*Afz.q*) being sold (redrawn and modified from FAEF, 2013). *Brachy/Julb. = Brachystegia/Julbernadia*; *Ery.s = Erythrophleum suaveolens; Mil.st = Millettia stuhlmannii; Ster.ap = Sterculia appendiculata; Ster.q = Sterculia quinqueloba; Term = Terminalia species.*

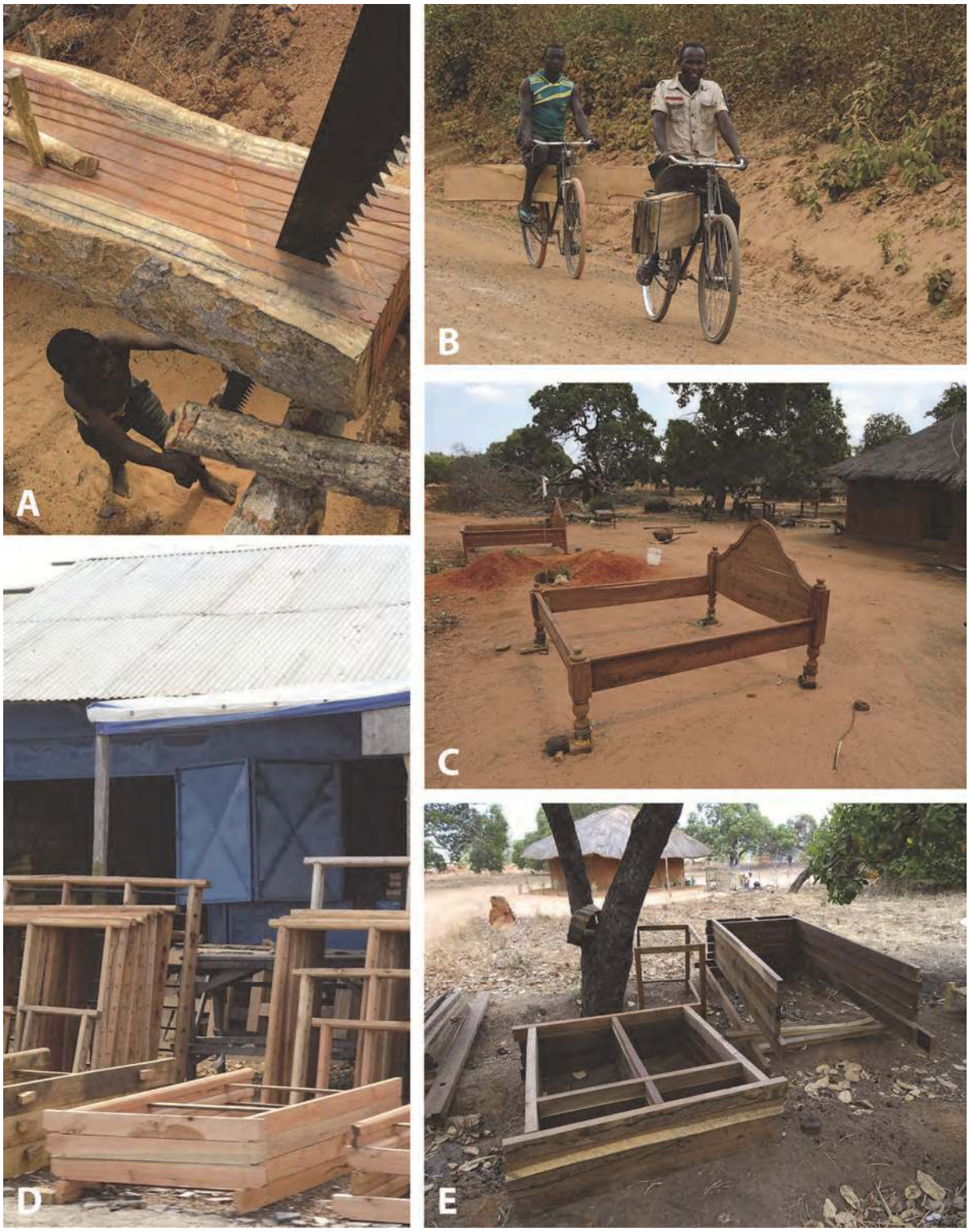

Figure 9. The scale and collective impact of domestic timber harvests by small scale loggers using pit-saws or chain-saws over large area of miombo woodland should not be underestimated. A. Pitsawing *Afzelia quanzensis* (Tanzania). **B.** Bringing *Pterocarpus angolensis* planks to the Mtwara market. **C.** Local value-adding for furniture is better than exporting unprocessed logs to Asia. **D.** When local hardwoods are over-exploited and become too costly, pine plantation timber from Tanzania is used as an alternative (Mombasa, Kenya). **E.** Door and window frames for local housing made from *P. angolensis* (Tanzania). Photos: A.B. Cunningham.

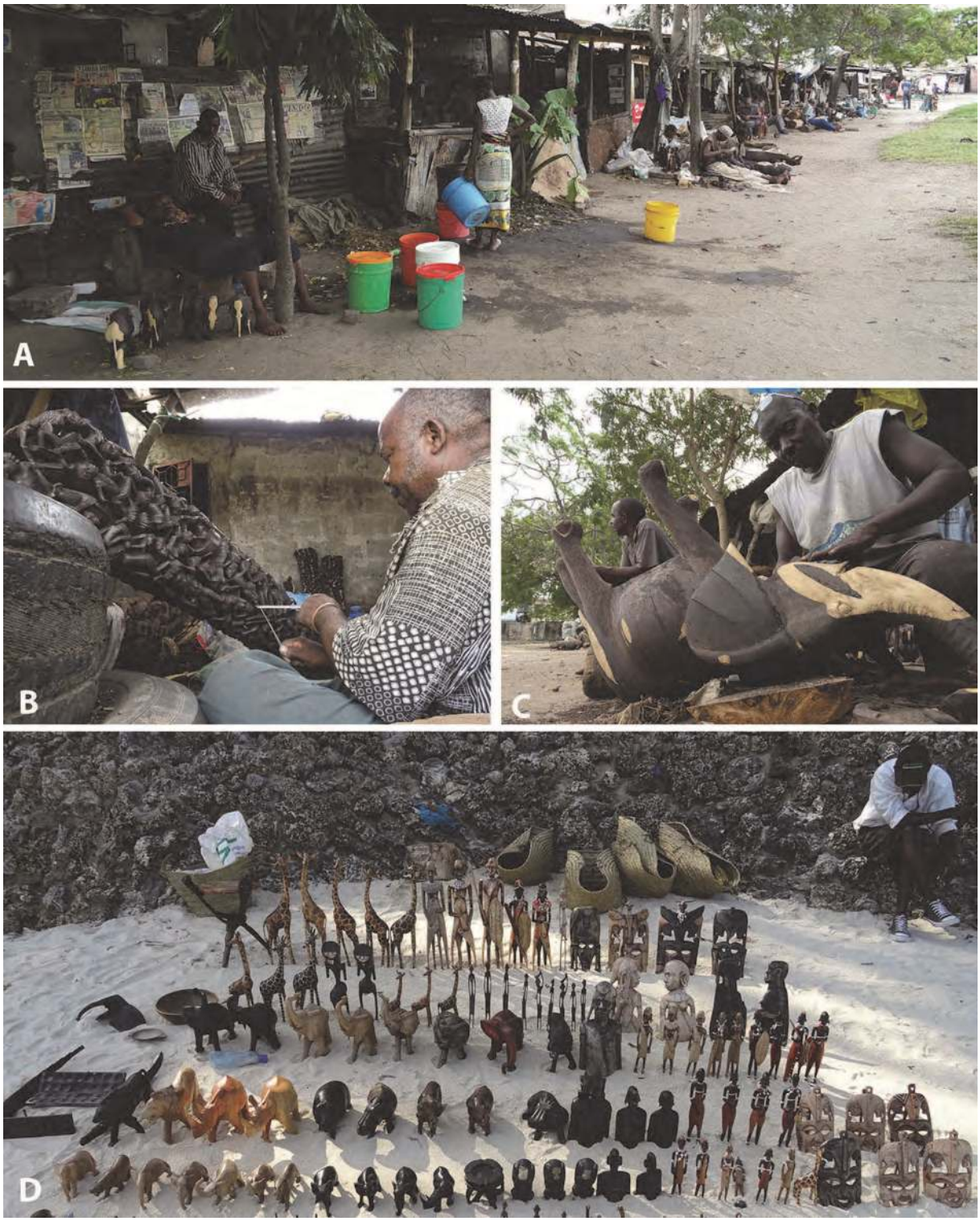

Figure 10. The commercial scale and impacts of woodcarving enterprises should not be underestimated. A. Carvers of *Dalbergia melanoxylon* at Mwenge market, Tanzania. **B.** and **C.** *D. melanoxylon* carvers in Dar es Salaam, Tanzania. **D.** Mombasa, Kenya: carvings from *Brachylaena huillensis, Dalbergia melanoxylon* and the introduced species, *Azadirachta indica*. Photos: A.B. Cunningham.

4.4 *Afzelia quanzensis* WELW.

4.4.1 Taxonomy

Afzelia quanzensis Welw. (THE PLANT LIST, 2013)

4.4.2 Synonyms

Afzelia quanzensis (synonyms: *A. cuanzensis* sensu auct., *Pahudia quanzensis* (Welw.) Prain; *Instsia quanzensis* (Welw.) Kuntze and *Afrafzelia quanzensis* (Welw.) Pierre)).

4.4.3 Trade names for *A. quanzensis*

The most common trade names for *A. quanzensis* timber are pod mahogany or Rhodesian mahogany (in South Africa and Zimbabwe), peulmahonie (Afrikaans, in Namibia and South Africa), mbambakofi (in kiSwahili, the trade language used for this species in Kenya, Tanzania and northern Mozambique) or chanfuta (Mozambique) (BEENTJE, 1994; PALMER & PITMAN, 1972). Other names used are the Lucky bean tree (English), doussié (French), uvala and mussacossa (Portuguese).

4.4.4 Names for *A. quanzensis* in African languages

In southern Africa, *A. quanzensis* is known as inKehli (for the seeds only, which are medicinal), umhlavusi, or umshamfuthi (isiZulu); umkholikholi (siSwati); mukamba (Sarwa); nxenhe (Tsonga); mutkota (chiVenda); umkamba (isiNdebele); mugogoma (chiTonga); mugoriondo, mujarakamba, mukamba, mungwingwi (viShona). In East Africa, *A. quanzensis* is known as nkongo (chiYao); mbambakofi, mukambakusi and mkonge (kiSwahili).

4.4.5 Distribution

In terms of habitat, *Afzelia quanzensis* is one of the exceptions in the genus *Afzelia*. *Afzelia* species are found in both Africa (7 species) and South-east Asia (4 species), with most African species occurring in moist tropical Guineo-Gongolian forests (LEWIS et al., 2005). In contrast to the genera *Dalbergia* and *Pterocarpus*, where new species have been discovered recently, no new *Afzelia* species have been described since the 1950's. The focal species in this report, *A. quanzensis* is one of the two African species (the other species being *A. africana*) that extend into savanna systems. *A. quanzensis* also occurs in coastal dune forests from Kenya southwards through Mozambique to north-eastern KwaZulu/Natal, South Africa.

Of the three focal species in this report, *A. quanzensis* has the more limited distribution, occurring in scattered populations in Zambezian woodlands, in a few wetter patches of Somali-Masai scrub forest (such as the northern slopes of the West Usambara mountains, Tanzania) and in forests and woodlands of the Zanzibar-Inhambane southwards to the northern part of the Tongaland-Pondoland regional mosaic in southern Mozambique and KwaZulu/Natal, South Africa.

Figure 11. Map showing the African distribution of *Afzelia quanzensis* (redrawn and combining distribution data from the African Plant Database initiative (http://www.villege.ch/musinfo/bd/cjb/africa/help.php?langue=an) and other sources (CURTIS & MANNHEIMER, 2005).

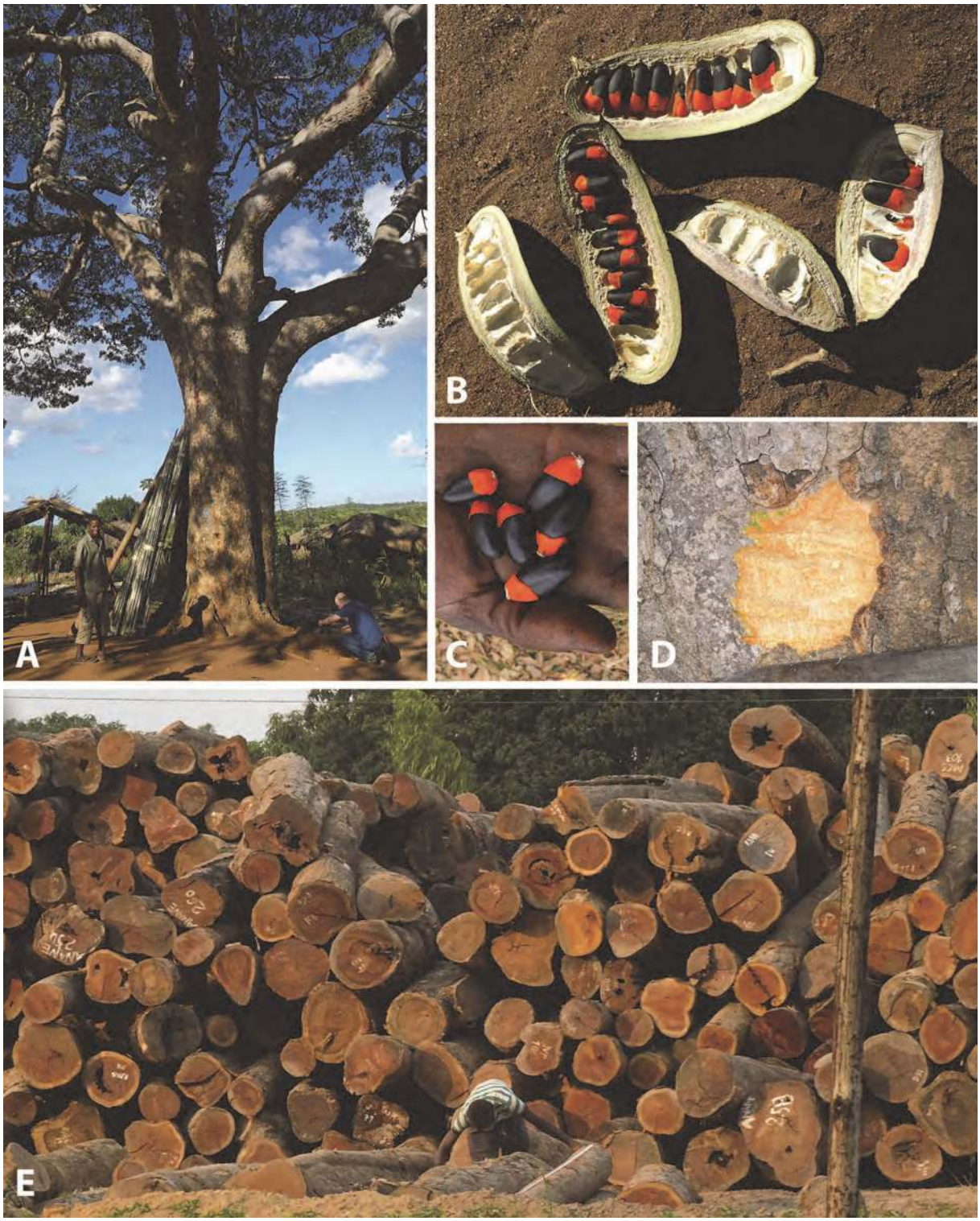

Figure 12. A. A large *Afzelia quanzensis* conserved for shade at a roadside sale point in Cabo Delgado, Mozambique. Trees of this size are now rare. **B.** *A. quanzensis* pods. **C.** Characteristic *A. quanzensis* showing the red arils eaten by seed dispersers such as hornbills. **D.** Bark slash showing underbark of *A. quanzensis*. **E.** Chinese run logging yard near Dondo, Sofala, Mozambique showing a worker measuring *A. quanzensis* with a mix of *Guibourtia conjugata* and a few *A. quanzensis* logs behind him, ready for packing into containers for export to China (Sept 2014). Photos: A.B. Cunningham.

Table 2. Summary of the distribution and conservation status of *A. quanzensis* across all Range States. The largest *A. quanzensis* populations are in Angola, Mozambique, Zambia and Zimbabwe.

Range state	Status of *A. quanzensis* populations and current threats
Angola	Large populations may occur in Angola, for example in SE Angola, with significant populations along the Cuando river. These were badly affected by illegal logging during the Angolan war (1975 – 1992) largely due to commercial logging associated with the South African Defence Force. Parts of this area have land-mines and no studies on the effects of this logging on *A. quanzensis* have been done.
Kenya	Distributed along the higher rainfall coastal area, where major habitat loss has occurred over the past century due to agricultural transformation. Long history of logging for dhow construction as *A. quanzensis* wood is resistant to marine wood-worms. There is a significant population in Arabuko-Sokoke forest (BEENTJE, 1994), but poaching of valuable hardwoods for the commercial woodcarving is prevalent, including inside Arabuko-Sokoke and other "protected" areas. Also in demand for furniture making, dhows and doors of Swahili style houses (e.g: Lamu and Shela). Trade for this timber for carpentry in Kenya now extends southwards as far as northern Mozambique.
Malawi	Listed as **Vulnerable A1acd**. Over-exploited for its high quality timber (GOLDING, 2002).
Mozambique	Listed as **Lower risk, not threatened**. Used locally for grain stamping mortars, dugout canoes and woodcarving. One of three main timber species commercially logged in Mozambique (GOLDING, 2002). Since that assessment was done, there has been a huge increase in timber exports and growth in domestic demand for *A. quanzensis* timber. Mozambique is now the sixth most important African timber supplier to China and since the main exporter supplier of timber from African dry forests and woodlands (CANBY et al. 2007; JANSEN & KIALA 2009). *A. quanzensis* (along with *Pterocarpus angolensis* and *Millettia stuhlmanii*) are the three species that are logged in the highest volume in Mozambique. Over the last 6 years, with 727000 m³ of logs exploited in 2012, of which 414000m³ consumed domestically (FAEF, 2013). FAEF (2013) concluded that consumption of these three species in urban areas exceeded the maximum annual allowable cut in 2012 and the total harvested volume has exceeded the maximum annual permitted cut since 2011. Illegal logging is a major problem (EIA, 2013; MACKENZIE, 2006; MACKENZIE & RIBEIRO, 2009).
Namibia	Rare in Namibia, only found in a small area of the East Caprivi (Katima Mulilo southwards to the Chobe river and east to Mpalila island) with no conservation concerns (CURTIS & MANNHEIMER, 2005).
Somalia	Remnant population may be on the coast of southern Somalia. Likely to have been heavily impacted in the past due to demand for furniture.
South Africa	*A. quanzensis* reaches its southern most limit in the Maputaland area of KwaZulu/Natal, where the largest populations are in Sand forest, including in the Tembe Elephant Reserve. Heavily exploited in the past for railway sleepers, but now a nationally protected species. Highly valued for carving, including grain stamping mortars.
Swaziland	In forest patches in the Lebombo mountains.
Tanzania	Minimum diameter for harvesting in Tanzania is 55 cm, but in many cases, this is ignored (e.g: MILLEDGE et al., 2007).
Zambia	Widespread, popular for grain stamping mortars, commercial carving and timber.

Range state	Status of *A. quanzensis* populations and current threats
Zimbabwe	Red listed as "**Lower Risk-least concern (LR-lc)"** (Golding, 2002). Since then, hyper-inflation in Zimbabwe and the need for hard currency have driven extensive felling for trade in *A. quanzensis carvings* (such as hippos) to South Africa. One of the main species used in the past for railway sleepers, paneling (e.g: in the old Rhodesian railways carriages), flooring, furniture and as battery separators (as the wood withstands corrosive chemicals) (GOLDSMITH & CARTER, 1992). A highly favoured wood for grain stamping mortars, with a range of diameter sizes commercially carved for local sales and large-scale export to South Africa. Commercially logged since at least the 1950's. Due to its commercial value, it has disappeared from conservancies such as Middle Save conservancy that have been the focus of "re-settlement schemes" (CHIBISA et al., 2010).

4.4.6 Habitat and role in ecosystem

Afzelia quanzensis trees occur in a range of habitats in East Africa, ranging from coastal forests (such as Arabuko-Sokoke forest, Kenya) and the Dune forests of the Mozambique coastalplain through to miombo woodlands. *A. quanzensis* trees play an important role in the forests and woodlands in which they occur, not only as habitat for other species, but also as food sources for animals and indirectly, due to the association of *A. quanzensis* with ecotomycorrhizal (ECM) fungi, that are gathered as food by local people (Figure 37). In common with several tropical African Caesalpiniodae, this ecomycorrhizal role is significant (BÂ et al., 2012), not only for *A. quanzensis* growth (BÂ et al., 2002; DIÉDHIOU et al., 2005) but possibly also through the below-ground effects of nutrient fixation (such as of phosphorus) in nutrient poor landscapes. These physiological influences of the ECM symbiosis may be an advantage to growth of African trees during the dry season. An additional value of *A. quanzensis* is that their seeds are adapted to dispersal by birds (particularly hornbills) that are attracted by the red arils and are also eaten by baboons, monkeys and squirrels. In a study in Arabuko-Sokoke forest, Kenya, GATHUA (2000) showed that baboons and squirrels are seed predators while monkeys are seed dispersers of *A. quanzensis*.

4.4.7 Ecology and population dynamics

Very few studies have been done on population structure of *A. quanzensis*, but GERHARDT & TODD (2009) showed that few seedlings made the transition to the juvenile tree stage. Growth rates of *Afzelia quanzensis* (GAUGRIS et al., 2008) and *A. xylocarpa* (BAKER et al., 2005) both range from 2-3mm/yr. Recruitment failure – even in the absence of logging that cuts down the reproductively mature trees – is a major challenge to *Afzelia* populations. In the case of *A. xylocarpa*, for example, the oldest trees were at least 257 yrs old and that no *A. xylocarpa* in the populations studied were less than 135 yr old. Unlike *Pterocarpus angolensis*, where a study has been done projecting the effects of climate change on *P. angolensis* populations, similar studies have not been done of *A. quanzensis*. Based on field observations and available research, however, I suggest that *Afzelia quanzensis* may be even more vulnerable than *P. angolensis* to climate change. The reasoning behind this suggestion is two-fold. Firstly, like *P. angolensis, A. quanzensis* sheds its leaves early on in the dry season in response to water-stress. Secondly, the evolutionary origins of the genus *Afzelia* are in African moist tropical forests (LEWIS et al., 2005) and only two African species (*A. quanzensis* and *A. africana*) have extended their range into seasonally dry woodlands, where they are limited by water stress.

4.4.8 Regulations and management

Through much of the range of *A. quanzensis*, there is a massive gap between legal protection and what really happens on the ground. This gap is wider than ever before, despite the governments of Kenya, Mozambique, Tanzania all being signatories to the Yaounde Ministerial Declaration (2003) on African Forest Law Enforcement and Governance (AFLEG). Three years later, MACKENZIE (2006) gave compelling evidence on the gap between rhetoric and reality, pointing out how the Government of Mozambique *"– and by association – the donors who support it, have thus far failed to deliver*" on commitments made at the 2003 AFLEG meeting. Similarly, nine years later, AKIDA et al. (2012) reported that "*Tanzania has yet to review and implement the Indicative List of Actions arising from the AFLEG Ministerial Conference*". A series of studies since then have continued to document this "implementation gap" (e.g: RIBEIRO & NHABANGA (2009); EIA (2013), EIA (2014a), FAEF (2013) and SITOE et al. (2014)).

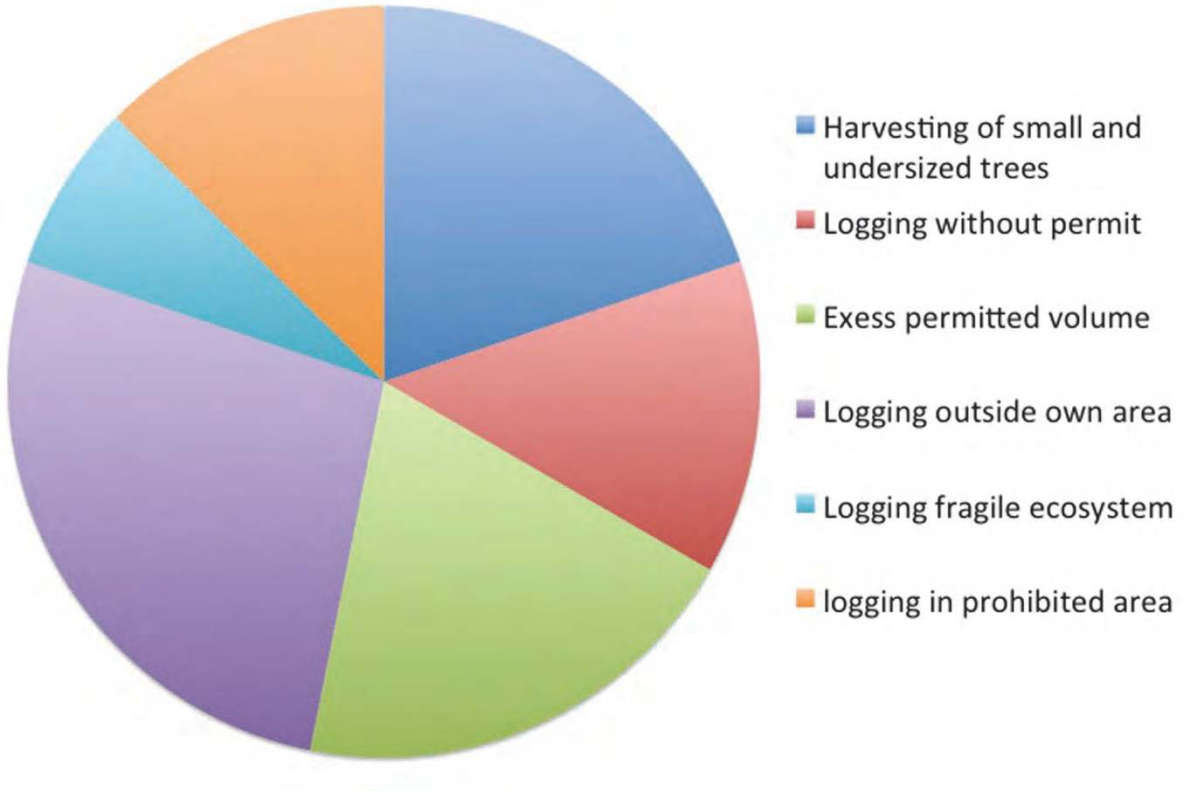

Figure 13. Types of illegality followed in the process of logging *A. quanzensis* in Mozambique (redrawn from FAEF, 2013).

Similarly in South Africa, where *A. quanzensis* is listed a protected tree species, and where section 15(1) of the National Forests Act, 1998 states that "*no person may cut, disturb, damage or destroy any protected tree; or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree or any product derived from a protected tree, except under a licence or exemption granted by the Minister of Agriculture, Forestry and Fisheries*". In practice, felling of *A. quanzensis* regularly occurs without any license to do so due to the value of this species for commercial carvings, timber and grain stamping mortars.

In Mozambique, where commercial logging takes place through licenses for forest concessions or through smaller scale “simple licenses”, a variety of methods for breaking regulations for logging *A. quanzensis* is common (Figure 13).

4.4.9 Use of the species and demand

Wood from *Afzelia quanzensis* plays a crucial role in local livelihoods. Throughout its range, *A. quanzensis* wood is highly favoured for carving grain stamping mortars, which are essential for processing the grains (maize, millet, sorghum) which form the starchy staple diet in East and southern Africa. Furthermore, due to its durability in water, *A.quanzensis* logs are either carved into dug-out canoes or along the East African coast, from Somalia, Kenya and southwards to Mozambique, are used at the most favoured planks for making dhows. Just as *Instia bijuga* (formerly *Afzelia bijuga*) was described as the strategic resource of the South Pacific, as it enabled the Tongan kingdom to expand trade and political influence (BANACK & COX, 1987).

Figure 14. Use of *A. quanzensis* in East Africa. A & B. Planting for the dhows that are important in small-scale coastal trade and **C.** Historically, for construction of doors in the Swahili style architecture of wealthy traders.

Similarly, *A. quanzensis*, with similar chemical properties in the wood that confer durability in the sea has been the strategic resource for the dhows of East Africa’s Swahili traders and fishermen (Figure 14). *A. quanzensis* also is a favoured timber for making the magnificent doors that characterize houses of Swahili coastal trading towns of Lamu, Mombasa and Shela (Kenya) and Zanzibar (Tanzania). Although the oldest doors in some houses in Zanzibar’s Stone Town were constructed for wealthy Omani Arabs out of teak (*Tectona grandis*) by specialist woodcarver from Gujarat in India, door construction shifted to doors from *A. quanzensis. A. quanzensis* also is a favoured woods for high quality furniture made by Swahili carpenters in coastal East Africa. Finally, in addition to these uses of the wood, *A. quanzensis* is the source of mycorrhizal fungi gathered to supplement the starchy staple diet, of medicinal bark and symbolically important seeds.

4.4.10 Look-alike issues with other hardwoods

As discussed in above, several *Afzelia* species are traded from Africa. In addition to export of *Afzelia quanzensis* from East Africa (mainly Mozambique and Tanzania), timber from *Afzelia africana* and *Afzelia bella* is exported from West Africa and *Afzelia bipindensis* and *Afzelia pachyloba* timber is exported from Central Africa. In addition, without careful examination, there may be confusion with timber from merbau (*Intsia bijuga*) (formerly *Afzelia bijuga*) also known as Borneo teak or Moluccan ironwood, which is exported from South-east Asia and New Guinea (G. Koch, in lit. 30.04.2015).

4.5 *Dalbergia melanoxylon* GUILLENIN & PERROTETT

4.5.1 Taxonomy

Dalbergia melanoxylon GUILLENIN & PERROTETT (THE PLANT LIST, 2013)

4.5.2 Synonyms

Amerimnon melanoxylon (GUILL. & PERR.) KUNTZE, *Amerimnon stocksii* (BENTH.) KUNTZE and *Dalbergia stocksii* BENTH. (THE PLANT LIST, 2013)

4.5.3 Trade names for *D. melanoxylon*

Confusion over trade names started thousands of years ago, continuing into the present day. Over 4000 years ago, *D. melanoxylon* (and possibly also *Diospyros mespiliformis* (DIXON, 1961)), were traded into Egypt from further south in what were then termed Nubia and Punt, with the Egyptian name, hbny. The English word ebony, used as a common name for both *D. melanoxylon* (Senegal ebony, Sudan ebony) and several *Diospyros* species (Ebenaceae) is derived from this Egyptian word (hbny). The most common trade names are African blackwood, African grenadillo, African ironwood, zebra wood (En), sebrahout (Afrikaans), Grenadille d'Afrique, ébénier du Sénégal (French), Grenadilha, grenadill, pau preto (Portugese for black wood), African ebony, Senegal ebony, Sudan ebony, Mozambique ebony (Table 3) and in East Africa, mpingo (kiSwahili).

Table 3. Trade names applied to *D. melanoxylon* have been a source of confusion for centuries.

Trade name	Species to which the trade name refers
Blackwood	*Dalbergia melanoxylon (African blackwood);* Australian or Tasmanian blackwood (*Acacia melanoxylon*), which is also cultivated and commercially used in South Africa as a subsititute for *Ocotea bullata* (black stinkwood); Bombay blackwood or Indian blackwood (*Dalbergia latifolia).*
Ebony	Although *Dalbergia melanoxylon* is the original ebony (derived from the Egyptian word **hbny**). This gave rise to the trade names African ebony, Senegal ebony, Sudan ebony and Mozambique ebony for *D. melanoxylon.* However, as the term ebony was later applied to *Diospyros* species, particularly D. *ebenum* (Ebenaceae), this created confusion. There is also potential confusion with American or Jamaican ebony (*Brya ebenus),* black ebony (*Euclea pseudebenus),* which also occurs in southern Africa*;* Bombay ebony (*Diospyros muntana)*; Cape ebony (*Heywoodia lucens),* ebony heart (*Elaeocarpus bancroftii),* Macassar ebony (*Diospyros celebica),* Madagascar ebony (*Diospyros haplostylis).*
Grenadille, grenadilha or grenadill	Here these is potential confusion with the related South American species *Dalbergia granadillo*, as trade names used for *D. melanoxylon* are grenadille d'Afrique, grenadilha or grenadill.
Zebrawood	The trade name zebrawood is given to several species in a range of families, all of which has black heartwood and white sapwood. In addition to *Dalbergia melanoxylon*, this is applied to *Astronium fraxinifolium (*Anacardiaceae) from the neotropics*, Centrolobium robustum* (from South America), *Diospyros* species (Africa and Asia) and *Microberlinia brazzavillensis* (African zebrawood, zebrino, zingana) from the Congo basin.

4.5.4 Names for *Dalbergia melanoxylon* in African languages

D. melanoxylon (Figure 15) is known in southern Africa as driedoring ebbehout or swart driedoring (Afrikaans), umphingo (isiZulu), xilutsi and xipalatsi (xiTsonga), mokelete (seTswana); muhuluri (chiVenda); murwiti, mugweze, muhati, mukudziti, mumhingwe, munhowe (viShona); umbambangwe (siNdebele); mufulamamba (chiTonga) and chilutsu (Hlengwe) (PALMER & PITMAN, 1972).

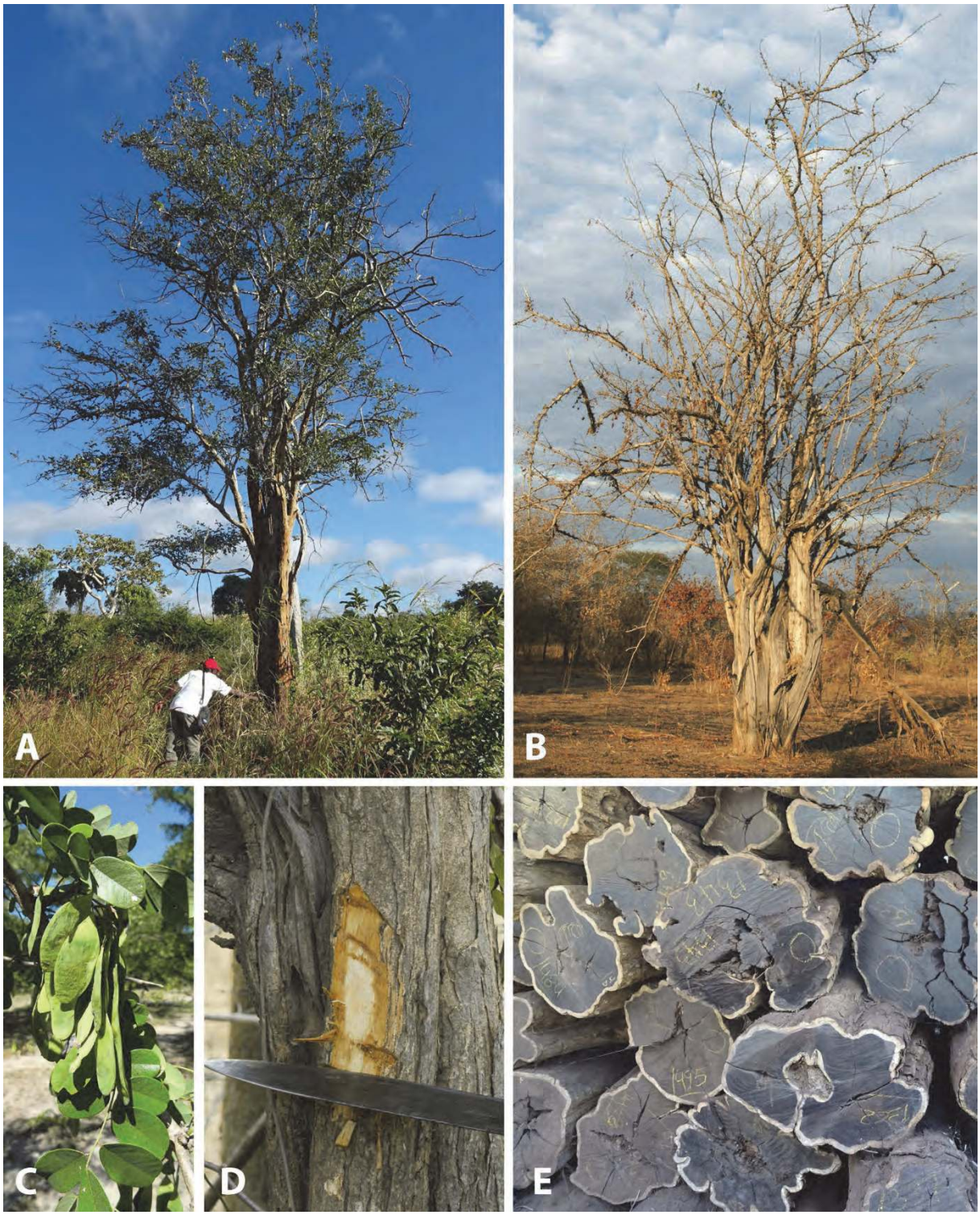

Figure 15. A. A large *D. melanoxylon* in Cabo Delgado, Mozambique with leaves at the end of the rainy season. Trees of this form and size are rarely seen outside of moist coastal Mozambique, Tanzania and before they were totally overharvested, coastal Kenya. **B.** *D. melanoxylon* typically leaf-less during the dry season (Niassa, Mozambique). **C.** Fruits and leaves. **D.** Bark slash showing relatively thin bark for a tree of fire prone woodlands and savannah. **E.** Logs showing how each log has a unique flutred cross-section that can enable local "tracking" of illegally cut logs.

In East Africa, *Dalbergia melanoxylon* is known as mpingo (kiSwahili and Digo), mvingo (kiKamba), munyingo (Taita), mwengo (Meru) and humbolanguluwe (Digo). In West Africa, it is known as asango (Arabic, used in Senegal), bab-a-nouss (Arabic, used in Niger), tabum (Hausa), keledenne (Dogon), dialambane (Manding-Bambara); ndelemban (Wolof) and fara-kaykay (Maninka) (BURKILL, 1995).

4.5.5 Distribution

Figure 16

Figure 16. Map showing the African distribution of *Dalbergia melanoxylon* (redrawn and combining distribution data from the African Plant Database initiative (http://www.villege.ch/musinfo/bd/cjb/africa/help.php?langue=an) and other sources (CURTIS & MANNHEIMER, 2005).

Table 4. Summary of the status of *D. melanoxylon* across all Range States. The largest remaining *D. melanoxylon* populations, with large trees that are in the highest commercial demand are in Mozambique and Tanzania.

Range state	Status of *D. melanoxylon* populations and current threats
Angola	Small trees in miombo woodlands in south-eastern Angola (Cubango).
Botswana	Scattered in Northern and NE Botswana, adjacent to the Zimbabwe border (SETSHOGO & VENTER, 2003).
Central African Republic	No information available.
Chad	Recorded as intensively exploited in West Africa, becoming "less and less common in some areas" (ARBONNIER, 2004).
Cote d'Ivoire	No information available.
Democratic Republic of Congo	Occurs in savanna woodlands in Kasai, Upper Katanga and around Lake Albert.
Ethiopia	In Tigray and Gonder, along the border with Sudan.
Eritraea	No information available.
Burkina Faso	Recorded as intensively exploited in West Africa, becoming "less and less common in some areas" (ARBONNIER, 2004).
Kenya	Proposed for CITES App. II listing by Kenya in 1994, but then withdrawn. Population declines due to overexploitation (BEENTJE, 1994). Destructive use in Kitui, Kwale and Makueni has included digging up the roots to make tall thin carvings (Maasai figures). Illegal exploitation from forest reserves such as Arabuko-Sokoke forest for commercial carvings. Some woodcarvers say that a few large trees are available in remote areas of Kitui (such as Bitini) (pers.comm., to TC, Oct 2014). Most carvers now buy their *D. melanoxylon* wood from traders who cross the border from Tanzania, particularly at Lunga-Lunga border post. The wood is now so highly valued that even the smallest pieces are used (to make keyrings and wooden beads for necklaces).
Malawi	Assessed as **Endangered (EN A2cd),** but is not protected by any national laws (KAMUNDI 2000), but downgraded to **Vulnerable (VUA1abcdB1B2abce)** in GOLDING (2002). Based an assumed generation time of 15-30 years (which is likely to be an underestimate, given the slow growth rates and long life-span of this species), KAMUNDI (2000) estimated a 30% range decline over the past 45-90 years and a projected decline of 50% of the next 45-90 years. Habitat loss and commercial woodcarving are the main factors influencing decline. Since the 1980's there has been a cross-border trade in *D. melanoxylon* from Mozambique to Malawi (pers. obs, 1987).
Mozambique	In the 1960s it was recorded as being rare due to intensive exploitation, whereas it had previously been abundant in Mozambique (GOMES e SOUSA, 1966). JENKINS et al. (2002) were less concerned about future supplies from Tanzania and Mozambique, for the music industry, as quantities exported have remained relatively constant. The biggest concern is the massive increase in exports to Asia, particularly China.
Namibia	Only occurs in the East Caprivi. No conservation concerns (CURTIS & MANNHEIMER, 2005).
Nigeria	Occurs in northern Nigerian savanna (Kano, Bauchi, Bornu).
Senegal	Recorded as intensively exploited in West Africa, becoming "less and less common in some areas" (ARBONNIER, 2004).

Range state	Status of *D. melanoxylon* populations and current threats
South Africa	Most trees are small, with poor form from a commercial timber perspective.
South Sudan	Occurs in Upper Blue Nile state. Area currently in conflict, so no updated information, although increased investment in South Sudan by China may stimulate greater commercial trade in *D. melanoxylon* wood.
Sudan	Occurs in River Blue Nile state and South Kurdofan state. The 1994 CITES App. II submission noted that *D. melanoxylon* was "*considered threatened and its range is retreating southwards due to exploitation for fuelwood, furniture, and carvings".*
Tanzania	Commercial sawmilling started under German colonial rule in the 1900's, continuing under British rule after the First World War. In the 1930's, *D. melanoxylon* was considered plentiful (GRANT, 1934). 25 years ago, HALL (1988) noted rapidly depletion of large trees and little regeneration, although OPULUKWA et al. (2002) recording good regeneration near Nachingea. Export of unprocessed logs from Tanzania was banned in 1993. Export values of carvings is increasing to be close the value of sawn timber (WEST & MALUGU, 2003). The development of FSC certified *D. melanoxylon* production in Tanzania for the music industry market is a positive development (BRIDGLAND & HARRISON, 2008). Salvage rates for sawn timber are low (as low as 4-6%), or put in another way, 96% of the total wood biomass is wasted.
Uganda	Occurs in low altitude savanna in Acholi, Bunyoro, Karamoja, Madi, Mbale and West Nile districts (EGGELING & DALE, 1952). Used locally for carving. The 1994 CITES App. II application noted that exploitation had reduced population numbers in some districts. Current population status and trends are unknown.
Zambia	Listed as **Vulnerable (VUA1d)** (GOLDING, 2002) despite being widespread in southern Zambia. Some of the tallest trees are on termite mounds on the Kafue Flats, but generally trees are small (M. Bingham, pers. comm, 2014).
Zimbabwe	Listed as Low risk, not threatened **(LR-nt)**, (GOLDING, 2002) due to widespread distribution, coppicing habitat, good recruitment and low level of exploitation in Zimbabwe. Most trees are small, with poor form from a commercial timber perspective. Used for traditional snuff containers and small carvings.

4.5.6 Habitat and role in ecosystem

Almost all mature *D. melanoxylon* trees are hollow, providing habitat for a range of animal species from snails and reptiles to small mammals. The impact of logging on animals is unstudied, however.

4.5.7 Ecology and population dynamics

Although no national inventories have been carried out for *D. melanoxylon*, localized inventories have been done by OPULUKWA et al. (2002), BALL (2004) and BALL & GREGORY (2006). After an inventory in the area exploited by the Dubai Blackwood Enterprise Sawmill since 1945 for export to Japan and the UK, OPULUKWA et al. (2002) noted that it was now very hard to find *D. melanoxylon* trees of a harvestable size and with reductions in the number and volume of trees due to excessive exploitation. Quantitative studies have also been done over many years by the Mpingo Conservation project. GREGORY et al. (1999) suggested that stocks were being depleted. BALL & GREGORY (2006)'s inventory in the Kilwa district showed that a high proportion of trees were cut below minimum DBH. BALL (2004) sums up the situation well, suggesting that *D. melanoxylon* "*is not in any immediate danger of biological extinction, but illegal harvesting, land clearance, and poor fire management could make it commercially unviable in the near future*".

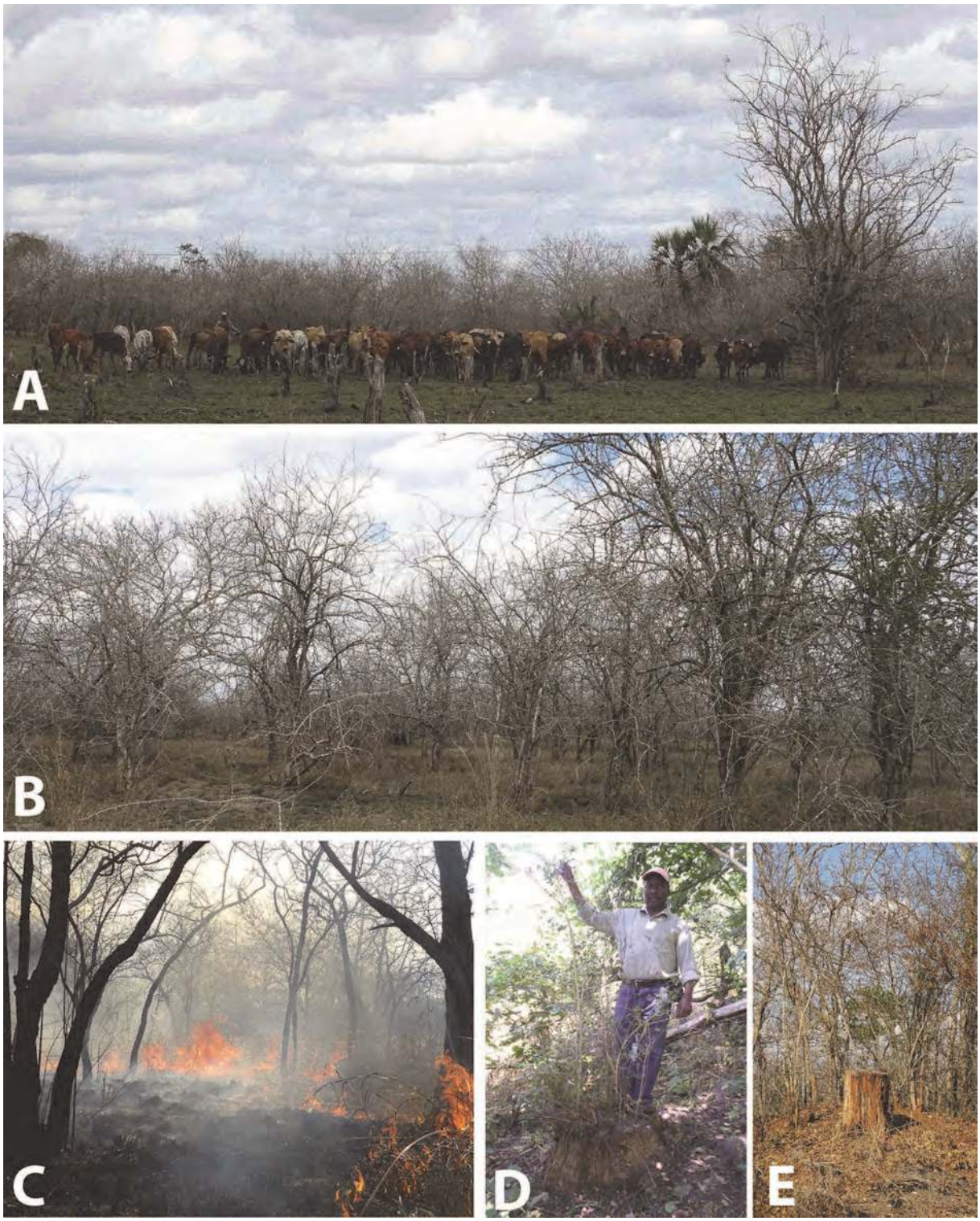

Figure 17. ***Dalbergia melanoxylon*** **at a landscape level. A.** *D. melanoxylon* prefers clay rich alluvial soils and termitaria, with excellent recruitment of seedlings in the absence of fire. **B.** Dense *D. melanoxylon* stands creamed of large trees on the old floodplain of the Pungwe river, Sofala, Mozambique. **C**. Small seedlings are killed by hot fires until they are tall enough to escape the “fire trap”. **D.** *D. melaonoxylon* can be a vigorous resprouter (Mozambique), but systematic monitoring is needed on the survival rates of resprouts when not protected from fire and browsing animals. **E.** A cut stump on a termitarium that has died with no resprouts (Tanzania). Photos: A.B. Cunningham, with the exception of D (Mpingo Madeiras, with permission).

4.5.8 Regulations and management

D. melanoxylon is legally considered a Madeira Preciosa ("precious wood") in Mozambique, with a minimum legal size for commercial logging of 20 cm DBH (REPÚBLICA DE MOÇAMBIQUE, 2002) The minimum legal size for commercial logging in Tanzania is 24 cm DBH (MILLEDGE et al., 2007).

4.5.9 Use of the species and demand

International demand for *D. melanoxylon* is from three sources: (a) global demand for musical instruments; (b) Chinese demand for reproduction furniture and (c) international demand for African woodcarvings (formally exported and bought in country, then exported by tourists).

4.5.10 Look-alike issues with other hardwoods

D. melanoxylon is a very distinctive, dense wood that unlike some other *Dalbergia* species, has few "look-alike" issues. Microscopic identification is nonambigous (G. Koch, in lit. 30.04.2015).

4.6 *Pterocarpus angolensis* DC.

Africa has the highest diversity of the world's 35 – 40 *Pterocarpus* species (21 species of which are in Africa). *P. santalinoides* occurs both in West Africa and is widespread in the neotropics (LEWIS et al., 2005). In total there are twelve *Pterocarpus* species in the neotropics, including *P. monophyllus*, which was described in 2004 from collections in Bahia/Brazil (ROCHA et al., 2004) and *P. dubius*, which until 2013 was placed in the mono-specific genus *Etaballia dubia* (KLITGÅRD et al., 2013). Just as the Asian *Pterocarpus indicus* is the most economically valuable legume timber species in terms of the total value of the logs and sawnwood (LEWIS et al., 2005), so *P. angolensis* is the most widely logged timber species in southern Africa (VON BREITENBACH, 1973; DE CAUWER et al., 2014). *P. angolensis* is currently listed on the IUCN Red List as "Lower risk/near threatened" (WORLD CONSERVATION MONITORING CENTRE, 1998b), in part due to its wide geographic distribution (Figure 19).

4.6.1 Taxonomy

Pterocarpus angolensis DC. (THE PLANT LIST, 2013)

4.6.2 Synonyms

Pterocarpus bussei HARMS., *Pterocarpus dekindtianus* HARMS., or *Pterocarpus dekindtianus* var. *latifoliolatus* DE WILLD. (THE PLANT LIST, 2013)

4.6.3 Trade names for *P. angolensis*

African teak, South African teak, kiaat, dolf, dolfholz, bleedwood, bloodwood, African bloodwood, mukwa, muninga, mninga and umbila. Some of these trade names can cause confusion, not only because of sharing the same but also for having similar markets or end products. "Bloodwood", for example, is also used for two species in the Moraceae, *Brosimum paraense* (endemic to the Peruvian Amazon) and *B. rubescens* (which is more widespread in the neotropics). These species have crimson red wood used in furniture as well as for inlay on guitars and other stringed instruments.

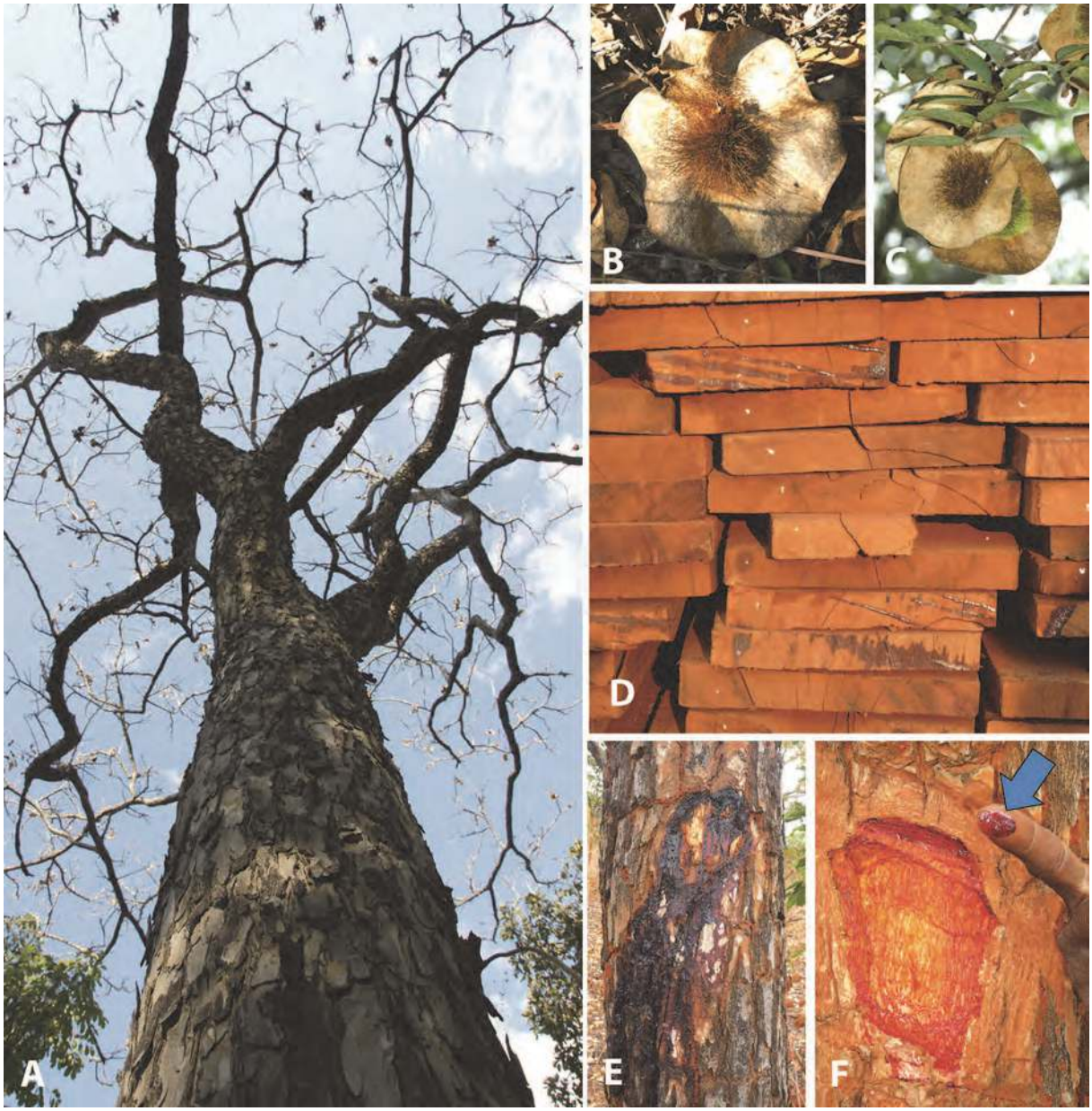

Figure 18. Pterocarpus angolensis: A. showing its typical form and deciduous (dry season) phenology. **B.** Characteristic fruits (dry) and **C.** green. **D.** Stacked *P. angolensis* timber. **E.** Elephant damage to *P. angolensis* trunk showing dry red medicinal resin (kino) and **F.** Fresh sap and bark slash. Photos: A.B. Cunningham.

4.6.4 Names for *P. angolensis* in African languages

omuuva (KwaNyama Owambo), mubvamakovo, mubvamaropa, mubvinzaropa, mukambira, mukurambira, mukwirambira, mukwa, mushmbaropa (viShona), umvagazi (siNdebele), mukulambira, musomba (chiTonga), kwanambila, mukonambiti (Hlengwe), ntumbati (chiYao) and umbila (which is a widely used name in several African languages) (CURTIS & MANNHEIMER, 2005; PALMER & PITMAN, 1972; RODIN, 1985).

In the current IUCN Red List process (IUCN STANDARDS & PETITIONS SUBCOMMITTEE, 2014), the guidelines for assessing conservation status of long-lived species based on generation length of the species concerned is complex, as discussed in the methods section of this report. Fortunately, excellent recent studies have been done on growth rates of *P. ango-*

lensis from sites in Mozambique, South Africa, Zambia and Zimbabwe (STAHLE et al., 1999; THERRELL et al., 2007).

4.6.5 Distribution

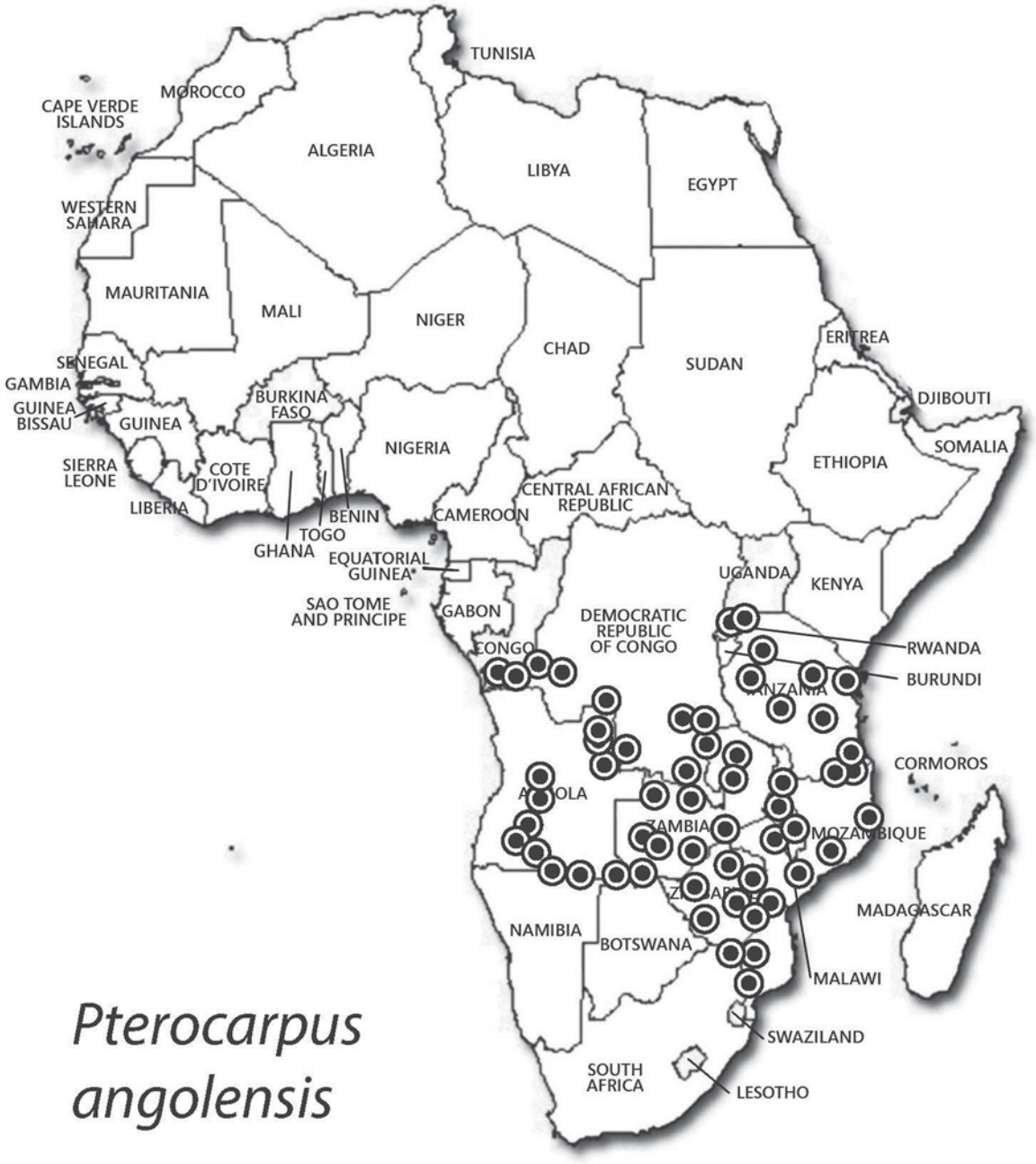

Figure 19. Map showing the African distribution of *P. angolensis* (redrawn and combining distribution data from the African Plant Database initiative (http://www.villege.ch/musinfo/bd/cjb/africa/help.php?langue=an) and other sources (CURTIS & MANNHEIMER, 2005).

Table 5. Summary of the status of *P. angolensis* across all Range States.

Range state	Status of *P. angolensis* populations and current threats
Angola	Large populations still remain. *P. angolensis* was the focal species of unmanaged , extensive exploitation in southern Angola during the Angolan war (1975-2002) by Frama Intertrading Pty Ltd, a front company of South African military who also dealt in ivory (REEVE & ELLIS, 1995), using a sawmill at Bwabwata, West Caprivi, Namibia. Cross border trade in sawn timber from unmanaged logging in Angola to the Kavango and West Caprivi, Namibia continues today. Major declines in distribution are predicted due to climate change (De Cauwer, 2014).
Botswana	Commercial logging over the past 50 years. Serious declines in *P. angolensis* distribution predicted due to climate change (De Cauwer, 2014).
Democratic Republic of Congo	Logged in the DRC since the 1950's. Probable cross-border trade in timber from the southern DRC into the Copperbelt, Zambia. More data needed for any assessment of conservation status.
Malawi	**Vulnerable A1cd/A2cd** noting that most large *P. angolensis* used in Malawi are brought in from Mozambique (Golding, 2002).
Mozambique	One of the largest *P. angolensis* populations in the region. Although *P. angolensis* was not included in the southern African Red list (GOLDING, 2002), a recent FLEGT funded study concluded that logging has grown over the last 6 years, with a total of 727000 m^3 of logs of all species (with *P. angolensis* one of the focal ones) exploited in 2012, of which 414000m^3 consumed domestically (FAEF, 2013). Illegal logging is a major problem in Mozambique. *P. angolensis* (along with *A. quanzensis* and *M. stuhlmanii*) is the one logged in the highest volume in Mozambique. FAEF (2013) concluded that consumption of these three species in urban areas exceeded the maximum annual allowable cut in 2012 and the total harvested volume has exceeded the maximum annual permitted cut since 2011. Even to an experienced wood-worker, *P. angolensis* timber is indistinguishable from that of *P. indicus* (an official *hongmu* species) in China. In addition to the huge volumes of *P. angolensis* exported to China, there is a significant cross-border trade to Tanzania. From 2007 onwards, chainsaw logging and cutting of planks increased within the hunting concession (L9) in Niassa National Reserve. Cross-border trade worsened with completion of the Unity (Umoja) bridge and also took place through use of dug-out canoes. Signing of the MOU between Mozambique and Tanzania (ANON., 2012) has reduced the trade across the Rovuma river. Nevertheless, cross-border trade still occurs, including by sea in dhows sailing from the area north of Palma (Mozambique) to Mtwara (Figure 6)
Namibia	Considered **Vulnerable (A1bcd2bcd)** due to urban expansion (north-central Namibia), habitat loss to agriculture and fire effects (Golding, 2002), later downgraded to "**Low Risk, near Threatened**" (LR/nt) by Loots (2005). Given extensive commercial logging in communal conservancies in the Caprivi, much of it for export to South Africa (pers. obs., 2010) and De Cauwer et al's (2014) predictions, this needs to be reviewed. Based on observations from the national atlas project, CURTIS & MANNHEIMER (2005) express concern about the lack of young trees.
South Africa	Long history of commercial logging and domestic use for carvings. Although a nationally protected species (KRYNAUW, 1998), felling for carvings and other uses is widespread. Woodcarvers consider that *P. angolensis* is becoming rare (STEENKAMP, 1999). Poor natural regeneration documented by von Maltitz and Rathogwa (1999) and VAN DAALEN (1991). In the first ever population matrix model for *P. angolensis*, Desmet et al (1996) concluded that the population studied was in decline, also confirmed by Shackleton (2002).

Range state	Status of *P. angolensis* populations and current threats
Swaziland	*P. angolensis* is popular for woodcarving. Not listed in GOLDING (2002). More data needed.
Tanzania	Large remaining populations, however *P. angolensis* is one of the most widely logged species in Tanzania, both for domestic carpentry, woodcarving and for export. Major increases in exports, accompanied by illegal logging were studied by MILLEDGE et al (2007). Official minimum DBH sizes are widely ignored (CARO et al., 2005; MILLEDGE et al., 2007). Detailed population matrix modeling studies carried out in several sites predict population declines (CARO et al., 2005; SCHWARTZ & CARO, 2003; SCHWARTZ et al., 2002). In protected areas, *P. angolensis* is affected by elephant damage (VAN DE VIJVER et al., 1999) and by illegal logging (SCHWARTZ & CARO, 2003). Regeneration was very low both inside and outside protected areas in the Rukwa region (SCHWARTZ et al., 2002).
Zambia	Large populations. Extensive commercial exploitation since the 1950's, with high domestic demand for carpentry and building poles for house construction. Under one of DE CAUWER et al.'s (2014) climate change scenarios, *P. angolensis* is likely to increase in Zambia. Fungal wilt ("mukwa die-back) is an added concern in terms of higher mortality rates to adult trees (PIEARCE, 1979).
Zimbabwe	Considered Low Risk, near threatened under IUCN criteria. BRADLEY & DEWEES (1999), CLARKE et al. (1996) and MUSHOVE (1996) all highlighted their concerns about population declines. The fungal wilt disease of *P. angolensis* (Mukwa die-back) also occurs in Zimbabwe (VAN WYK et al., 1993). Felling for the woodcarving trade to South Africa has undoubtedly increased.

4.6.6 Habitat and role in ecosystem

Pterocarpus angolensis is widespread through deciduous broadleaf savannas and miombo woodlands in East and southern Africa. *P. angolensis* occurs on a range of soil types, including nutrient poor sandy soils of the Kalahari basin and Mozambique coastalplain. Sensitive to moisture deficit, *P. angolensis* is one of the first tree species to shed its leaves as the dry season approaches. The ecosystem role of *P. angolensis* is poorly known and more information is needed.

4.6.7 Ecology and population dynamics

Based on ages determined by THERRELL et al. (2007) and STAHLE et al. (1999), we know that just to reach 35cm diameter at breast height (DBH), the minimum harvestable size in several forestry management plans, it can take at least 85 – 137 years. These are the minimum time frames, as *P. angolensis* can spend decades in a deep-rooted "suffrutex stage" (SHACKLETON, 2002). *P. angolensis* trees of 60cm diameter are likely to be over 200 years old (Figure 20). Using a time frame of 100 years to projecting future declines would seem entirely reasonable for *P. angolensis*. There is little doubt that significant declines in terms of the availability of large trees have already occurred since the 1950's due to commercial woodcarving and logging for timber. As I discuss below, looking forward over the next century gives a bleak outlook for *P. angolensis*. Although the exact range size of *P. angolensis* isn't known, changes due to habitat loss can be inferred from our knowledge of the extent of transformation of miombo woodland, which contains the bulk of *P. angolensis* populations. FROST et al. (2003) suggest that 466,000 km² of miombo woodland has been transformed, 17.8% of the total area of 2.4 million km² for Africa's miombo region.

P. angolensis was listed as Lower Risk/near threatened on the IUCN Red List (WORLD CONSERVATION MONITORING CENTRE, 1998b), noting that this species had become less frequent over most of its range, particularly where extensively used by local people. WORLD

CONSERVATION MONITORING CENTRE (1998b) also noted that in most parts of the range there was no control over the rate of harvesting. Production of *P. angolensis* in plantations has not been successful (THERRELL et al., 2007), so the continued use of this highly valued species depends on wise management of wild populations. This is a complex task, not only due to poor governance and weak forest management capacity in many Range States, but also due to the compounding effects of biological factors and climate change on this species.

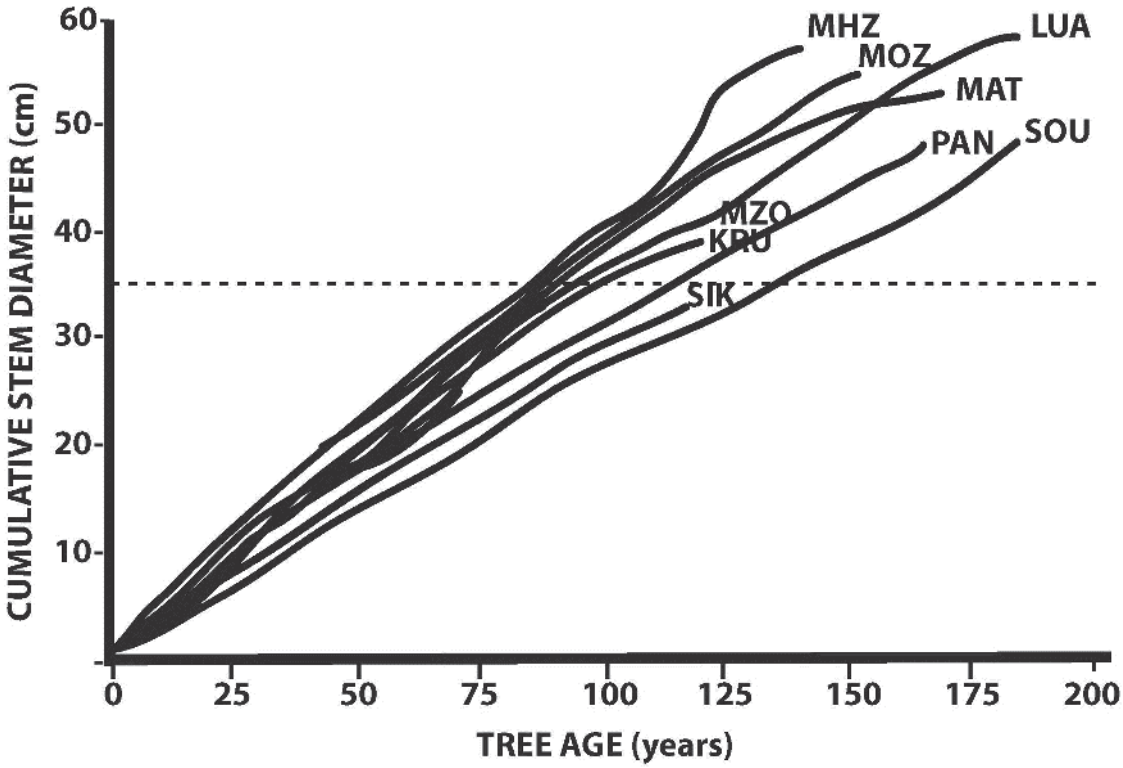

Figure 20. Mean *P. angolensis* growth curves from each of nine sites in Mozambique, South Africa, Zambia and Zimbabwe showing the relative differences in cumulative stem diameter at different sites. The dotted line shows how long it takes *P. angolensis* to 35 cm diameter, ranging from 85 years at the Mozambique site to over 130 years at the Soutpansberg site in South Africa (from THERRELL et al., 2007).

When they did the IUCN Red List assessment, WORLD CONSERVATION MONITORING CENTRE (1998b) also noted that large *P. angolensis* trees were reported to be suffering from fungal attack, presumably referring to the study by PIEARCE (1979) that identified wilt disease for the first time as a factor causing widespread decline in *P. angolensis* populations across Zambia. What also needs to be taken into account in conservation assessments is the full spectrum of factors that affect *P. angolensis* populations. These range from the region-wide factors such as climate change, fire and logging through to factors that influence *P. angolensis* populations within forest reserves and protected areas (such as elephant damage). At the time that IUCN Red List assessments were carried out by WORLD CONSERVATION MONITORING CENTRE (1998b) for a global assessment, or regionally (GOLDING, 2002) and for Namibia (LOOTS, 2005) there was not as much knowledge of the multiple factors affecting *P. angolensis* as we have now. Nor was commercial logging as extensive then as it is known to be today. These are discussed below, starting with an overview of the conservation status across all the Range States, followed by more detail on factors influencing *P. angolensis* in Mozam-

bique and Tanzania. As the most northerly populations of *P. angolensis* occur near the southern end of Lake Victoria, Tanzania (BOALER, 1966), with no wild populations in Kenya (BEENTJE, 1994), Kenya is not included in this assessment. In summary, for reasons given below, despite the wide distribution of *P. angolensis*, the situation facing this species is worse than previously appreciated and a reassessment of IUCN Red List status and consideration for CITES Appendix II listing is recommended.

In addition to continued habitat loss, five factors are likely to have significant negative impacts on *P. angolensis* populations in the future: (1) climate change; (2) fungal wilt disease causing mass die-offs of large *P. angolensis*; (3) changed fire ecology, where the cooler fires required for seed germination are replaced either by very hot fires that kill seeds and seedlings, reducing recruitment or in some areas, fire suppression; (4) increased commercial exploitation of larger trees (for timber and carving) combined with local harvest of smaller diameter trees for construction; (5) *P. angolensis* use for domestic energy production (charcoal and woody biomass).

4.6.7.1 Impacts of climate change on *P. angolensis*

Recent modelling of the effects of climate change shows that the geographic distribution of *P. angolensis* will decrease (DE CAUWER et al., 2014). Based on these predictive models, future situation for P. angolensis is worst across the western parts of its distribution (Angola, Botswana and Namibia) and best for Zambia, where an increase is predicted. Under DE CAUWER et al.'s (2014) worst case scenario, *P. angolensis* may even disappear from large areas of its western distribution by 2080, including from Namibia and Botswana, with a significant reduction in the range of this species in Angola. This prediction is backed up by climate models for tree cover more generally across the region, with MIDGLEY et al. (2005) also suggesting that tree cover and woody biomass will decrease across northern Namibia, southern Angola and eastern Botswana by 2080.

4.6.7.2 Impacts of fungal wilt disease

As mentioned earlier, PIEARCE (1979) identified wilt disease for the first time as a factor causing widespread decline in *P. angolensis* populations across Zambia. "Mukwa wilt" disease is now known to be a factor affecting *P. angolensis* populations in South Africa, Zambia and Zimbabwe (MEHL et al., 2010). Although a synergistic link between fungal wilt disease and climate change is possible, this has not been investigated yet. Prior to PIEARCE's (1979) study, the *P. angolensis* die-offs were thought to be caused by a succession of drought years. In Asia, *Fusarium* is known to cause wilt in *Pterocarpus indicus* (SANDERSEN et al., 1997). In southern Africa, the fungus *Lasiodiplodia pseudotheobromae* has been suggested as the main cause of *P. angolensis* die-offs (MEHL et al., 2010). Changes in fire ecology and absence of fire management may also be a contributing factor to *P. angolensis* die-back and tree mortality (MEHL et al., 2010).

4.6.7.3 Changes in fire ecology and *P. angolensis*

Fire, its role in the maintenance of savanna structure, and its use in management, is probably the oldest issue in savanna ecology (SCHOLES & WALKER, 1993) and has been a central theme of ecologists in Australia and Africa for decades. Despite the widespread awareness about the role of fire in savanna ecosystems, there has been a history of an antipathy to fire, which was seen as an unnatural disturbance (BOND & VAN WILGEN, 1996). *P. angolensis* is fire-adapted, needing low intensity fires, not only for seed germination with moderate exposure to fire (BANDA et al., 2006), but also to reduce competition between saplings (GRAZ, 2004). Although some forest managers assume that there is a close relationship between fire intensity and fire frequency, fire intensity in savanna and woodland systems

depends more on the previous year (or previous two years) rainfall than on time since the last fire. The reason for this is that grass is the main fuel load, and rainfall influences the amount of grass in savanna systems, as has been well documented in southern Africa (GOVENDER et al., 2006). Consequently, climate change can influence fire intensity. However, it is not only fire, but also interactions between elephants, grazing animals and logging that need to be taken into account (MIDGLEY et al., 2010).

4.6.8 Regulations and management

P. angolensis is widely protected by law across southern Africa and is considered a Class 1 timber in Mozambique[7]. In theory, Class 1 timbers have set stumpage fees and require a management plan before commercial harvest is permitted. In practice, however, *P. angolensis* is widely logged without permits.

4.6.9 Use of the species and demand

P. angolensis is the most widely used indigenous tree species in southern and south-central Africa, both for domestic purposes (Figure 9 B) and for export.

4.6.10 Look-alike issues with other hardwoods

Several “look-alike” issues need to be taken into account. Firstly, In Tanzania and Zambia, *P. tinctorius* is logged and mixed in with *P. angolensis*. The timber of these two species looks very similar. Secondly, *P. antunesii* is sometimes logged and mixed in with *P. angolensis* in south-western Zambia (J. Mwitwa, pers. comm, 2015). Generally, *P. atunesii* trees are smaller than *P. angolensis*, but the timber from large *P. antunesii* could be confused with *P. angolensis*. Thirdly, even to an experienced craftsperson, to the naked eye, *P. angolensis* timber looks similar to that of *P. indicus*, a South-East Asian species that is an official Hongmu wood, so there is the possibility of confusion here too.

4.7 Cultivation of *Afzelia*, *Dalbergia* and *Pterocarpus* in Kenya, Mozambique and Tanzania

For almost a century, Forestry departments in East Africa have experimented with cultivation of indigenous tree species. In Kenya, the first *Prunus africana* plantations were planted in 1919 and extensive plantation trials of *Brachylaena huillensis* were planted near Nairobi from the 1930’s. All three focal species in this report have been cultivated, either from seed (*Afzelia quanzensis*) or from both seed and through vegetation propagation (*Dalbergia melanoxylon* (GREGORY et al., 1999) and *Pterocarpus angolensis* (KASUMU, 1998). In a plantation trial at Mugasha, Tanzania, for example, *D. melanoxylon* cultivation using vegetative propagation was more successful than from seed (GREGORY et al., 1999). In Mozambique, plantation trials of *Afzelia quanzensis* and *Millettia stuhlmannii* were established outside Maputo on the road to Xai-Xai in the 1930’s. In Tanzania, early studies also assessed rainfall as a predictor of suitability for *P. angolensis* production (BRYANT & PROCTER, 1970). With more sophisticated analytical tools, studies across southern and south-central Africa continues to be done on genetic diversity (CHISHA-KASUMU et al., 2009) and growth rate predictors (MWITWA et al., 2007) of *P. angolensis* to better inform domestication of this species and provenance trials. In general, trials are small (such as the 0.5 ha *P. angolensis* planting established at Katombora Reformatory in southern Zambia (J. Mwitwa pers. comm., 2015) or the 0.4 ha *P. angolensis* trials in Zimbabwe (CALVERT, 1993). Others are more extensive, such as the 24

[7] NEXO I: Listas de classificação das espécies produtoras de madeira previstas no n.o 1 do artigo 11 do Regulamento da Lei de Florestas e Fauna Bravia

hectare *D. melanoxylon* planting established in 1976 outside Chinokole village, Tanzania (GREGORY et al., 1999) or the *Afzelia quanzensis* trial in Mozambique (pers. obs., 1990). So if all three species can be planted, and this has been demonstrated in plantation trials, why aren't there extensive plantations of these species across East and southern Africa?

Figure 21. An *Afzelia quanzensis* plantation trial established in the 1930's in Mozambique. In 1990, when this photograph was taken, these trees would have been 55-60 years old. Photo: A.B. Cunningham.

The short answer is that plantations of slow growing species are too economically risky. This is due to a combination of factors: slow growth rates and the consequent long time to any economic return), political uncertainties and land-tenure issues. In communal areas, fires, goats, termites combine with poor maintenance of plantations once development aid funds run out. When GREGORY et al. (1999) visited the 24ha trial at Tanzania village of Chinokole, for example, the trial had not been maintained for a decade due to "lack of funds" and no thinning had taken place at all. At the small *D. melaonoxylon* trial plantation right outside the forestry office in Nachingwea (which was planted in 1979), weeding continued until 1996, but then stopped when funds ran out (GREGORY et al., 1999). Political factors may also play a role. HURST (2003) for example suggests that marginalization of the State Forest service in Tanzania reduced their effectiveness. Biological factors and site selection also play a role. When I visited the *Afzelia quanzensis* trials in Mozambique in 1990, just before the end of the civil war, it was clear that most *A. quanzensis* in the trial had short trunks and branched much lower down than wild *A. quanzensis* trees in Sand forest or Dune forest (Figure 21). As result, this represented poor economic returns in terms of marketable timber. This short trunk height is consistent with the seedlings being planted in relatively open *Terminalia sericea* woodland with a low canopy, confirming with KRUGER et al.'s (1997) observation that the height of first branching reflects forest canopy height. Today, most of trees in this indigenous forestry trial have been cleared as settlements have extended northwards from Maputo.

Figure 22. Softwood plantations play a crucial role in providing an alternative timber to high value hardwoods such as *Afzelia quanzensis* and *Pterocarpus angolensis*. A. Pine plantations near Njombe, southern highlands, Tanzania. **B.** Sawn pine timber at a loading depot (Njombe, Tanzania). **C.** Pine timber from Tanzania in Tunduma en route to Zambia. **D & E.** Pine timber from the southern highlands for sale at an informal sector market in Dar es Salaam. **F.** A builders merchant outside Nairobi, Kenya selling pine timber from plantations in Tanzania. Photos: A.B. Cunningham.

The fact that plantation production of these slow growing hardwoods is not viable underscores the importance of sustainable management of wild populations of these species. But it is clear from earlier sections of this report that there are few cases where this is happening. Clearly cultivation of *Afzelia quanzensis, Dalbergia melanoxylon* and *Pterocarpus angolensis* cannot reduce harvesting pressure off wild stocks. So what is happening in Kenya, Tanzania and Mozambique as these stocks of these species decline? Three alternative supply trends are clear from field observations for this report.

Firstly, the important role played by softwood plantations (particularly pine plantations in Tanzania'a southern highlands) is providing timber that is used as a substitute for beds, chairs, doors and window frames from increasingly scarce *A. quanzensis* and *P. angolensis*. In the 1970's, about 80,000 hectares of industrial forest plantations were established in the southern highlands and to a lesser extent in NW Tanzania (WELLS & WALL, 2005). Although poorly managed, the importance of these plantations in supplying timber is clearly evident. This large-scale trade occurs within Tanzania as well as to northern Zambia through Tunduma border post and even to Kenya (Figure 22). On a much smaller scale, a similar substitution of *P. angolensis* for pine household furniture and doors is evident around Lichinga, the capital of Niassa province, northern Mozambique, where pine plantations were established by the Portuguese in the 1960's. As WELLS & WALL (2005) point out, maintaining the supply of wood from these plantations is critically important both from a livelihoods perspective and a conservation perspective. In more remote areas, however, away from reliable transport routes, *P. angolensis* continues to be the main source of construction timber (doors, window frames) and furniture.

Secondly, and most evident in Kenya is the use of tropical forest hardwoods (mainly *Entandrophragma* species and *Khaya antotheca*) from the Democratic Republic of Congo (DRC) for construction purposes and household furniture (Figure 23). In part this is due to depletion of local hardwoods from Kenya's montane and coastal forests, but is also due to the lower prices of timber logged in the DRC. WWF (2012) reported that over 60,000 m³ of timber per year was being transported to regional markets, with Kenya the largest market of all. In 2011, Kenya imported over half of the timber exported from the war-torn Eastern DRC (32,100 m³), with South Sudan the next biggest importer (10,700 m³), followed by Uganda imports (8,300 m³), Rwanda (7,000 m³) and Burundi (an estimated 1,000 m³) (WWF, 2012). This form of substitution is not sustainable and triggered an early German proposal to include all *Entandrophragma* species in CITES App. II in 1994. Unfortunately, this proposal was not successful. The policy context of this tropical timber trade to Kenya is also significant. As WWF (2012) points out, Kenya has the largest industrial timber plantations of East Africa, with about 107,000 ha of publicly owned industrial plantation forests and around 90,000 ha of private timber and fuel-wood plantations. Although these plantations are large enough to supply domestic industrial wood needs, harvesting in government plantations has been restricted by presidential ban and the timber industry consequently depends on imported industrial wood (mainly pine and cypress) from Tanzania and Malawi and hardwoods from DRC. This cross-border trade from the DRC to Kenya is benefitted by an interesting "hybrid" trade policy situation due to the fact that Kenya is both a member of the Common Market for Eastern and Southern Africa (COMESA) and of the East African Community (EAC) (CUNNINGHAM et al., 2007). Neither Mozambique nor Tanzania are COMESA members. In theory, timber importers need to pay VAT at 16% based on a valuation of US$ 220 per m³ of timber, but because both DRC and Kenya are members of COMESA and are subject to the free trade area agreement, timber is imported duty-free, thus avoiding the EAC common external tariff (of 10% duty and 18% VAT on timber imports) (WWF, 2012). This creates market advantage over non-COMESA members of the EAC (such as Tanzania) and a "perverse policy incentive" for a continued tropical timber trade from the DRC to Kenya: a trade that is widely acknowledged to be unsustainable, including logging in protected areas, benefitting armed

militia groups in a country considered as "*one of the two most problematic countries in Africa for illegal exploitation of natural resources*" (NELLEMAN et al., 2014).

Figure 23. *Entandrophragma* timber from the war-torn Eastern DRC outside a small factory in Bombolulu area, Mombasa, Kenya. Kenya is the major regional importer of tropical timber from the DRC (Oct 2015). Photo: A.B. Cunningham.

Figure 24. Wooden frames for lounger furniture that will later be covered and stuffed. These have been made by one of many entrepreneurs in the Bombululu area, Mombasa where wooden pallets used to transport industrially packed products are available at low costs near this major East African port. Photo: A.B. Cunningham.

The third trend is far more positive: recycling the timber from wooden pallets used to transport industrially packed products to make the wooden frames of the stuffed lounge furniture that is popular amongst millions of emerging middle class households across Africa (Figure 24). This is sustainable, but localized around major ports such as Mombasa, Kenya, where used pallets are readily available.

4.8 The wider context of timber economics and trade: values and value-chains

Amidst the very real concerns about poaching of African elephants and rhinos and the illegal trade in ivory and rhino horn, it is easy to forget that economic value from illegal logging and forest crime completely dwarfs the value of the wildlife trade. In their influential review of environmental crime, NELLEMANN et al. (2014) put things in context: forest crime and illegal logging represent a value of US$ 30 – 100 billion per year (or 10 – 30% of the total global timber trade). Even at inflated end-user street values in Asia used by NELLEMANN et al. (2014), the combined annual trade in African ivory (US$ 165 – 188 million) and rhino horn (US$ 63.8 – 192 million) are worth less than 1% of the value represented by illegal logging and forest crime. Neither illegal logging, nor elephant and rhino poaching are easy problems to solve. But as the recommendations in this report suggest, they not only have similar drivers of demand, but also similar end markets. Under these circumstances, considering coordinated strategies would be cost effective. But there also is a need for pragmatism at multi-levels. In particular, the misleading conclusions by EKMAN et al. (2013) in a study funded by the German Federal Ministry of Economic Cooperation and Development (BMZ) need to be corrected. In their report, EKMAN et al. (2013) state that: "*China is almost the only market for Mozambican timber and as such this market exhibits some peculiar features. Contrary to price trends of global forest products, sawn timber fetches a lower unit price than do logs, due to the preference of manufacturers in China who are willing to pay a premium for logs, which are essential for producing Chinese antique-style furniture. Exporting sawn timber means not only that the product loses value on the Chinese market, but also that a Mozambican-based company must face the costs of running a sawmill and compete with timber from countries that have not illegalized the export of logs. The end result is squeezed profit margins and a strong incentive to break the log-export ban*".

The massive export of logs from Mozambique is not sustainable. Nor is export of logs economically the best use of a precious national resource. A good example of the poor returns that Mozambique is getting on its valuable hardwoods was given in a recent WWF-Mozambique study summarized by HANLON (2015), which reported that a container of unprocessed logs was worth only US$ 8,250, with US$ 520 paid in out bribes (Figure 25). Contrary to EKMAN et al.'s (2013) view, there are significant markets outside of China for high value-added products based on Mozambican wood products, including in Europe and within the southern Africa (Figures 31 and 32). By comparison, a 20-foot container of music instrument blanks from *Dalbergia melanoxylon* is worth 26 – 67 times more (Figure 29), but this generates more employment with better pay and worker safety conditions than any export of unprocessed logs and uses a fraction of the wood in the process. The same applies to the high quality, high value-added production of furniture by the Mezimbite project in Sofala (Figure 31) and the TCT Dalmann company, who run one of the best managed forest concessions in Mozambique.

Furthermore, as SUN et al. (2008) point out in an excellent study on timber markets carried out jointly with the Chinese Ministry of Commerce (MOFCOM), Chinese producers risk losing market share and long-term availaibility of timber supplies due to poor forest management and poor governance in source countries. In addition, SUN et al. (2008) pointed out that working conditions sawmills in Mozambique did not meet basic health and safety stand-

ards, as workers did not use any personal protective gear, were operating band or circular saws that are obsolete, damaged and unstable and that all loading was done by hand. These continue to be challenges in logging yards today (Figure 28).

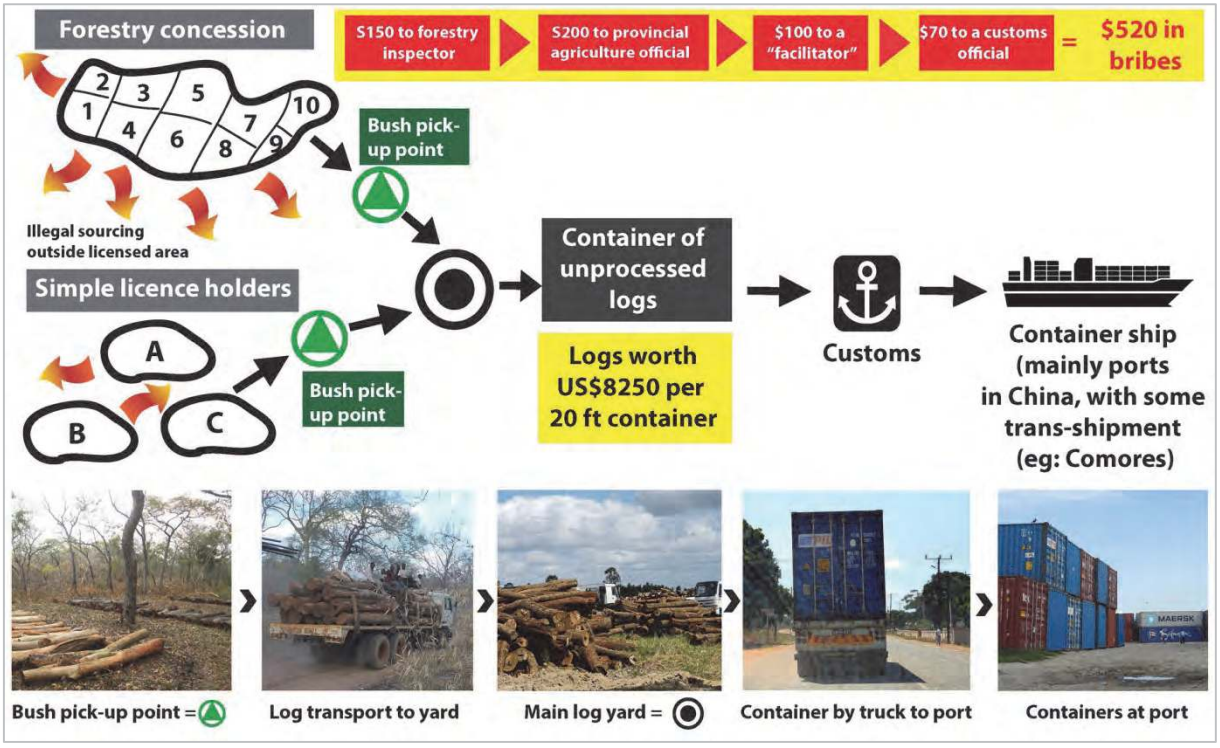

Figure 25. A simplified supply chain for log exports from Mozambique. Logs are supplied from Forest concessions and from Simple licence holders, commonly and illegally sourcing outside these designated areas (see FAEF, 2013). According to a recent WWF-Mozambique report (HANLON, 2015), a container of unprocessed logs is worth just US$ 8,250, and US$ 520 would have been paid in bribes at different stages of the supply chain (US$ 150 to forest inspectors, US$ 70 to customs officials, US$ 200 to the provincial agriculture directorate and US$ 100 to a "facilitator"). Photos: A.B. Cunningham.

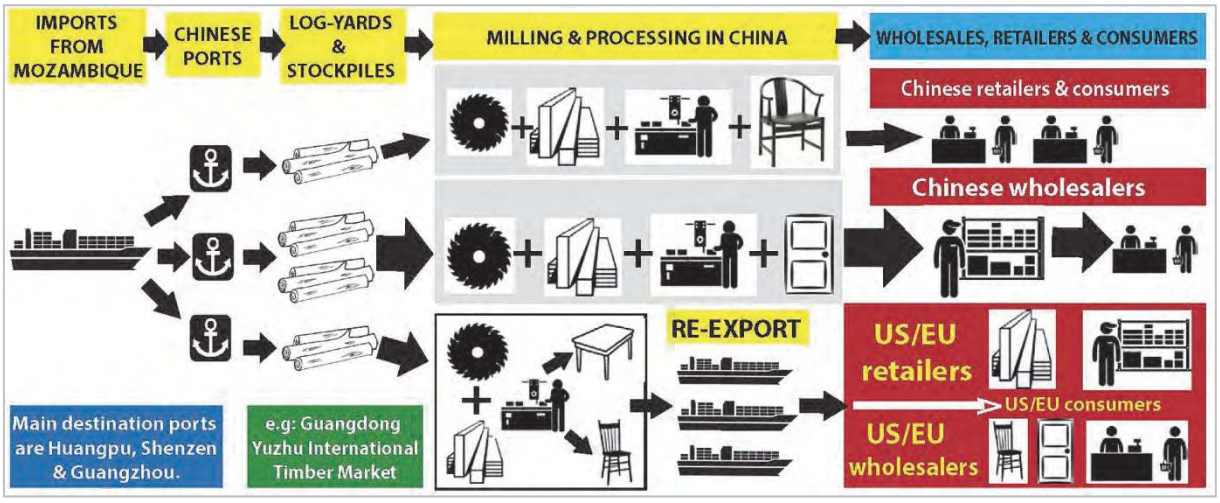

Figure 26. Simplified supply chain once unprocessed logs from Mozambique get to China.

Figure 27. Over the past decade, rising per capita incomes in China have driven demand for luxury homes with high quality doors, flooring and furniture, including those made from African species such as *Afzelia quanzensis, Colophospermum mopane, Milettia stuhlmanii* and *Pterocarpus angolensis*. **A.** Flooring retailer in Chengdu. **B.** A showroom for builders and consumers with high quality doors, furniture and fittings from hardwood species, including from the African tropics. **C. & D.** Hardwood flooring prices US$ 44 – 52 per m^2). **E.** One of many showrooms for timber in the wood-processing district of Chengdu, Sichuan, China (2010). Photos: A.B. Cunningham.

Figure 28. Workers manually loading containers with rough-cut logs at a Chinese owned logging yard near Dondo, Sofala, Mozambique. Health and safety standards in most logging yards are poor, despite SUN et al.'s (2008) recommendations on personal safety gear and improved working conditions. Photo: A.B. Cunningham.

Table 6. Market categorization of different hong mu species in China. The category given to *Dalbergia melanoxylon*, a high value species in Europe and North America that is considered a "low end class" *hong mu* wood in China is highlighted in yellow (modified from WENBIN & SUN, 2013).

Market class by value		Botanical name	Region of origin
Collectable class	Class 1	*Dalbergia odorifera*	China (Hainan)
	Class 2	*D. tonkinensis*	Vietnam
		Pterocarpus santalinus	India
		D. lovellii	Madagascar
	High-end class	*D. cochinchinensis*	Cambodia, Thailand, Laos, Vietnam
		D. retusa	South America
		P. macrocarpus	Cambodia, Thailand, Laos, Vietnam
Ordinary class	Medium level class	*D. caerensis*	Cambodia, Thailand, Laos, Vietnam
		D. olivieri	
		P. pedatus	
		D. stevensonii	South America
		Milettia laurentii	Congo Basin
		M. leucantha	SE Asia
	Low end class	*D. melanoxylon*	Mozambique & Tanzania
		P. erinaceus	West Africa

In contrast to the extremely high prices paid for some *hong mu* species, NELLEMANN et al. (2014) correctly indicate the much lower prices paid for African species, with average prices less than US$ 1,500 per m³. As a result, a species such as *D. melanoxylon* that is so highly valued in Europe is shipped to China in log-form where it is considered a “low end class” species (Table 6).

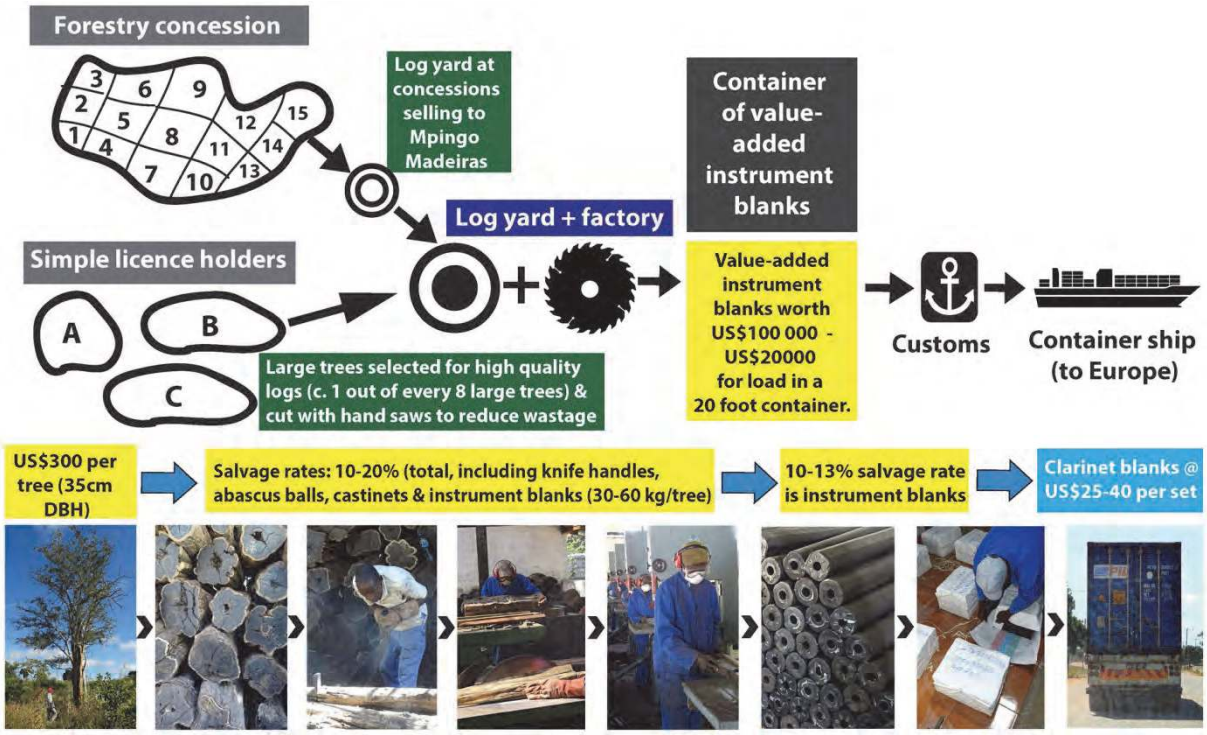

Figure 29. A simplified supply chain for musical instrument blanks at Mpingo Madeiras Lta., a company in northern Mozambique that supplies high quality products to European and North American markets. In contrast to the companies that export unprocessed logs (worth just US$ 8,250 per container), a container of value-added D. melanoxylon instrument blanks is worth between US$ 220,000 and US$ 552,800. This has been achieved over many years by the company invested in marketing, high quality equipment and training of Mozambican workers. Photos: A.B. Cunningham.

Figure 30. Mpingo Madeiras Lda.: creating employment and adding value after investing in training, equipment to produce world-class export products in remote northern Mozambique. A. Sawing *D. melanoxylon* into useable blocks, showing safety gear. **B.** Stacked logs of *D. melanoxylon* before processing into blanks for the world's best wood-wind instruments. **C.** Precision equipment for drilling through the centre of locally turned clarinet and oboe blanks. **D.** Use of band-saws to minimize the width of cuts and maximise wood use. **E.** Investment in an automatic band-saw sharpening machine. **F.** Stacked sections of clarinet blanks. Photos: A.B. Cunningham.

Figure 31. Mezimbite project, Sofala, Mozambique: Why export unprocessed or rough cut logs when wise use of wonderful timber from miombo woodlands can add value and create local employment? A. The carved top of a *Pterocarpus angolensis* cabinet. **B.** Indigenous hardwood „waste wood“ salvaged from woodland heavily impacted by illegal logging that will be turned into high value products. **C.** World-class turned items from *D. melanoylon, Combretum imberbe* and *Berchemia discolor*. **D.** A table made from *Colophosperum mopane*: a species considered a low value timber in southern Africa, currently logged on a massive scale in the Zambezi valley, Mozambique and exported as unprocessed logs to China, where it is used for flooring. Photos: A.B. Cunningham.

Figure 32. Money going up in smoke: there is a great opportunity for more efficient use of D. melanoxylon and to reduce wastage. Salvage rates in Tanzania typically are 5 – 8% of the felled stems, which have taken over a century to the minimum harvestable diameter (24cm). **A.** Mingoyo Sawmill south of Lindi. **B.** Reject *D. melanoxylon* that is in great demand across the border in Kenya and with the correct documentation, could be sold of wood-carvers co-operatives in Mombasa, Malindi and Wamunyu. **C.** Reject *D. melanoxylon* instrument blanks and off-cuts piled up to be burnt and sold as charcoal. **D.** Use of circular saws (rather than band-saws) and limited investment in equipment increases wastage rates. **E.** Reject instrument blanks with minor flaws that could be used for castinets or knife handles, but are likely to be burned for charcoal instead. Photos: A.B. Cunningham.

Table 7. Comparitive prices of tonewoods based on low and high prices paid for instrument blanks per m³ in October 2014. Prices for instrument blanks cited by JENKINS et al. (2012) originally US$ are also shown for comparison, but were converted to Euro (€) at the 2012 rate of US$ 0.775 = 1€.

Family	*Species names* and trade names	Range states	Price ranges		
			Low	High	JENKINS et al., 2012
Boraginaceae	*Cordia dodecandra* (Ziricote)	Belize, Cuba, El Salvador, Guatemala, Honduras, Mexico	€10,000	€20,000	€114,939
	Cordia gerascanthus (Bocote)	West Indies, Central America	€10,000	€20,000	€62,276
Ebenaceae	*Diospyros celebica* (Indonesian ebony, Macassar ebony)	Sulawesi, Indonesia	€10,000	€30,000	€110,917
Fabaceae	*Dalbergia cearensis* (kingwood)	Brazil	€20,000	€40,000	€61,510
	Dalbergia decipularis (tulipwood)	N E Brazil	€20,000	€40,000	€59,047
	Dalbergia frutescens (tulipwood)	Brazil	€20,000	€40,000	€61,372
	Dalbergia latifolia (East Indian rosewood)	India, Indonesia and Nepal	€5,000	€20,000	€38,483
	Dalbergia melanoxylon (African blackwood)	Widesrpead across West, East and southern Africa.	€10,000	€25,000	€116,438
	Dalbergia paloescrito (Palo escrito)	Mexico	€5,000	€15,000	€66,534
	Dalbergia retusa (Cocobolo)	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama	€20,000	€40,000	€72,676
	Dalbergia stevensonii (Honduras Rosewood)	Belize, Guatemala, Mexico	€5,000	€25,000	€60,040
Moraceae	*Brosimum guianensis* (Snakewood, Leopardwood, Letterwood)	Guyana and Surinam	€50,000	€100,000	€307,539
	Brosimum paraense, (satine, bloodwood)	Peru	€5,000	€10,000	€49,206
	Brosimum rubescens, (satine, bloodwood)	Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guyana, Panama, Peru, Suriname, Venezuela.	€5,000	€10,000	€49,206
Rhamnaceae	*Berchemia zeyheri* (pink ivory, red ivory)	Botswana, South Africa, Mozambique, Zimbabwe, Zambia	€20,000	€30,000	€246,032

Family	*Species names* and trade names	Range states	Price ranges		
			Low	High	JENKINS et al., 2012
Rutaceae	*Chloroxylon swietenia* (Ceylon satinwood, East Indian satinwood or buruta)	India, Pakistan, Sri Lanka,	€3,000	€10,000	€110,891

Figure 33. Although the world's finest wood for clarinets and oboes takes centuries to grow, the cost of the instrument blanks for *D. melanoxylon* clarinet represents just 0.5 – 1.3% of the retail value of a clarinet. Photos: A.B. Cunningham.

4.9 Domino effects and impacts

Far more CITES-listed species are impacted by the "domino-effects" of logging in East Africa than is usually appreciated, as logging for Asian markets not only involves timber, but also trade in ivory from African elephants (CITES App. I), rhino horn (CITES App. I), a growing trade in scales from Cape pangolins (*Manis temminckii*, CITES App. II) and in Tanzania, export of East African sandalwood (*Osyris lanceolata*), which was listed in CITES App. II in 2013. The combination of timber, ivory and pangolin scales also occurs in West Africa. The extent of the trade in all four Africa pangolin species should not be underestimated. In June 2014, for example, 3 tonnes of pangolins scales worth HK$ 17 million were seized by Hong Kong customs in two shipping containers, one exported from Uganda via Kenya and the other from Cameroon[8].

Although the South African abalone (*Haliotis midae*) only occurs in cold water in-shore marine areas off the West Cape province, South Africa, customs records include seizures of illegally traded South African abalone in Kenya, Mozambique, Swaziland and Zimbabwe, in some cases in conjunction with ivory. Lastly, in terms of "ripple effects" on CITES listed species, is the link between poaching of large mammals (such as elephant or buffalo) and deliberate poisoning of vultures (GROOM et al., 2013). In some cases this is done to avoid early detection of carcasses (SMILLIE, 2014), and in others to also get vulture heads, which are traded for traditional medicine in Mozambique and exported from Mozambique to South Africa (CUNNINGHAM, 1990; MANDER et al., 2007).

[8] http://www.scmp.com/news/hong-kong/article/1534140/pangolin-scales-worth-hk17m-found-hidden-shipments-africa

Commercial logging, whether legal or illegal, is often linked to other issues of conservation concern. These range from the use of fire to clear the understorey of miombo woodland during the process of finding suitable timber trees, to bushmeat hunting and targeting valuable animals such as elephant and pangolins in the vicinity of logging camps (Figures 36 and 37). In West Africa, links between commercial logging and bushmeat hunting are relatively well known, with logging often correlated with rapidly escalating and unsustainable levels of hunting (NASI et al., 2008). Links between logging, hunting and bushmeat consumption are not well studied in East Africa however. Yet, in common with West Africa, they require a coordinated response in terms of policy implementation and law enforcement.

Figure 34. Aerial view of a Chinese owned logging yard outside Pemba, northern Mozambique (May 2013), showing roundwood (including *Dalbergia melanoxylon*) ready for packing into 20 ft and 40 ft containers. These are then transported directly to the port for loading. Rising prices for ivory and pangolin scales increase the temptation for hiding wildlife products in containers of logs. Two years later, in May 2015, this logging yard had virtually no logs, but like many other former logging concerns, had re-invested funds from logging into other enterprises (in this case, construction). Photo: A.B. Cunningham.

Figure 35. Ripple effects: Trade in African pangolin scales to Asia has increased, often in containers with timber. A. Skins of Cape pangolins confiscated prior to sale to Chinese buyers in north-east Namibia. **B.** A traditional healer selling pangolin scales in KwaZulu/Natal, South Africa. Domestic demand for Cape pangolin scales (plus mortality due to electric game fencing around conservation areas) are additional factors depleting *Manis temminckii* populations. **C.** Asian pangolin (*Manis pentadactyla*) scales for sale in south-west China. **D.** A young African Giant pangolin (*Smutsia gigantea*) that was captured for sale in the south-eastern Democratic Republic of Congo: a regular occurrence for sale to Chinese miners in the area. **E.** Pangolin scales from *M. teminckii* are also commonly used by local people in Niassa, northern Mozambique. Photos: A.B. Cunningham (A – C & E) and Patrick Carey (D).

Figure 36. Domino effects: linking hunting, bushmeat with logging and charcoal production in northern Mozambique. A. A young buffalo snared near a logging camp in a conservation concession south of Negamano, Niassa National Reserve (NNR). **B.** Although few large wildlife are left in charcoal production areas, sale of bushmeat (in this case a smoked leg of a bush-pig) helps supplement local income from charcoal sales (Lichinga-Montepuez road). **C.** Ivory retrieved from an elephant shot and wounded by hunters in an area (L9) of NNR increasingly logged illegally by Tanzanian loggers. **D.** Elephant carcass near a logging camp, NNR. **E.** Pangolins are rarely seen, even by experienced fieldworkers, but their value is well known. **F.** Specialist trap for tree hyrax set near an illegal logging camp, L9, NNR. Photos: W. Ebersohn (A, D, F) and A.B. Cunningham (B, C, E).

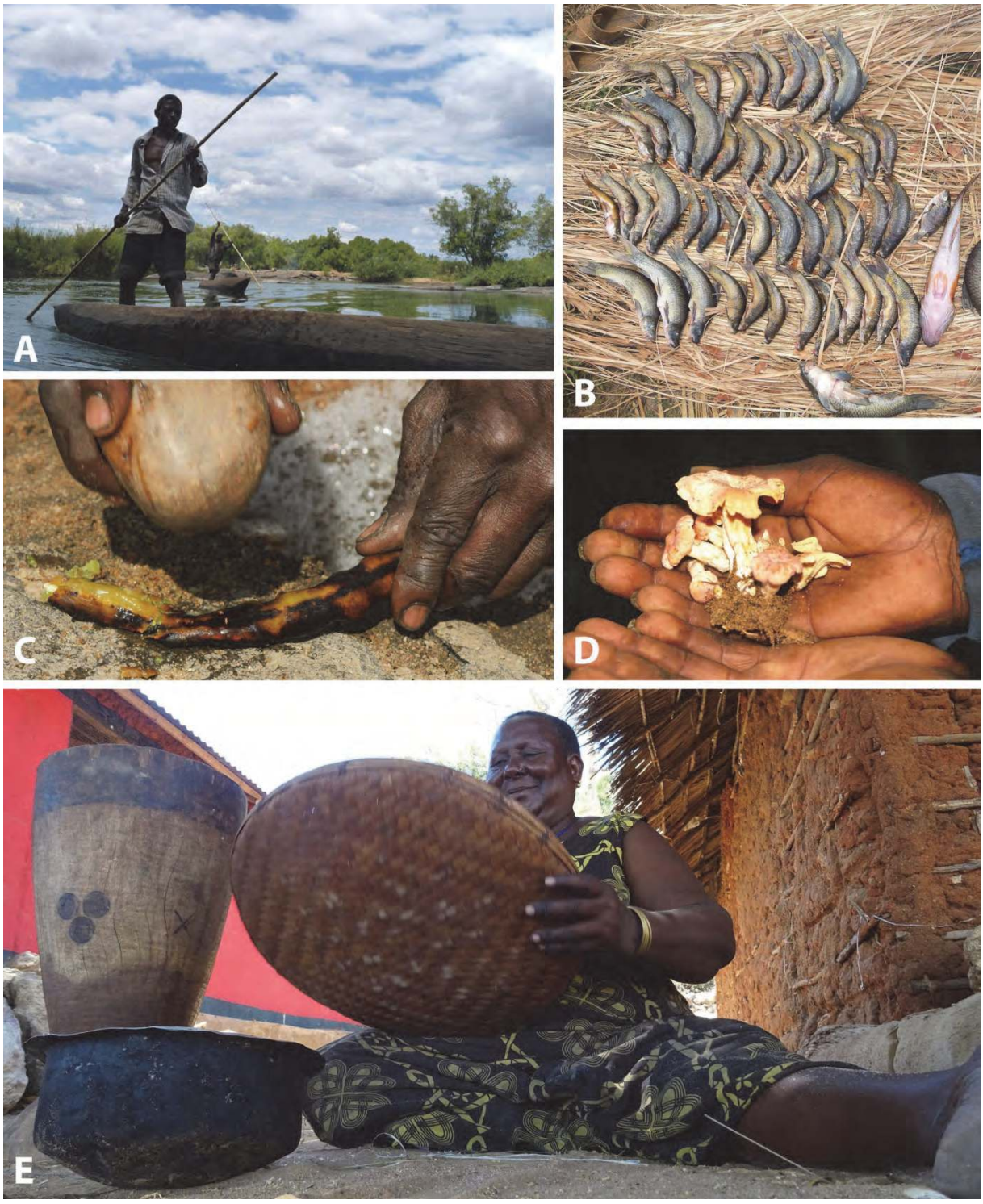

Figure 37. Linking livelihoods, nutrition and trees used for timber. A. Dugout canoes, such as these ones from *Pterocarpus angolensis* are important for fishing and local transport along river systems in Mozambique and Tanzania, but they are becoming more difficult to replace as large *Afzelia quanzensis, Pterocarpus angolensis* and *Diospyros mespiliformis* trees are logged for timber. **B.** Fish are an important protein source in all three countries. **C.** Fish are not only caught from canoes but in still pools using saponin rich fish poisons such as pounded *Bobgunnia* (*Swartzia*) *madagascariensis* pods. These are becoming scarce due to commercial logging. **D.** Edible ecotomycorrhizal fungi associated with *Afzelia quanzensis*. With logging, this food resource declines. **E.** In sandy areas, grain is pounded using hardwood mortars from *A. quanzensis, P. angolensis* or *Combretum imberbe*: all beign depleted by commercial logging. Photos: A.B. Cunningham.

4.10 Beyond timber: what are the consequences of unsustainable logging for people's livelihoods?

Unsustainable and wasteful exploitation of valuable timber species is not just economically inefficient with negative outcomes for biodiversity. It also has social impacts that are poorly recognized. These go beyond what effectively is the "export of local jobs" as logs are exported with minimal value-adding and job creation. There also are more subtle impacts. Most tree species commercially logged in East and southern Africa also have "non-timber" uses (Figure 37; Appendix 2). A similar situation applies in eastern Amazonia, where eight of the most valued fruit and medicinal species are also extracted as timber (SHANLEY & LUZ, 2003). This is a critical issue in sub-Saharan Africa, where food crops are particularly vulnerable to climate change (CHALLINOR et al., 2007; ROSEGRANT & CLINE, 2003) and people commonly supplement their starchy staple diet with gathered foods and locally caught fish. Household studies have shown that poor rural households are vitally dependent on miombo woodlands because of their role as a safety net (DEWEES et al., 2010). Loss of this „green social security" due to deforestation or unsustainable logging puts additional pressure on public institutions that often are poorly equipped to handle the problem of rural poverty.

5 Strategies for a sustainable use and effective conservation of the species

While none of the three species (*Afzelia quanzensis, Dalbergia melanoxylon* and *Pterocarpus angolensis*) is under the immediate threat of extinction, all of them are under severe pressure of international and domestic demand. There is strong evidence, ranging from anecdotal evidence to matrix population models for *P. angolensis* in South Africa (DESMET et al., 1996) and Tanzania (SCHWARTZ et al., 2002; CARO et al., 2005) to the recent nation-wide assessment for Mozambique that concluded that the current harvest levels exceeded the sustainable Annual Allowable Cut (AAC) (FAEF, 2013). This evidence supports the view that if the current rate of harvest continues, populations of the species will severely decline and a viable timber production of these species will no longer be possible in the short to medium term. This is exacerbated in Tanzania by the involvement of senior politicians and government officials in the illegal timber trade, particularly those in the forestry sector (MILLEDGE et al., 2007; SULLE, 2013). As an example of this, SULLE (2013) observed collusion between illegal timber traders and district forest officials in Masasi transporting illegal timber towards Kilwa and Dar es Salaam. Similar challenges are also prevalent in Mozambique, where there has been a transfer of subsidized companies and concessions of high value natural resources to political elites (ANON., 2013; CASTEL-BRANCO, 2015). Challenging this situation carries major risks. As this report has been completed, for example, Carlos Nuno Castel-Branco, one of Mozambique's best known academics went to trial on 31 August 2015 on charges of defaming the former President, Armando Guebuza in a public letter that also asked him to "*pedir desculpas e devolver a riqueza roubada*" (apologize and return the stolen wealth). Also on trial will be Fernando Mbanze, the editor of MediaFax, one of Mozambique's most respected independent newsletters. The role of civil society and the media in the face of very real challenges to good governance, transparency and sustainable natural resource governance need to be recognized and supported.

5.1 CITES

All three species meet the Criteria of Res. Conf. 9.24 (Rev. CoP16). All are extremely long-lived and slow growing. As a result, historical influences on population declines need to be recognized over the past three generations of these species (300 – 600 years). Major factors have been habitat loss due to clearing for subsistence & commercial agriculture, poor fire management, felling trees across a range of diameter size classes for domestic & export purposes and most recently, the easy availability of low cost chainsaws. There is no doubt that expansion of commercial cashew production and of sisal production during the colonial period resulted in massive clearing of miombo woodlands in southern Tanzania that were rich in *Pterocarpus angolensis* and *Dalbergia melanoxylon*. While there are very few long term monitoring plots for any of these species, it is also widely recognized that clearing woodlands for subsistence agriculture in Mozambique and Tanzania is closely linked to population growth. If this is a valid proxy for declines in these three species, then population growth in Tanzania from 12,313,469 in 1967 to a total population of 44,928,923 in 2012 would indicate major declines in miombo woodland. Likewise in Mozambique, where the total population was 2.6 million people in 1900, 6.4 million in 1950, 23.3 million in 2010 and is 24 million today. In summary, CITES App. II listing is justified for:

- *A. quanzensis* on the basis of the habitat declines, the massive increase in export of this species to Asia (primarily China) where it is popular for flooring, doors and possibly as an "unofficial" rosewood (*hong mu*, 红木) species[9] due to its red-brown timber. Even without the influence of climate change on its population biology, *A. quanzensis* is characterized by poor recruitment (GERHARDT & TODD, 2009) coupled to a typically clumped distribution and very slow growth rates (GAUGRIS et al., 2008);
- *D. melanoxylon* due to the huge rise in export of *D. melanoxylon* to Asia (including as unprocessed roundwood from Mozambique), high levels of illegal logging, very slow growth rates and unsustainable use in several Range States, including Burkina Faso, Kenya, Malawi, Mozambique and Tanzania, coupled to habitat loss of this slow growing, highly valuable species;
- *P. angolensis* due to the increase in both domestic and international demand for this species, including as an substitute for *Pterocarpus indicus*, an official *hong mu* species whose appearance is almost identical to that of *P. angolensis*. Matrix population models and ecological studies of this species in South Africa and Tanzania predicting population declines (CARO et al., 2005; DESMET et al., 1996; SHACKLETON, 2002 and SCHWARTZ et al., 2002). High levels of illegal logging and DE CAUWER et al.'s (2014) projections of the negative impact of climate change on this species in the drying western parts of its range (western Botswana, eastern Namibia, south-eastern Angola) and the influence of fungal wilt disease on this species in wetter parts of its range (parts of South Africa, Zambia and Zimbabwe).

6 Recommendations

In the introduction of this report, I quoted from the INDUFOR (2005) study on Tanzania timber management that pointed out the overwhelming evidence that the current system of timber regulation is unworkable. It is too „slippery" due to the „mismatch between the regulatory regime and the system it is expected to regulate on the ground". This „slipperyness" is

[9] the term "unofficial" is used here as *A. quanzensis* is not listed on China's national standard (SAQSIQ 2000) for rosewood "hong mu" species that nominated 33 "hong mu" tree species (one of which is a synonym) in two plant families and five genera.

not uncommon. So the overarching question in relation to the CITES related recommendations in the preceding section is: Do we really want to be effective?

There is no doubt that CITES Appendix II listing for timber species raises awareness. In the European market, CITES App. II listing also offers opportunities for more stringent measures in the face of poor governance, for example through "Non-detriment findings" and trade to the EU. Trade regulations such as the European Union Timber Regulation (EUTR) and the EU's voluntary agreement process on Forest Law Enforcement, Governance and Trade (FLEGT) certainly have an important role to play. However, to win more than a single victory, while still losing the war against environmental crime requires a comprehensive approach. Solving the challenge to sustainable development and conservation posed by environmental crime requires political will, civil society support and the actions of independent judiciaries in timber exporting and importing countries. It also requires great resilience. This is not a sprint to quick success over a political term of a few years. It is a long-distance marathon that requires well thought out strategies over decades. After all, we are dealing with valuable hardwoods that take over a century to get to a minimum harvestable diameter. Highly relevant recommendations have already been made in the excellent recent UNEP report (NELLEMANN et al., 2014). As this UNEP report is easily available, it is not the intention of this report to repeat all of them. So I will quote just three recommendations from NELLEMANN et al. (2014). These are that UNEP:

- "***Calls upon the entire international and bilateral donor community to recognize and address environmental crime as a serious threat to sustainable development*** *and revenues, and to support national, regional and global efforts for the effective implementation of, compliance with and enforcement of targeted measures to curb illegal trade in wildlife species and their products as well as illegal logging in timber*"; and to
- "***Support immediate, decisive and collective action to narrow the gap between commitments and compliance,*** *such as the ones expressed in multilateral environmental agreements, through national implementation and enforcement, including the relevant decisions and resolutions taken by their governing bodies intended to combat the illicit trade in wildlife and forest products*", and to
- "***Strengthen international and development support to the entire enforcement chain,*** *including frontline, investigator, customs, prosecutors and the judiciary, with particular reference to environmental crime to support legal revenues and sustainable development, and to reduce the impacts on the environment from environmental crime*".

The recommendations made below build on those given above.

6.1 Understand where the power lies and take a comprehensive approach

It is clear from field observation and discussions held during this study that political power and elite capture have a much greater influence than property rights on who is able to exploit high value timber resources. It is also well known that in common with many countries, the Ministries of Finance and Revenue Authorities are far more powerful than those dealing with forestry or conservation. It is true that illegal logging and associated impacts on wildlife are a complex problem, often with major vested interests. However the financial costs of illegal logging are increasingly well known and large enough for illegal logging to be declared an economic crime rather than just environmental crime so that State Revenue authorities become more closely involved.

Several recent policy initiatives offer hope if they are comprehensively implemented and scaled out. These are firstly, the International Consortium on Combating Wildlife Crime (ICCWC) and secondly, the Extractive Industries Transparency Initiative (EITI) and the "*Publish*

what you pay" movement. As recommended below, asset forfeiture is a key deterrent (see also GREENBERG et al., 2009). The role of anonymous tips about illegal logging and the wildlife trade should not be discounted. During this study for example, I met with a person working together with mining companies in Tanzania. In addition to information on illegal trade in gemstones, gold and human trafficking from a network of informants, he also periodically gets information on the illegal wildlife trade. While I was in southern Tanzania this included reports of an individual in a village close to the Mozambique border, offering four elephant tusks, two lion skins, a leopard skin and two pangolin skins for sale. If such information could be passed on to a trusted environmental crime unit, this could assist law-enforcement efforts.

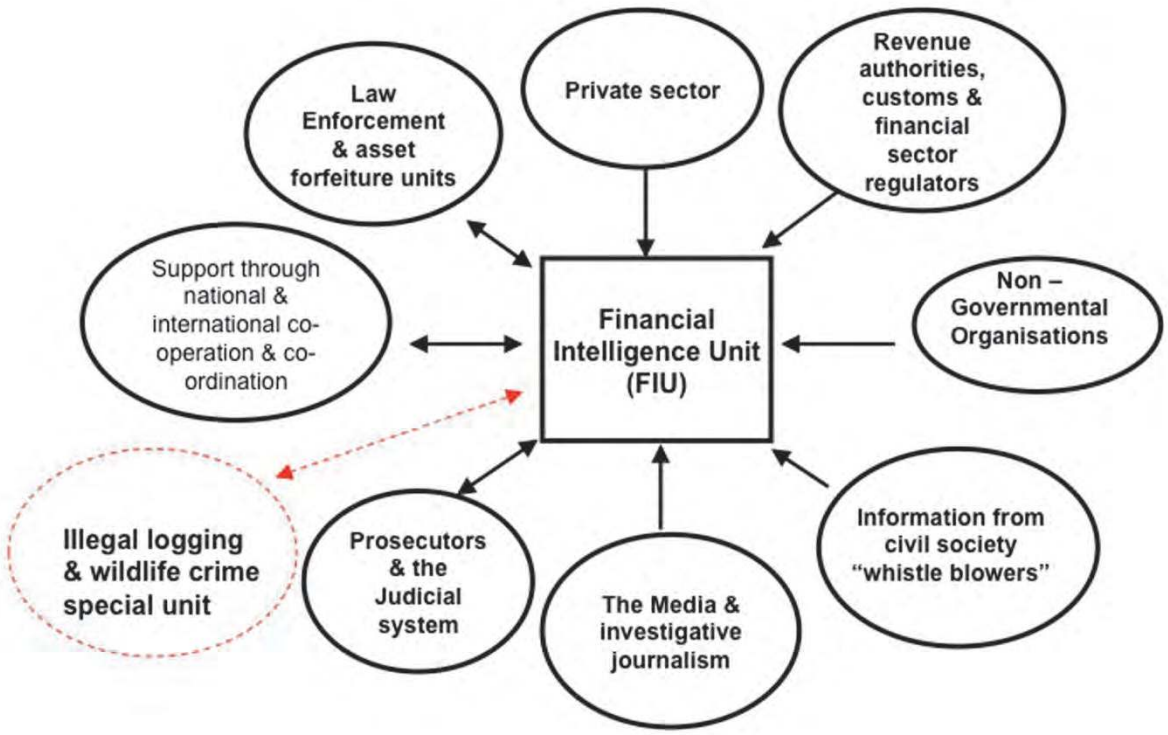

Figure 38. Financial intelligence = intelligent conservation. Modified and redrawn from the World Bank Financial Intelligence Unit Work book (WORLD BANK, 2005).

6.1.1 Scale out and support implementation of the International Consortium on Combating Wildlife Crime (ICCWC) goals. The first initiative that deserves support for on-the ground implementation is the ICCWC. This was formed in November 2009 by representatives from the CITES Secretariat, the International Criminal Police Organization (INTERPOL), the United Nations Office on Drugs and Crime (UNODC), the World Bank and the World Customs Organization (WCO). Realistically, effective implementation of the ICCWC is only possible in countries where the political will exists to do so and where there is the capacity to enforce regulations. So the establishment of a new Interpol office in Nairobi in October 2014 that will be dedicated to fighting environmental crime in the East African region is an encouraging development.

6.1.2 Strengthening ICCWC implementation through the World Customs Organization (WCO). By increasing the costs and efficiency of shipping goods worldwide, containerization

has revolutionized trade since the 1950's (HAYUT, 1981; MCCALLA et al., 2004). By 2009, about 90% of non-bulk globally was moved in containers on transport ships and 26% of all container transshipment was carried out in China. Most of these shipments are perfectly legal. But some are not. In those cases, ivory and pangolin scales are often shipped with timber or on their own in mis-labelled containers. For example in 2013, a Chinese garlic business in Dar es Salaam tried to mask an 1.8-ton ivory shipment from Tanzania, and in Mozambique in 2011, the Chinese company Tienhe tried to smuggle 126 tusks hidden in a timber consignment (NELLEMAN et al., 2014). Unlike the "slippery" side of illegal logging and hunting in remote areas that is so difficult to track, containerization concentrates products in ports and on ships, offering a tracking and control opportunity that is not „slippery" at all. The ports of Mombasa (Kenya) and Dar es Salaam (Tanzania) are good examples. Mombasa handles export goods from a huge area of East and Central Africa (Uganda, Tanzania, the DRC, Southern Sudan, Rwanda, Sudan, Ethiopia and Somalia) in addition to goods from Kenya. And the port of Dar es Salaam exports goods from Zambia, Malawi, Burundi, Rwanda, Uganda and the DRC in addition to Tanzania. It therefore makes strategic sense to strengthen the WCO/ICCWC partnership. Even without the WCO, it is possible to use container numbers to track individual containers from 123 companies using the website http://www.track-trace.com. With the WCO a member of ICCWC, much more is possible. Recommendations in this regard are made below.

6.1.2.1 Work with the World Customs Union (WCO) to track containers with illegal wildlife and timber products and get data on the firms involved. There already are policy initiatives through the EU, UNCTAD and the World Bank to gather firm-level data on customs and trade. With the right support and political will, this should be extended to use the databases on international trade maintained by customs administrations to gather firm level data on companies involved in environmental crime, including illegal timber trade.

6.1.2.2 Support the recent call for fine-tuning of the Harmonized Commodity Description and Coding System (usually referred to as the Harmonized System (HS)): As Chan et al. (2015) point out, both timber trade statistics collected under the current HS system are very poor. So is the accuracy of taxonomic records under the HS codes. This is unfortunate given the volume and value of the timber trade. CHAN et al. (2015) have therefore recommended that at the forthcoming amendment process, the global HS codes should be expanded from their current 6 to 10 digits. Ideally this should improve taxonomic data by specifying the genera and species of the products in trade.

6.1.2.3 Through the ICCWC partnership with WCO, work with shipping companies from the EU and North America. There is not only a high level of public awareness of the illegal ivory and timber trade in Europe and North America, but also amongst shareholders of these companies. Some companies, such as the A.P. Moller – Maersk Group also produce annual sustainability reports. Most will be aware of the EUTR, the Lacey Act, or in Canada, the Wild Animal and Plant Protection and Regulation of International and Inter-provincial Trade Act (WAPPRIITA).

In cases where organized crime is involved, such in the abalone and ivory trade, then the Racketeer Influenced and Corrupt Organizations Act (RICO) legislation in the USA may also apply. The Pelly Amendment may also be relevant.

6.1.2.4 Encourage checking of containers before they get to port. Some neighbouring countries that rely on East African ports such as Dar es Salaam have their own cargo centers. These may be on the way to the port or can be far inland, such as at Mbeya. The Zamcargo yard near Dar es Salaam is owned by Zambia, consolidating imports and exports to

clear and forward cargoes destined for Zambia. Similarly, the Malawi Cargo Centers (MCCL) owned by the Malawian government in Mbeya could be a place to check containers before they are shipped (Figure 39).

Figure 39. Through their partnership with the ICCWC, the World Customs Union (WCO), working with regional customs unions, can play an important role in dealing with environmental crime, including through checking containers in inland “dry ports” owned by one country (Malawi) in another (Tanzania), such as the Malawian government’s Malawi Cargo Center (MCCL) in Mbeya, Tanzania. Photo: A.B. Cunningham.

6.1.2.5 Improve collaboration between the Forestry and Conservation authorities and Revenue and Customs authorities. This could start at the major ports then expand to smaller ports. In Tanzania, this could start at Dar es Salaam and then expand to small ports at Kilwa Kivinje, Kilwa Masoko, Lindi and Mtwara, all of which are run by the Tanzania Ports Authority. This would help prevent the cross-border „leakages“ that currently occur. In Kenya, the starting point would be Mombasa, then scaling out to smaller harbours where transport timber by dhows occurs (Lamu and Malindi). The same could apply in the five ports in Mozambique (Beira, Pemba, Nacala, Maputo, Quelimane) and 15 official ports in Tanzania, including Zanzibar (which is said to sometimes serve as an illegal trans-shipment point for *Dalbergia* logs from Madagascar).

6.1.2.6 Through Regional Customs Unions and support from the WCO, develop a common approach to timber valuation. According to WWF (2012), customs clearance in parts of East Africa use kilograms instead of m^3 for timber. It would be useful for the WCO, through the EAC and COMESA to ensure that sawn wood dimensions, number of pieces and volume are given in m^3 rather than kilograms (which vary according to wood density). At the moment, based on the 2007 EAC Common External Tariff, taxes are paid on volume (m^3) and quantity of timber should be expressed in m^3, in common with international standards.

6.1.2.7. Train customs staff in correct wood identification: In addition to "high tech" tools like micro-satellite markers for tracking timber, an affordable way of distinguishing between woods that look alike is using fluorescence. This enables woods (such as some *Pterocarpus* and *Dalbergia* species) that look very similar to the naked eye under normal lighting conditions to look very different using a black-light based on the presence or absence of their fluorescent qualities. In his key to Indian timbers, for example, PURKAYASTHA (1997) points out that water extracts from *Pterocarpus* are fluorescent, while water extracts from *Dalbergia* are not fluorescent. This may be a cost effective tool worth testing across the full range of species.

6.1.2.8 Implement a ban on export of unprocessed roundwood and rough-cut logs. Tanzania already implements their ban on export of unprocessed logs, but Mozambique does not. What is urgently needed is a ban on the export of unprocessed logs, half-cut logs and rough-cut timber > 125mm thick. Based on discussions during this study, there is widespread support for a ban of this type, including from the head of the Associacao de Industriais de Madeira de Cabo Delgado (AIMCAD) (N. Gabriel pers. comm, 2015).

6.1.2.9 Improving timber trade tracking along supply chains and better use of tracking technologies: Improving tracking of timber and wildlife products helps gather information to prevent illegal trade. There are several ways of doing this, from practical low technology methods to the use of micro-satellite markers. In field situations, practical methods use the unique fluted profiles of *D. melanoxylon* trees. This has been used with success to locate illegally felled logs in containers at the port of Pemba, Mozambique. Other detection or tracking options are use of:

- sniffer dogs trained to detect pangolin scales, abalone and ivory hidden in containers;
- high resolution satellite imagery to identify and track illegal shipments of timber as part of European and North Amercian initiatives back up to the EUTR, *Canada's Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act* (WAPPRIITA) and the Lacey Act in the USA;
- radio-frequency identification (RFID) tags that emit radio-frequency electromagnetic fields to track many industrial products or livestock (see for example: http://www.hidglobal.com). RFID tags are bar-coded and are getting cheaper and cheaper (often less than $ 1 each). The cheapest tags are wires used in retail stores and industry for inventory and tracking of clothing, pharmaceuticals or other stock. These are read at short ranges (a few meters) as they are based on magnetic fields. Others are powered by tiny batteries and are used to track trains or animals. These could be used to track individual logs, tusks, pangolin skins or logging vehicles;
- additional research on tracking timber through use of micro-satellite markers.

6.2 Support the Extractive Industries Transparency Initiative (EITI) and the "*Publish what you pay*" movement.

International donors have put significant funding into improving financial accountability in the minerals and oil and gas sectors. Unlike the Kimberly Process (2003), that is focused on diamonds, the EITI started with minerals, oil and gas but has since expanded in African countries such as Liberia and Mozambique to include timber. In Mozambique, six Mozambican civil society organizations (CSOs) have formed a coalition to bring greater transparency to the extractive industries, including forestry (CIP, 2010). This CSO coalition is linked to Global Witness's *Publish What You Pay* movement and to EITI. Through the newsletter of one of the CSO coalition members (the Centro de Integridade Pública [CIP; Public Integrity Centre]), it has been possible to expose cases such as illegal logging corruption (CIP, 2014). In Liberia,

this has been taken even further through the Liberia Extractive Industries Transparency Initiative, an Act of Parliament in 2009 formally including timber within the Liberian EITI[10].

6.3 Strengthen ICCWC implementation through the World Bank and national asset forfeiture and money laundering units in relation to environmental crime.

Given the logistic difficulties and disheartening process of arresting individual illegal loggers who are trying to survive economically in remote and poverty stricken areas, it makes sense, if the legal commitment and political will allow this to go for "kingpins" in the illegal logging and wildlife trade. The WCO recommendations given in the previous section are part of this. But with the World Bank a partner in the ICCWC, this offers a very important tool: asset forfeiture or asset seizure. This involves the confiscation of assets by the state that are derived from the proceeds of crime or were used in the process (such as vehicles and other equipment). Unlike laws in many countries where people are assumed innocent until proven guilty, the opposite applies in where it is suspected that assets were acquired due to illegal activity. In those cases, the individuals concerned need to prove that they are innocent (reverse onus). In South Africa, the Asset Forfeiture Unit (AFU) in the Office of the National Director of Public Prosecutions has focussed on taking test cases to court and creating the legal precedents to show the effective use of the law in order to have an impact on priority crimes. In the process, there is strong co-ordination between the South African Police Service (SAPS), and the South African Revenue Service (SARS)[11]. A similar approach could be taken in East Africa. Ted Greenberg, who works on money laundering related to illegal logging for the World Bank's Financial Market Integrity section would be a key person in this regard. Particularly in connection with non-conviction based asset forfeiture (see GREENBERG et al., 2009). The big challenge in tackling the "kingpins" rather than local villagers at the start of the supply chain is that it needs significant legal expertise and financial support. Unlike villagers doing the illegal logging or hunting elephant or rhino, „kingpins" are usually very well connected and can afford to get the best legal expertise to avoid prosecution.

6.4 Improvements to trade policies on timber

The Chinese government can play key role in ensuring that African hardwoods are used wisely for the future. Based on discussions with Chinese colleagues, there still is a need to build awareness about the scale of over-exploitation that has ocurred. And there is embarrassment about exploitation by Chinese logging companies that "*drain the pond to catch all the fish*" (竭泽而渔, *jiézé'éryú*) (the equivalent of the English expression, of "*killing the goose that lays the golden eggs*"). This lack of awareness persists despite very frank reports on the impact of the timber trade from Mozambique, such as „*Chinese Takeaway*" (MACKENZIE, 2006) and „*First class crisis: China's criminal and unsustainable intervention in Mozambique's miombo forests*" (EIA, 2014a) that are widely available in English. There is no doubt that both of these reports had a high impact in Europe and North America. Based on the perspective advocated by CHAN (2013), a scholar at the School of Oriental and African Studies with many years of experience on what the most effective approaches are in terms of Beijing's policy in Africa, a more nuanced strategy is recommended below. This is worth pursuing through current Sino-German co-operation initiatives and requires a better understanding

[10] see http://www.leiti.org.lr/

[11] http://www.npa.gov.za/ReadContent387.aspx

of the roles of Chinese private enterprise, the Chinese national and provincial government in the logging trade.

6.4.1 Develop a better understanding of the role of kinship networks in the timber trade from Africa to China. Across the world, social relationships (through kinship, marriage and ethnicity) provide an important mechanism in business for establishing long-term trust. I suggest that the role kinship networks in environmental crime are poorly understood. And that a hypothesis worth testing is that the timber trade from Africa to China is dominated by Fujianese networks. This hypothesis is also backed up by two sets of evidence. Firstly, the recent study across six southern African countries, where in some countries, over half of all the Chinese traders (in all businesses, not just timber) were from Fujian, the origin of less than 3% of China's total population (McNamee, 2013). In the cases encountered by McNamee (2013), the shift from China to being a self-employed trader and small business owner in Africa was enabled by strong family, village or provincial networks. Secondly, the major ports through which African timber is imported into China are between Guangdong and Shanghai, the coastal area to which many Fujianese entrepeneurs migrated. There are several reasons why a better understanding of these kinship networks would be useful. One is that overemphasis on the Chinese governments „going-out" policy as a major driver (e.g: Wertz-Kanounikoff et al., 2013) can be misleading. Based on Wenbin & Sun's (2013) study of rosewood business's, only 14.8% were State-owned enterprises, whereas 80.4% were private enterprises. The other is that while people from Fujian are incredibly entrepreneurial in Africa, McNamee (2013) reports that there also is „*considerable tension, not least amongst the wider Chinese migrant community, who are widely critical of their approach to business, if not their character*". In African conservation circles, these tensions are evident within southern Africa due to cases of mainly Fujianese traders illegally buying wildlife products from local people who are offered money to do so. These range from Carmine bee-eaters and pangolins to ivory and timber. In terms of a policy reforms, the increased awareness that "*draining the pond to catch all the fish*" is not good for China's international image is an important opportunity.

6.4.2 Through international co-operation with China, initiate a consultation process with key Ministries in Beijing on how to change the current „resource mining" of timber and animal products to wise management and more effective *in situ* conservation. Since the 1998 logging ban, China has become the major importer of tropical timber, including from Mozambique. Most of this timber is exported to ports on the seaboard of eastern China, from Guangzhou to Shanghai. China's largest timber market, the Guangdong Yuzhu International Timber Market in Guangzhou, is State owned. As the Guangdong Yuzhu International Timber Market handles timber from the Huangpu harbour as well as Shenzhen, Shanghai and Zhangjiagang port, positive changes in trade policy that influenced this State-run market would have major influences on what happens in tropical forests worldwide. An example of the types of policy change that could take place through positive dialogue are:

- Changes to the import agent system, which as Wenbin & Sun (2013) point out, increases the risk of illegal trade;
- revision of the National Hongmu Standard so that trade shifts to faster growing, less threatened *hongmu* species and away from highly threatened species and improved monitoring of imported *hongmu* species.

Discussions with China's National Forest Product Industry Association and the Hongmu Sub-Committee would be an important part of this process.

6.4.3 Raise awareness about the seriousness of illegal wildlife trade in order to discourage buying of ivory and pangolin skins by workers in the four Chinese construction companies currently building a tarmac road through the elephant corridor that links Niassa National Reserve (Mozambique) and Selous Game Reserve (Tanzania). All four construction companies (the China Railway Seventh Group Co. Ltd., the Jiangxi Geo-Engineering Group Corporation, the Sinohydro Corporation Ltd. and the China Civil Engineering Construction Corporation) that are building different sections of the road through the wildlife corridor (Figure 40) are State owned or have strong links to the Chinese government. They also are amongst the world's largest construction companies and work across Africa, Asia and South America. If implemented, this would build on significant German funding through BMZ, KfW Bank and the Frankfurt Zoological Society over many years to support Selous Game Reserve and the Niassa-Selous corridor. It would also link to the current cross-cutting political cooperation (Polifund) project supported by BMZ („*Combating Poaching and Illegal Wildlife Trade (Ivory and Rhino Horn) in Africa and Asia*" that runs until December 2015 (OECD, 2014) and the GIZ project on „*Sustainable Management of Natural Resources in Tanzania*" (GIZ, 2014).

6.5 Improve plantation management

6.5.1 Develop and better manage plantations for domestic production of timber for domestic use (construction, carpentry) from overexploited indigenous species to on-farm production & plantations species. The significant shift in domestic timber use away from indigenous hardwoods (*Pterocarpus angolensis* and *Afzelia quanzensis*) towards lower cost softwoods (pine, cypress) needs to be supported. Plantations could play an even greater role in supplying wood to the towns and cities. Improved softwood production can relieve pressure on the miombo woodlands and indigenous forest that have been over-exploited in the past and need to be better managed for the development of products based on high value indigenous hardwoods.

6.5.2 Re-assess the re-planting schemes that are a requirement of the wild harvest management plans. In Mozambique, a requirement of both simple licences and large commercial logging concessions is that licence holders need to replant seedlings. This generates businesses for local nurseries supplying seedlings (Figure 41). But based on field observation, seedling survival rates are low due to the effects of fire, grazing and lack of water after planting out into miombo woodland.

6.5.3 Undertake environmental impact assessments before new plantations further expand into montane grasslands in East Africa. Although the pine and *Eucalyptus* plantations in southern Tanzania provide the major alternative source of timber to indigenous hardwoods, they appear to have had an impact on populations of several orchid genera that produce edible orchid tubers. Due to overharvest of edible orchid tubers in Zambia, an estimated 2.2 – 4.1 million orchid tubers in the genera *Brachycorythis, Disa, Habenaria* and *Satyrium* are collected from the Tanzanian Southern Highlands region each year for consumption in Zambia (DAVENPORT & NDANGALASI 2003; MAPUNDA, 2007). All Orchid species are CITES listed, this is an issue of concern. According to local people in Makete, southern Tanzania, edible orchids rarely occur in *Pinus* and *Eucalyptus* plantations (MAPUNDA, 2007).

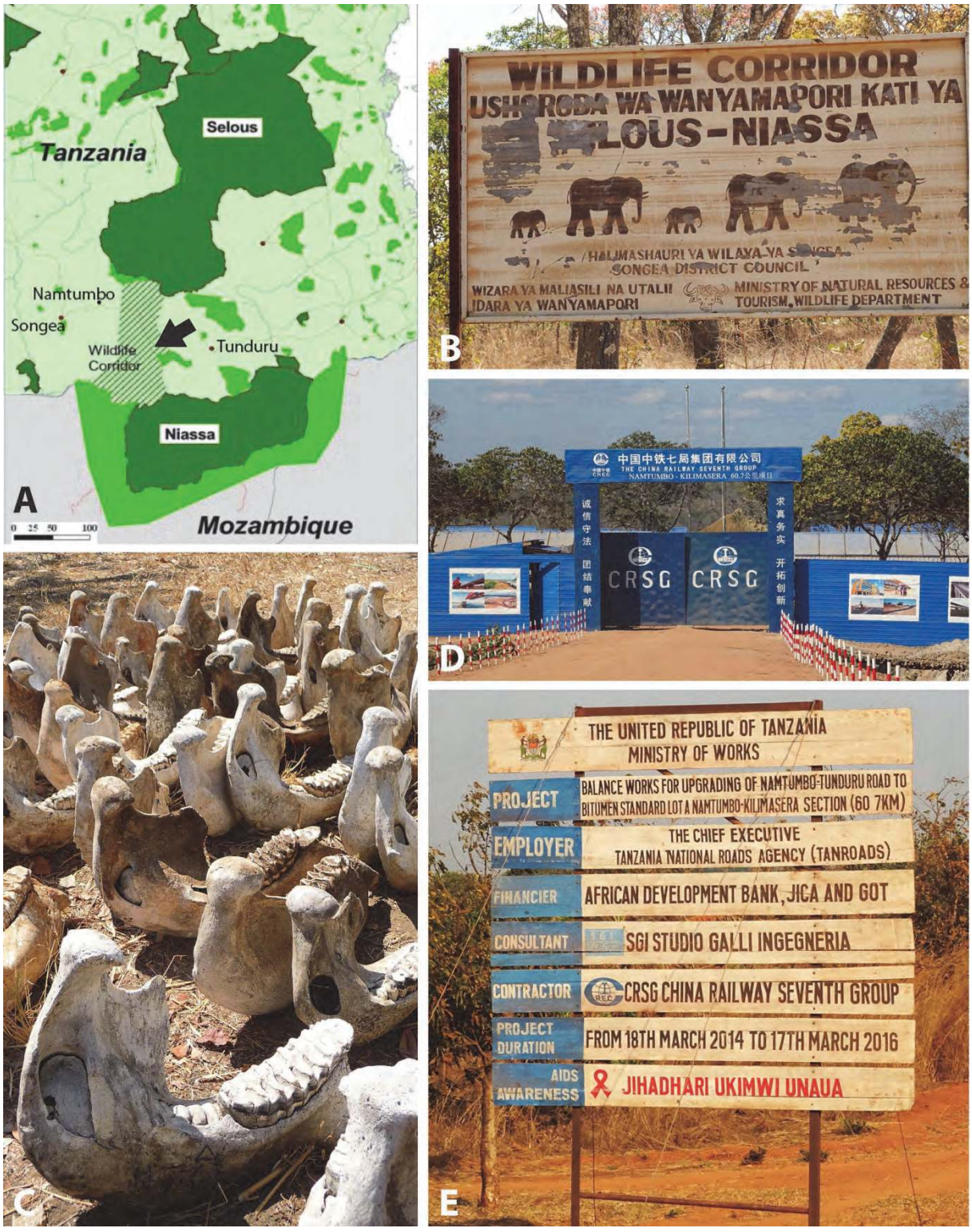
Selous
Tanzania
Namtumbo
Songea
Wildlife Corridor
Tunduru
Niassa
Mozambique
A
0 25 50 100
WILDLIFE CORRIDOR
USHOROBA WA WANYAMAPORI KATI YA
LOUS-NIASSA
HALMASHAURI YA WILAYA YA SONGEA
SONGEA DISTRICT COUNCIL
WIZARA YA MALIASILI NA UTALII
IDARA YA WANYAMAPORI
MINISTRY OF NATURAL RESOURCES &
TOURISM, WILDLIFE DEPARTMENT
B
C
中国中铁七局集团有限公司
THE CHINA RAILWAY SEVENTH GROUP
CRSG
CRSG
D
THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF WORKS
PROJECT
BALANCE WORKS FOR UPGRADING OF NAMTUMBO-TUNDURU ROAD TO BITUMEN STANDARD LOT A NAMTUMBO-KILIMASERA SECTION (60 7KM)
EMPLOYER
THE CHIEF EXECUTIVE
TANZANIA NATIONAL ROADS AGENCY (TANROADS)
FINANCIER
AFRICAN DEVELOPMENT BANK, JICA AND GOT
CONSULTANT
SGI STUDIO GALLI INGEGNERIA
CONTRACTOR
CRSG CHINA RAILWAY SEVENTH GROUP
PROJECT DURATION
FROM 18TH MARCH 2014 TO 17TH MARCH 2016
AIDS AWARENESS
JIHADHARI UKIMWI UNAUA
E

Figure 40

Figure 40. If roads through wildlife corridors are inevitable, then impacts on illegal logging and the wildlife trade need to be minimized. A. Map showing the area zoned as a Wildlife Management Area (WMA) in order to maintain a wildlife corridor. **B.** The sign marking the corridor for elephant movement between Niassa National Reserve and Selous Game Reserve. **C.** Lower jaws of a few of the thousands of elephants poached per year in Niassa National Reserve. Much of this is transported into Tanzania, including through the border between Namtumbo and Tunduru (well known for its trade in gemstones and illegal timber). **D.** The road camp of the China Railway Seventh Group (CRSG) near the Niassa-Selous corridor. CRSG are a subsidiary of the state owned China Railway Engineering Corporation (CREC), one of the largest engineering companies in the world. **E.** Coordination to combat wildlife crime may also be possible through donors such as the Japan International Cooperation Agency (JICA) and the Africa Development Bank (ABD) who while they fund the road, also express concerns about the environment. Map modified from map in PICARD (2010). Photos: A.B. Cunningham.

Figure 41. Selling thousands of seedlings as required by forestry policy is good business: but what are seedling survival rates after being planted out? *Afzelia quanzensis* seedlings in a nursery south of Pemba, Cabo Delgado. Very few seedlings will survive fire and dry season conditions. Photo: A.B. Cunningham.

6.6 Improved management of natural populations

During this project, the combination of poor road conditions after the floods in northern Mozambique did not allow for a field inspection of the concessions (either simple concession for commercial forestry concessions) harvested for *Dalbergia melanoxylon, Pterocarpus angolensis* or *Afzelia quanzensis*. It is generally acknowledged that in all three countries there is a big gap between well-written policies on forest management and the reality of what is happen-

ing on the ground (MILLEDGE et al., 2007; KLÄY et al., 2008; FAEF, 2013). Based on three years work in Cabo Delgado, Mozambique in the 1980's, followed by an assessment in 2008, KLÄY et al. (2008) sum up the situation well:

> *"The research team observed that current management schemes consist mainly of strategies of nature mining by most stakeholders involved. Institutional settings - formal and informal - have little impact due to weak capacity at the local level and corruption. Local difficulties in a remote rural area facilitate external access to resources and are perpetuated by the loss of benefits. The benefits of logging remain at the top level (economic and political elites)".*

KLÄY et al., 2008 also point out that:

- the data on which logging is based in management plans and the underlying statistical extrapolations are both weak;
- overexploitation is particularly prevalent in concession blocks that are more accessible; and
- assessments of timber potential made by the concessionaires are „rough" and are *„characterised by a very high level of uncertainty, due to the fact that very little is known about the history of degradation/deforestation (i.e. prior to the establishment of the concession)".*

6.6.1 Revise policies on forestry concessions and simple licences in Mozambique. While the intention behind „simple licences" in Mozambique was good, they are often mis-used for large-scale commercial purposes. Excellent recommendations were made in this regard by MACKENZIE & RIBEIRO (2009) and deserve support so that they are implemented. These are to:

- "*implement a moratorium on simple licenses and new concessions; subject all existing concessions to independent assessment, and any approved operators, continue subject to routine independent forest monitoring;*
- *Stop the illegal export of logs;*
- *Revise concession policy to ensure fewer, larger concessions that have Annual Allowable Cuts (AACs) based on at least a 30 year rotation that are sufficient to support a viable industry;*
- *Reinstitute the requirement for full processing; end rough sawing and export of planks.*
- *Support local industries for sustainable economic development. Facilitate affordable credit. Provide technical training for forest industry workers.*
- *Conduct independent reviews of the two existing forest inventories and develop a realistic assessment of remaining forest resources.*
- *As part of the reactivated computerised forest licensing and infractions databases, get licences and transport permits printed off directly from the computer, with unique reference numbers linking back to the database.*
- *Publish the details of all licences issued each year and inform concerned communities of the volumes and species that will be extracted and the value of the 20% of royalties they can expect to receive.*
- *Strengthen enforcement at the checkpoint at Nicoadala – since it is on the only road route to the Quelimane port, it is the key point for any forest law enforcement.*

- *As a matter of urgency, the fully computerised SPFFBZ* (editor's note: Servicos Provinciais de Florestas e Fauna Bravia da Zambézia/Provincial Forest and Wildlife Services) *checkpoint in the Quelimane port should be re-established;*
- *Establish full computer links between the Nicoadala and port checkpoints and the provincial headquarters.*
- *Link licensing and infractions databases to an internet site, with open public access;*
- *Devise a national standardised annual reporting format for forestry that is meaningful, and ensure accurate completion every year*".

6.6.2 Growth rate and tree age data. Although reliable age estimates are available for *D. melanoxylon* (GREGORY et al., 1999; BALL, 2004) and *P. angolensis* across a range of sites (STAHLE et al., 1999; THERRELL et al., 2007) and some annual girth increment data are available for *Afzelia quanzensis* (GAUGRIS et al., 2008), accurate age estimates are urgently needed for *A. quanzensis*. Ring-dating for tropical trees is more widely applicable than previously thought (STAHLE, 1999). It is recommended that a study is funded to establish the ages of samples of *A. quanzensis* based on samples collected from sawmills in northern Mozambique (Pemba) and in southern Tanzania.

6.6.3 Build on existing initiatives for independent monitoring in Tanzania and Mozambique, coordinating with FLEGT in the process: Independent monitoring is a useful but politically sensitive step where governance is weak and corruption levels are high. Recommendations have been made for independent monitoring in Tanzania (REM, 2009).

6.7 Support businesses that add value to sustainably harvested indigenous hardwoods.

In Kenya, Mozambique and Tanzania, there are businesses that make wise use of local hardwoods. As MACKENZIE & RIBEIRO (2009) have recommended, there is a need to support local industries for sustainable economic development. This can include technical training, not only for forest industry workers, but also in product design and marketing. This is available across southern Africa through the Furniture Technology Centre Trust t/a Furntech[12], who are based in South Africa, but have recently opened up a branch in Maputo, Mozambique.

6.8 Raising awareness: civil society, end-users of timber products and the media

Without the checks and balances that lead to good governance, neither sustainable harvest nor conservation are possible. An aware citizenry, independent media and functioning judiciary are essential.

6.8.1 Civil society within Kenya, Mozambique and Tanzania. There is a need to actively support the efforts by intergovernmental and non-governmental organizations to halt illegal logging and wildlife crime. Support to civil society organisations such as Amigos da Floresta and Justiça Ambiental in Mozambique and the Tanzania Forest Conservation Group (TFCG) in Tanzania is an essential component of maintaining transparency through appropriate checks and balances and the media.

[12] www.furntech.org.za

6.8.2 Support the careful design of consumer awareness campaigns: Awareness campaigns need to be tailored to different audiences in specific contexts, whether local, national or international. There is significant scope to work with musicians on *Dalbergia melanoxylon* issues, as the “Soundwood” and “Sound and Fair” programmes have done in the past.

6.8.3 Raise awareness amongst wood buyers and importers: It would be strategic to consider working with Eric Meier, who created the Wood Database project (http://www.wood-database.com) to contribute to this website by adding more detail on the conservation status of the timber species, including *Afzelia, Dalbergia* and *Pterocarpus* species.

6.8.4 Strengthen pubic awareness through certification schemes, such as the Forest Stewardship Council (FSC), to increase consumer recognition of sustainably harvested products and encourage exporters to consider full FSC certification rather than just certification of processing facilities.

6.9 Dealing more effectively with environmental crime and corruption.

It is clear from many studies on the timber trade that political power and elite capture have a much greater influence than property rights on who is able to exploit high value timber resources. Linked to this is the need to develop approaches to deal with corruption that recognize the power of many of those same actors. Several components of this have been mentioned already. These include comprehensive, co-ordinated approaches based on financial intelligence (Figure 38), an informed citizenry and an independent media and judicary and effective monitoring. Linked to this is the need to:

6.9.1 Support capacity building and the use of new technologies (tracking, monitoring, law enforcement). In particular, there is a need for support to field rangers employed by national forestry and conservation environment law enforcement agencies and for local communities committed to participatory forest management.

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8 References

AKIDA, A., MNANGWONE, I., & LYIMO, L. (2012). Financing for Sustainable Forest Management in Tanzania. Indufor Oy. – URL: http://www.un.org/esa/forests/pdf/facilitative-process/Tanzania_study.pdf (downloaded 23 June 2015).

ANON. (2012). Joint Statement. Operationalization of Memorandum of Understanding signed between National Directorate of Land and Forests of the Republic of Mozambique and Tanzania Forest Services of the United Republic of Tanzania.

ANON. (2013). Frelimo's gold rush. – Africa Confidential 54: 8-9.

ANON. (2014). Rosewood plunder in Guinea Bissau. 22 July 2014. – URL: http://www.irinnews.org/report/100387/rosewood-plunder-in-guinea-bissau (downloaded 12 August 2014).

ARBONNIER, M. (2004). Trees, shrubs and lianas of West African dry zones. – Editions Quae.

BÂ, A. M., DUPONNOIS, R., MOYERSOEN, B., & DIÉDHIOU, A. G. (2012). Ectomycorrhizal symbiosis of tropical African trees. – Mycorrhiza 22 (1), 1-29.

BÂ, A. M., SANON, K. B., & DUPONNOIS, R. (2002). Influence of ectomycorrhizal inoculation on *Afzelia quanzensis* WELW. seedlings in a nutrient-deficient soil. – Forest ecology and management 161 (1), 215-219.

BAKER, P. J., BUNYAVEJCHEWIN, S., OLIVER, C. D., & ASHTON, P. S. (2005). Disturbance history and historical stand dynamics of a seasonal tropical forest in western Thailand. – Ecological Monographs 75 (3), 317-343.

BALL, S. M. (2004). Stocks and exploitation of East African blackwood *Dalbergia melanoxylon*: a flagship species for Tanzania's miombo woodlands? – Oryx 38 (03), 266-272.

BALL, S. M. J. & GREGORY, A.-M. (2006). Rapid Stocks Assessment of Mpingo and Other Timber Species for Kilwa District. – The Mpingo Conservation Project, Kilwa.

BANACK, S. A. & COX, P. A. (1987). Ethnobotany of ocean-going canoes in Lau, Fiji. – Economic Botany 41 (2), 148-162.

BANDA, T., SCHWARTZ, M. W., & CARO, T. (2006). Effects of fire on germination of *Pterocarpus angolensis*. – Forest Ecology and Management 233 (1): 116-120.

BEACHEY, R. (1967). The East African ivory trade in the nineteenth century. – Journal of African History VIII (2): 269-290.

BEENTJE, H. (1994). Kenya trees, shrubs, and lianas. – National Museums of Kenya, Nairobi.

BENNETT, E. L., EVES, H. E., ROBINSON, J. G., & WILKIE, D. S. (2002). Why is eating bushmeat a biodiversity crisis. – Conservation in Practice 3, 28-29.

BIGINAGWA, T. J. (2012). Historical archaeology of the 19th century caravan trade in north-eastern Tanzania: a zooarchaeological perspective. – PhD thesis, York University.

BOALER, S. B. (1966). The Ecology of *Pterocarpus angolensis* DC in Tanzania. – Overseas Research Publications. H.M. Stationery Office, London.

BOND, W. J & VAN WILGEN, B. W.(1996). Fire and Plants. – Chapman & Hall, London.

BRADLEY P. & DEWEES, P. (1993) Indigenous woodlands, agricultural production and household economy in the communal areas. – In: BRADLEY, P. N. and MCNAMARA, K. (Eds.) Living with Trees: Policies for Forestry Management in Zimbabwe. – World Bank Technical Paper 210, World Bank, Washington D.C., pp. 63-157.

BRIDGLAND, N., & HARRISON, P. (2008). Sound & Fair: A Strategy for Raising Awareness amongst UK Musicians Likely to Buy Instruments Made using FSC Certified African Blackwood.

BRYANT, C. L. & PROCTER, I. (1970). Rainfall distribution as a growth indicator for *Pterocarpus angolensis* DC in Tanzania. – The Commonwealth Forestry Review 180-184.

BURKILL, H. M. (1995). The useful plants of West Tropical Africa: volume 3. Families J-L. – Royal Botanic Gardens, Kew.

CALVERT, G. M. (1993). Indigenous species trials established upon the Kalahari Sands of north-western Matabeleland between 1926 and 1989: a summary. – In: PIEARCE, G. D. & GUMBO, D. J. (eds.). The ecology and management of indigenous forests in Southern Africa. Proceedings of an international symposium. Victoria Falls, Zimbabwe, 27-29 July 1992. – Forestry Commission, Zimbabwe/SAREC, pp. 168-181

CANBY, K., HEWITT, J., BAILEY, L., KATSIGRIS, E. & SUN, X. F. (2007). Forest products trade between China and Africa: An analysis of import and export statistics. – Washington, DC: Forest Trends.

CARO, T. M., SUNGULA, M., SCHWARTZ, M. W. & BELLA, E. M. (2005). Recruitment of *Pterocarpus angolensis* in the wild. – Forest Ecology and Management 219: 169-175.

CASTEL-BRANCO, C. N. (2015). Estado e a Capitalização do Capitalismo Doméstico em Moçambique. – Instituto de Estudos Sociais e Económicos, Bulletin 73, 10 June 2015.

CHALLINOR, A., WHEELER, T., GARFORTH, C., CRAUFURD, P. & KASSAM, A. (2007). Assessing the vulnerability of food crop systems in Africa to climate change. – Climatic change 83: 381-399.

CHAN, H.-K., ZHANG, H., YANG, F. & FISCHER, G. (2015). Improve customs systems to monitor global wildlife trade: widely used trade codes lack taxonomic granularity. – Science 348: 291-292.

CHAN, S. (2013). The Morality of China in Africa: The Middle Kingdom and the Dark Continent. – Zed books, London.

CHIBISA, P., RUZIVE, A. & MANDIPA, C. T. (2010). The 2000-2004 fast track land reform program and biodiversity issues in the Middle Save conservancy. – Journal of Sustainable Development in Africa 12: 74-100.

CHISHA-KASUMU, E., WOODWARD, S. & PRICE, A. (2009). RAPD markers demonstrate genetic diversity in Pterocarpus angolensis from Zimbabwe and Zambia. – Southern Forests: a Journal of Forest Science 71 (1): 63-70.

CHOGE, S. K., CUNNINGHAM, A. B. & ELLERY, W. (2005). Chasing the wooden rhino: the case of woodcarving in Kenya. – In: CUNNINGHAM, A. B., BELCHER, B. & CAMPBELL, B. M. (eds.). "Carving out a future: tropical forests, livelihoods and the international woodcarving trade". – Earthscan, London, pp. 31-42.

CLARKE J., CAVENDISH, W. & COOTE, C. (1996). Rural households and miombo woodlands: use, value and management. – In: CAMPBELL, B. (ed.) The Miombo in Transition: Woodland and Welfare in Africa. – Centre for International Forestry Research, Bogor, Indonesia, pp. 101-135.

COLLINSON, F. M. (1975). The Bagpipe: The history of a musical instrument. – Routledge, London.

CUNNINGHAM, A. B (1990) Vultures and the trade in traditional medicine. Vulture News 24:3–10.

CUNNINGHAM, A. B., GERMAN, L., PAUMGARTEN, F., CHIKAKULA, M., BARR, C., OBIDZINSKI, K., YATICH, T., NOORDWIJK, M. VAN, KONING, R. DE, PURNOMO, H., CAMPBELL, B. & PUNTODEWO, A. (2007). Sustainable Trade and Management of Forest Products and Services in the COMESA Region. – CIFOR, Indonesia.

CURTIS, B. & MANNHEIMER, C. (2005). Tree atlas of Namibia. – Windhoek: National Botanical Research Institute.

DAVENPORT, T. R. B. & NDANGALASI, H. J. (2003). An escalating trade in orchid tubers across Tanzania's Southern Highlands: assessment, dynamics and conservation implications. – Oryx 37: 55-61.

DE CAUWER, V., MUYS, B., REVERMANN, R. & TRABUCCO, A. (2014). Potential, realised, future distribution and environmental suitability for *Pterocarpus angolensis* DC in southern Africa. – Forest Ecology and Management 315: 211-226.

DESMET, P. G., SHACKLETON, C. M., & ROBINSON, E. R. (1996). The population dynamics and life-history attributes of a *Pterocarpus angolensis* DC. population in the Northern Province, South Africa. – South African Journal of Botany 62 (3): 160-166.

DEWEES, P. A., CAMPBELL, B. M., KATERERE, Y., SITOE, A., CUNNINGHAM, A. B., ANGELSEN, A. & WUNDER, S. (2010). Managing the miombo woodlands of southern Africa: Policies, incentives and options for the rural poor. – Journal of Natural Resources Policy Research 2: 57-73.

DIÉDHIOU, A. G., GUÈYE, O., DIABATÉ, M., PRIN, Y., DUPONNOIS, R., DREYFUS, B. & BÂ, A. M. (2005). Contrasting responses to ectomycorrhizal inoculation in seedlings of six tropical African tree species. Mycorrhiza 16 (1): 11-17.

DIXON, D. M. (1961). The ebony trade of ancient Egypt. – PhD thesis, University College London, UK.

EGGELING, W. J. & DALE, I.R. (1952). Indigenous trees of the Uganda Protectorate. 2nd edition – Government Printer, Entebbe.

EKMAN S.-M. S., WENBIN, H. & LANGA, E. (2013). Chinese trade and investment in the Mozambican timber industry: A case study from Cabo Delgado Province. – Working Paper 122. Bogor, Indonesia: CIFOR.

EIA (2013). First class connections: Log smuggling, illegal logging and corruption in Mozambique. – Environmental Investigation Agency, London. 16 p. – URL: http://eia-international.org/reports/first-class-connections (downloaded 12 August 2014).

EIA (2014a). First class crisis: China's criminal and unsustainable intervention in Mozambique's miombo forests. – URL: http://eia-international.org/reports/first-class-crisis-chinas-criminal-and-unsustainable-intervention-in-mozambiques-miombo-forests (downloaded 2 January 2015).

EIA (2014b) Routes of Extinction: The corruption and violence destroying Siamese rosewood in the Mekong. – URL: https://eia-international.org/report/routes-of-extinction-the-corruption-and-violence-destroying-siamese-rosewood-in-the-mekong-2 (downloaded 2 January 2015).

EUROPEAN COMMISSION. (2013). International Cooperation and Development. – URL: https://ec.europa.eu/europeaid/regions/african-caribbean-and-pacific-acp-region/main-programmes-eu-development-assistance-african_en (downloaded 6 January 2015).

FAEF (2013) Assessment of harvested volume and illegal logging in Mozambican natural forest. – Report of the Faculty of Agronomy and Forestry Engineering (FAEF), Eduardo Mondlane University, Forest Law Enforcement, Governance and Trade Support Programme for African, Caribbean and Pacific Countries (GCP/INT/064/EC).

FROST, P. G. H., TIMBERLAKE, J. & CHIDUMAYO, E. (2003). Miombo-Mopane Woodlands and Grasslands. – In: MITTERMEIER, R., GOETTSCH MITTERMEIER, C., ROBLES GIL, P., FONSECA, G., BROOKS, T., PILGRIM, J. & KONSTANT, W. (eds.). Wilderness: Earth's Last Wild Places. – Chicago: University of Chicago Press, pp. 183-204.

GATHUA, M. (2000). The Effects of Primates and Squirrels on Seed Survival of a Canopy Tree, *Afzelia quanzensis*, in Arabuko-Sokoke Forest, Kenya1. – Biotropica 32 (1): 127-132.

GAUGRIS, J. Y., VAN ROOYEN, M. W. & BOTHMA, J. D. P. (2008). Growth rate of selected woody species in northern Maputaland, KwaZulu–Natal, South Africa. – South African Journal of Botany 74 (1): 85-92.

GERHARDT, K. & TODD, C. (2009). Natural regeneration and population dynamics of the tree *Afzelia quanzensis* in woodlands in Southern Africa. – African journal of ecology 47 (4): 583-591.

GIZ (2014). Sustainable Management of Natural Resources in Tanzania. – URL: http://www.giz.de/en/worldwide/28017.html (downloaded 2 January 2015).

GOLDING, J. S. (ed.). (2002). Southern African plant red data lists (No. 14). – Pretoria: SABONET.

GOLDSMITH, B. & CARTER, D. T. (1992). The indigenous timbers of Zimbabwe. – The Zimbabwe Bulletin of Forestry Research 9.

GOMES E SOUSA, A. F. (1966). Dendrología de Moçambique. – Instituto de Investigação Agronómica de Moçambique. Centro de Documentação Agrária. Ser Memórias 1.

GOVENDER, N., TROLLOPE, W. S. & VAN WILGEN, B. W. (2006). The effect of fire season, fire frequency, rainfall and management on fire intensity in savanna vegetation in South Africa. – Journal of Applied Ecology 43 (4): 748-758.

GRANT, D. K. S. (1934). Some Local Timbers. – Government Printer, Dar es salaam, Tanzania.

GRAZ, F. P. (2004). Description and Ecology of *Pterocarpus angolensis* in Namibia. – Dinteria 29: 27-39.

GREENBERG, T. S., SAMUEL, L. M., GRANT, W. & GRAY, L. (2009). Stolen asset recovery: a good practices guide for non-conviction based asset forfeiture. – The International Bank for Reconstruction and Development / The World Bank, Washington D.C.

GREGORY, A.-M., BALL, S. M. J. & EZIEFULA, U.E. (1999) Tanzanian Mpingo 98 Full Report. – Mpingo Conservation Project.

GRIGG, D. B. (1980) Population growth and agrarian change: an historical perspective. – Cambridge University Press, Cambridge.

GROOM, R. J., GANDIWA, E., GANDIWA, P. & VAN DER WESTHUIZEN, H. J. (2013). A mass-poisoning of White-backed and Lappet-faced vultures in Gonarezhou National Park. – Honeyguide 59: 5-9.

GULLISON, R. (2003). Does Forest Certification Conserve Biodiversity? – Oryx 37 (2): 153-165.

HÅKANSSON, N. T., WIDGREN, M. & BÔRJESON, L. (2008). Introduction: Historical and Regional Perspectives on Landscape Transformations in Northeastern Tanzania, 1850-2000. – International Journal of African Historical Studies 41: 369-382.

HALL, J. E. (1988). A report on a mission to analyse the sawmilling practices of the mpingo wood industry in Tanzania with a collection of small grant proposals aimed at the conservation of the mpingo resource. – Unpublished report to UNEP, Nairobi.

HANLON, J. (2015). Mozambique News Reports & Clippings. No 295. – The Open University, UK. – URL: http://www.open.ac.uk/technology/mozambique/sites/www.open.ac.uk.technology.mozambique/files/files/Mozambique_295-27July2015-corrected_Castel-branco_agriculture_timber_Renamo.pdf (downloaded 2 August 2015).

HAYUT, Y. (1981). Containerization and the load center concept. – Economic Geography 57 (2): 160-176.

HORTON, M. & MIDDLETON, J. (2000). The Swahili: the social landscape of a mercantile society. – Oxford: Blackwell.

HUANG, W., WILKES, A., SUN, X. & TERHEGGEN, A. (2013). Who is importing forest products from Africa to China? An analysis of implications for initiatives to enhance legality and sustainability. – Environment Development and Sustainability 15: 339-354.

HURST, A. (2003). State forestry and spatial scale in the development discourses of post-colonial Tanzania: 1961-1971. – The Geographical Journal 169 (4): 358-369.

INDUFOR (2005). Review of Revenue Administration System report. – Prepared for the Ministry of Natural resources and Tourism, Forestry and Beekeeping Division, as part of the Tanzania Forestry Conservation Management Project.

IUCN STANDARDS & PETITIONS SUBCOMMITTEE (2014). Guidelines for Using the IUCN Red List Categories and Criteria. Version 11. – Prepared by the Standards and Petitions Subcommittee. – http://www.iucnredlist.org/documents/RedListGuidelines.pdf (downloaded 2 January 2015).

JANSEN, E. G. (2009). Does aid work? Reflections on a natural resources programme in Tanzania. – U4 Issue 2009 (2): 1-26.

JENKINS, M., OLDFIELD, S. & AYLETT, T. (2002). International Trade in African Blackwood. – Fauna & Flora International, Cambridge, UK and Bundesamt fur Naturschutz, Bonn.

JENKINS, A., BRIDGLAND, N., HEMBERY, R., MALESSA, U., HEWITT, J. & HIN KEONG, C. (2012). Background Paper 1: Precious Woods: Exploitation of the Finest Timber. – In: Chatham House Workshop: Tackling the Trade in Illegal Precious Woods, 23–24 April 2012. – http://www.traffic.org/forestry-reports/traffic_pub_forestry51.pdf (downloaded 11 January 2016).

KANER, J., JIUFANG, L., YONGJI, X. & IORAS, F. (2013). A reevaluation of woods used in Chinese historic furniture. – Bulletin of the Transilvania University of Braşov 6: 9-18.

KAMUNDI, D. (2000). A Red Data List assessment for *Dalbergia melanoxylon* in Malawi. – SABONET News 5 (1): 35.

KASUMU E. C. C. (1998). Nursery results on genetic variation, vegetative propagation and other important growth factors of importance for domestication of *Pterocarpus angolensis* DC. – MSc thesis, University of Stellenbosch, South Africa.

KLÄY, A., ADAM, Y. & STANTCHEV, D. (2008). Forest Regeneration Capacity and its Enhancement by Forest Management and Silviculture in Cabo Delgado. – CDE, Bern, Switzerland. Mission Report ESAPP Q804.

KITCHEN, K. A. (1971). Punt and how to get there. – Orientalia 40: 184-207.

KLITGÅRD, B. B., FOREST, F., BOOTH, T. J. & SASLIS-LAGOUDAKIS, C. H. (2013). A detailed investigation of the *Pterocarpus* clade (Leguminosae: Dalbergieae): *Etaballia* with radially symmetrical flowers is nested within the papilionoid-flowered *Pterocarpus*. – South African Journal of Botany, 89, 128-142.

KRUGER, L. M., MIDGLEY, J. J. & COWLING, R. M. (1997). Resprouters vs reseeders in South African forest trees; a model based on forest canopy height. – Functional Ecology 11: 101-105.

KRYNAUW, S. (1998). Report on the feasibility of the proposed utilization of kiaat (*Pterocarpus angolensis* D.C.) on Mawewe. – Mpumalanga Parks Board Research and Development, Lydenburg, South Africa.

LEWIS, G. P., SCHRIRE, B., & LOCK, M. (Eds.). (2005). Legumes of the World (Vol. 577). Richmond, UK: Royal Botanic Gardens, Kew.

LIU, X. Y., TIMAR, M. C & YI, S. L. (2013). A study on the history and materials of traditional Chinese furniture. – ProLigno 9: 256-264.

LO, C. (2014). Pangolin scales worth HK$ 17m found hidden in shipments from Africa. – South China Morning Post, 16 June 2014. – URL: http://www.scmp.com/news/hong-kong/article/1534140/pangolin-scales-worth-hk17m-found-hidden-shipments-africa (downloaded 12 August 2014).

LOOTS, S. (2005). A Red data book of Namibian plants. – SABONET Report 38, Pretoria.

LOVETT, J. & CLARKE, G. P. (1998). *Baphia kirkii*. – The IUCN Red List of Threatened Species 1998. – e.T35792A9953317. – URL: http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T35792A9953317.en (downloaded 15 August 2015).

MACKENZIE, C. (2006). Chinese Takeaway! – Forest Governance in Zambézia, Mozambique. Forum das Organizações Não Governamentais da Zambézia, Quelimane. 101 p. – URL: http://www.open.ac.uk/technology/mozambique/sites/www.open.ac.uk.technology.mozambique/files/pics/d72272.pdf (downloaded 2 June 2014).

MACKENZIE, C. & RIBEIRO, D. (2009). Tristezas Tropicais – More sad stories from the forests of Zambézia. – Amigos da Floresta and Justiça Ambiental, Maputo.

MANDER, M., DIEDERICHS, N., NTULI, L., MAVUNDLA, K., WILLIAMS, V. & MCKEAN, S. (2007). Survey of the trade in vultures for the traditional health industry in South Africa. – Unpublished report.

MAPUNDA, D. N. L. (2007). Edible Orchids in Makete district, the Southern Highlands of Tanzania: distribution, population and status. – International Master Programme at the Swedish Biodiversity Centre. – Master theses No. 39, Uppsala.

MCNAMEE, T. (2013). Africa in their words: A Study of Chinese Traders in South Africa, Lesotho, Botswana, Zambia and Angola. Discussion Paper 2012/03. – Brenthurst Foundation. – URL: http://www.thebrenthurstfoundation.org/files/brenthurst_commisioned_reports/Brenthurst-paper-201203-Africa-in-their-Words-A-Study-of-Chinese-Traders.pdf (downloaded 15 August 2015).

MEHL, J. W., GELDENHUYS, C. J., ROUX, J. & WINGFIELD, M. J. (2010). Die-back of kiaat (*Pterocarpus angolensis*) in southern Africa: a cause for concern? – Southern Forests: a Journal of Forest Science 72 (3-4): 121-132.

MCCALLA, R. J., SLACK, B. & COMTOIS, C. (2004). Dealing with globalisation at the regional and local level: the case of contemporary containerization. – The Canadian Geographer/Le Géographe canadien 48 (4): 473-487.

MIDGLEY, G., HUGHES, G., THUILLER, W., DREW, G. & FODEN, W. (2005). Assessment of potential climate change impacts on Namibia's floristic diversity, ecosystem structure and function. – For the Namibian National Biodiversity Programme, Directorate of Environmental Affairs, Ministry of Environment and Tourism. – South African National Biodiversity Institute, Cape Town.

MIDGLEY, J. J., LAWES, M. J. & CHAMAILLÉ-JAMMES, S. (2010). Savanna woody plant dynamics: the role of fire and herbivory, separately and synergistically. – Australian Journal of Botany 58: 1-11.

MILLEDGE, S., GELVAS, I. & AHRENDS, A. (2007). Forestry, Governance, and National Development: Lessons Learned from a Logging Boom in Southern Tanzania. – TRAFFIC, Tanzania Ministry of Forestry and Tourism, and Tanzania Development Partners Group, Dar es Salaam, Tanzania.

MUGA, M. A, GITHIOMI, J. K, & CHIKAMAI, B.. (2014). Classification of Kenyan Wood Carving Species Using Macroscopic and Microscopic Properties. – International Journal of Applied Science and Technology 4: 167-178.

MUSHOVE, P. T. (1996) Population dynamics of *Pterocarpus angolensis* D. C. stands growing on Kalahari sands. – In: MUSHOVE, P. T., SHUMBA, E. M. & MATOSE, F. (Eds.). Sustainable Management of Indigenous Forests in the Dry Tropics: Proceedings of an International Conference, 28 May-1 June 1996, Kadoma, Zimbabwe. – Forestry Commission, Harare, pp. 155-167.

MWITWA, J. P., MUNTHALI, C. R. Y. & VAN WYK, G. (2007). Half-sib family variation in shoot and root traits of seedlings of *Pterocarpus angolensis* (family: Fabaceae; syn. Papilionaceae). – Southern Hemisphere Forestry Journal 69 (2): 91-94.

NASI, R., BROWN, D., WILKIE, D., BENNETT, E., TUTIN, C., VAN TOL, G. & CHRISTOPHERSEN, T. (2008). Conservation and use of wildlife-based resources: the bushmeat crisis. – Secretariat of the Convention on Biological Diversity, Montreal, and Center for International Forestry Research (CIFOR), Bogor. – Technical Series no. 33.

NELLEMANN, C., HENRIKSEN, R., RAXTER, P., ASH, N. & MREMA, E. (eds.) (2014). The Environmental Crime Crisis – Threats to Sustainable Development from Illegal Exploitation and Trade in Wildlife and Forest Resources. A UNEP Rapid Response Assessment. – United Nations Environment Programme and GRID-Arendal, Nairobi and Arendal. – URL: http://www.grida.no/publications/rr/crime/ (downloaded 2 January 2015).

NAOT (2012). Performance audit on management of forest harvesting by the Ministry of Natural Resources and Tourism. – Report of the Controller and Audior General, The United Republic of Tanzania.

OECD (2014). GIZ and BMZ combating poaching and the legal wildlife trade in Africa and Asia for the anti-corruption task team. – URL: http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DCD/DAC/GOVNET(2014)10&docLanguage=En (downloaded 2 January 2015).

OPULUKWA, M. J., HAMZA, K. & MALENDE, Y. (2002). Inventory of *Dalbergia melanoxylon* (Mpingo) in the southern part of Tanzania: the case of Nachingwea. – African Study Monographs 23 (1): 1-10.

PALMER, E. & PITMAN, N. (1972). Trees of southern Africa covering all known indigenous species in the Republic of South Africa, South-West Africa, Botswana, Lesotho and Swaziland. – Cape Town, AA Balkema.

PATEL, E. R. (2007). Logging of rare rosewood and palisandre (*Dalbergia* spp.) within Marojejy National Park, Madagascar. – Madagascar Conservation & Development 2 (1): 11-16.

PICARD, C. (2010). The Promise and Peril of Large-Scale Conservation: An Appraisal of the Selous Niassa Wildlife Corridor, Tanzania. – PhD thesis, Yale University.

PIEARCE, G. D. (1979). A new vascular wilt disease and its relationship to widespread decline of *Pterocarpus angolensis* in Zambia. – Pans 25 (1): 37-45.

POULSEN, J. R., CLARK, C. J., MAVAH, G. & ELKAN, P. W. (2009). Bushmeat supply and consumption in a tropical logging concession in northern Congo. – Conservation Biology 23 (6): 1597-1608.

PURKAYASTHA, S. K. (1997). A manual of Indian timbers (No. Ed. 2). – Sribhumi Publishing Company.

REEVE, R. & ELLIS, S. (1995). An insider's account of the South African security forces' role in the ivory trade. – Journal of Contemporary African Studies 13: 227-243.

REM. (2009). Designing independent monitoring of forest law enforcement and governance in Tanzania. – URL: www.rem.org.uk/Tanzania.html (downloaded 2 January 2015).

REPUBLIC OF KENYA (2014). Forest Policy, 2014. – Ministry of Environment, Water and Natural Resources. Nairobi, Kenya. – URL: http://www.kenyaforestservice.org/documents/Forest%20Policy,%202014%20(Revised%2020-2-2014).pdf (downloaded 27 July 2015).

REPÚBLICA DE MOÇAMBIQUE (2002). Regulameno de Florestas e Fauna Bravia. Conselho de Ministros. Decreto no 12/ 2002. – Maputo, Mozambique.

RIBEIRO, D. & NHABANGA, E. (2009). Levantamento preliminar da problemática das florestas de Cabo Delgado. – Justiça Ambiental, Maputo, Moçambique.

ROCHA, P. L. B. D., QUEIROZ, L. P. D. & PIRANI, J. R. (2004). Plant species and habitat structure in a sand dune field in the Brazilian Caatinga: a homogeneous habitat harbouring an endemic biota. – Brazilian Journal of Botany 27 (4): 739-755.

RODIN, R. J. (1985). The ethnobotany of the Kwanyama Ovambos. – Monographs in systematic botany from the Missouri Botanical Garden (USA).

ROSEGRANT, M. W. & CLINE, S. A. (2003). Global food security: challenges and policies. – Science 302: 1917-1919.

SANDERSON, F. R., KING, F. Y., PHENG, Y. C., HO, O. K. & ANUAR, S. (1997). A *Fusarium* wilt (*Fusarium oxysporum*) of Angsana (*Pterocarpus indicus*) in Singapore: I. Epidemiology and Identification of the causal organism. – Arboricultural Journal 21 (3): 187-204.

SCHOLES, R. J. & WALKER, B. H. (1993). An African savanna: Synthesis of the Nylsvley study. Cambridge, Cambridge University Press.

SCHWARTZ, M. W. & CARO, T. M. (2003). Effect of selective logging on tree and understory regeneration in miombo woodland in western Tanzania. – African Journal of Ecology 41: 75-82.

SCHWARTZ, M. W., CARO, T. M., & BANDA-SAKALA, T. (2002). Assessing the sustainability of harvest of *Pterocarpus angolensis* in Rukwa Region, Tanzania. – Forest Ecology and Management 170: 259-269.

SGS QUALIFOR (2012). FSC Controlled wood risk assessment. – Pingo Madireas Lda., Project 12591-MZ, 5 December 2012. Public information. – URL: http://www.info.fsc.org/details.php?id=a0240000005sUsuAAE&type=certificate&return=index.php (downloaded 15 August 2015).

SCHUURMAN, D. & LOWRY II, P. P. (2009). The Madagascar rosewood massacre. – Madagascar Conservation & Development 4: 98-102.

SETSHOGO, M. P. & VENTER, F. (2003). Trees of Botswana: names and distribution. – Southern African Botanical Diversity Network Report No. 18.

SHACKLETON, C. M. (2002). Growth patterns of *Pterocarpus angolensis* in savannas of the South African lowveld. – Forest Ecology and Management 166 (1): 85-97.

SHANLEY, P. & LUZ, L. (2003). The impacts of forest degradation on medicinal plant use and implications for health care in eastern Amazonia. – BioScience 53: 573-584.

SITOE, A., WERTZ-KANOUNNIKOFF, S., RIBEIRO, N., GUEDES, B. & GIVÁ, N. (2014). Community rights and participation in the face of new global interests in forests and lands: The case of Mozambique. – In: Forests under pressure: Local responses to global issues, 345. – URL: http://www.researchgate.net/publication/266317444_Community_rights_and_participation_in_the_face_of_new_global_interests_in_forests_and_lands_The_case_of_Mozambique (downloaded 23 June 2014).

SMILLIE, S. (2014). Tell-tale vultures face extinction. Sunday Times, 23 June, 2014. – URL: http://www.timeslive.co.za/thetimes/2014/06/23/tell-tale-vultures-face-extinction (downloaded 2 January 2015).

STAHLE, D. W., MUSHOVE, P. T., CLEAVELAND, M. K., ROIG, F. & HAYNES, G. A. (1999). Management implications of annual growth rings in *Pterocarpus angolensis* from Zimbabwe. – Forest Ecology and Management 124: 217–229

STEENKAMP, C. (1999). South Africa's woodcarving industry. – Traffic Bulletin 18: 11-20.

SULLE, E. (2013). A Rapid Assessment of the Illegal Timber Trade Across the Ruvuma River on the Tanzania–Mozambique Border. – TRAFFIC East/Southern Africa, East Africa Sub-Regional Office, Dar es Salaam, Tanzania.

SUN, C., CHEN, L., CHEN, L., HAN, L. & BASS, S. (2008). Global forest product chains: Identifying challenges and opportunities for China through a global commodity chain sustainability analysis. – International Institute for Sustainable Development (IISD).

THE PLANT LIST, Version 1.1 (2013). *Paris polyphylla* Sm. – URL: http://www.theplantlist.org/tpl1.1/record/kew-283892?ref=tpl1 (downloaded 8 July 2015).

THERRELL, M. D., STAHLE, D. W., MUKELABAI, M. M. & SHUGART, H. H. (2007). Age, and radial growth dynamics of *Pterocarpus angolensis* in southern Africa. – Forest ecology and management 244 (1): 24-31.

VAN DAALEN, C. J. (1991). Germination of *Pterocarpus angolensis* seed. – South African Journal of Forestry 158: 33-36.

VAN DE VIJVER, C. A., FOLEY, C. A. & OLFF, H. (1999). Changes in the woody component of an East African savanna during 25 years. – Journal of Tropical Ecology 15: 545-564.

VAN WYK, M., CAMPBELL, B. M., CALVERT, G. M. & PIEARCE, G. D. (1993). Mukwa dieback in the state forests of western Zimbabwe. – In: PIEARCE, G. D. & GUMBO, D. J. (eds.). The Ecology and Management of Indigenous Forests in Southern Africa: Proceedings of an International Symposium, 27-29 July 1992, Victoria Falls, Zimbabwe, pp. 387-401.

VON BREITENBACH, F. (1973). *Pterocarpus angolensis*. A monograph. – Trees in South Africa. Journal of the Tree Society of South Africa XXV.

WELLS, J. & WALL, D. (2005). Sustainability of sawn timber supply in Tanzania. – International Forestry Review 7 (4): 332-341.

WENBIN, H. & X. SUN (2013). Tropical Hardwood Flows in China: Case Studies of Rosewood and Okoumé. – Forest Trends Association, Washington DC.

WERTZ-KANOUNNIKOFF, S., FALCÃO, M. P. & PUTZEL, L. (2013). Facing China's demand for timber: an analysis of Mozambique's forest concession system with insights from Cabo Delgado Province. – International Forestry Review 15: 387-397.

WEST, V. W. & MALUGU, I. (2003). Mpingo Carvings Investigation 2001 Full Report. – Mpingo Conservation Project.

WHITE, F. (1983). The Vegetation of Africa. A Descriptive Memoir to Accompany the UNESCO /AETFAT/UNS0 Vegetation Map of Africa. – UNESCO, Paris.

WIT, M., VAN DAM, J., CERUTTI, P. O., LESCUYER, G., KERRETT, R. & PARKER MCKEOWN, J. (2010). Chainsaw milling: supplier to local markets – a synthesis. – In: WIT, M. & VAN DAM, J. (eds.). Chainsaw milling: supplier to local markets. – Tropenbos International, Wageningen, the Netherlands, p.p. vii-xxii.

WORLD BANK (2005). Capacity enhancement program. Financial Intelligence Unit Workbook. World Bank, Washington.

WORLD CONSERVATION MONITORING CENTRE (1998b). *Pterocarpus angolensis*. The IUCN Red List of Threatened Species 1998. – e.T33190A9759374. – URL: http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T33190A9759374.en (downloaded 25 July 2014).

WWF (2012). Timber movement and trade in eastern Democratic Republic of Congo and destination markets in the region. – WWF Uganda, Kampala, Uganda.

ZEMPEL, C. (2014). Economies of Plunder: The Case of Rosewood Extraction and Indigenous Rights in Southern Belize. – Master of Public Policy Degree paper, Hubert H. Humphrey School of Public Affairs, University of Minnesota.

ZOS (2011). Local Forest Logging Stopped – Mutulanganga IBA in Zambia. – URL: http://www.birdlife.org/africa/news/local-forest-logging-stopped-mutulanganga-iba-zambia (downloaded 16 August 2015).

9 Appendices

Appendix 1. The wider context: a list of the main commercial timber species in trade from woodlands and coastal forests exploited in Kenya, Mozambique and Tanzania. Afromontane forests cover a tiny proportion (less than 5%) of the land area and in Kenya have been subject to logging bans since 1999, so are not included here. The three species on which this study focussed are amongst the most widely exploited species in the region. Wood density is included as a proxy for growth rate, as slow growing species have very dense wood. The terms "precious timber" and various timber classes are those used in Forestry legislation in Mozambique (República de Moçambique, 2002). Species of greatest concern in terms of overexploitation are highlighted:

low **emerging concern** **significant** **high** **very high**

Family	Species and Main vegetation type	Trade names	Countries where cut commercially and minimum legal dbh	Wood density (kg/m³) (from GOLDSMITH & CARTER, 1992)	Additional notes
Asteraceae	*Brachylaena huillensis* **coastal forests and sand forests**	Muhuhu	Kenya, Mozambique (30 cm DBH), Tanzania	--	Lower risk, near threatened (WORLD CONSERVATION MONITORING CENTRE, 1998) but needs updating. All trees logging for woodcarving in Kenya below minimum DBH, and most are imported from Tanzania. Hollow trees a key habitat for rare birds, including Sokoke Scops owl.
Bignoniaceae	*Markhamia obtusifolia*		Tanzania (24 cm DBH)	--	
Bombaceae	*Bombax rhodognaphalon*	Sumauma	Mozambique (50cm DBH), Tanzania (55 cm DBH)	--	One of the 9 most heavily logged species in Tanzania (MILLEDGE et al., 2007). Second class timber (Mozambique).
Combretaceae	*Combretum imberbe* **woodlands and savanna**	Mondzo	Mozambique (40cm DBH), Namibia, Tanzania, Zambia.	1,230	First class timber (Mozambique). Major use if for exports to China. This includes standing dead trees. This species provides an important habitat for rare reptiles and nesting birds (eg: raptors and Sparrow-weavers).

Family	Species and Main vegetation type	Trade names	Countries where cut commercially and minimum legal dbh	Wood density (kg/m³) (from GOLDSMITH & CARTER, 1992)	Additional notes
	Terminalia species (T. sericea, T. stenostachya & T. stuhlmannii) **woodlands and savanna**	Messinge, mangwe	Domestic use across East and southern Africa where *T. sericea* is the most favoured for axe and hoe handles and local construction. Mozambique 40cm DBH.	830 – 1,025	Second class timber (Mozambique). Commonly sold for low cost housing construction, virtually all below minimum DBH.
Ebenaceae	*Diospyros kirkii* **woodlands and savanna**	Pink diospyros	Mozambique (40 cm DBH), Zimbabwe.	735	Precious timber (Mozambique)
	Diospyros mespiliformis **riverine woodlands and savanna**	African ebony, Ebano.	Mozambique (50 cm DBH), Tanzania	850	Precious timber (Mozambique). Exported to Asia from both Mozambique and Tanzania.
Euphorbiaceae	*Spirostachys africana* **riverine woodlands and savanna**	Tamboti, msarakana, Sândalo	Mozambique (30 cm DBH), South Africa (where it is theoretically protected), Tanzania. Increasingly small diameter trees cut for commercial carvings.	1,010	Precious timber (Mozambique). Exported from Beira to China. Commercial commercial woodcarving species.
	Spirostachys venenifera **riverine woodlands and savanna**	Rosewood	Kenya, Tanzania. Increasingly small diameter trees cut for commercial carvings.	--	Commercial commercial woodcarving species in Kenya and Tanzania.
Fabaceae	*Acacia nigrescens* **riverine woodlands and savanna**	Namuno	Mozambique (40 cm DBH).	1,120	Exported to China from Mozambique. Third class timber (Mozambique)
	Afzelia quanzensis **miombo woodlands and coastal dune forests**	Chanfuta	Kenya, Mozambique (50 cm DBH), Tanzania (55 cm DBH), Zambia, Zimbabwe.	770	Exported to Asia from both Mozambique and Tanzania. First class timber (Mozambique)

Family	Species and Main vegetation type	Trade names	Countries where cut commercially and minimum legal dbh	Wood density (kg/m³) (from GOLDSMITH & CARTER, 1992)	Additional notes
	Albizia glaberrima **miombo woodlands**		Mozambique (40 cm DBH).	--	First class timber (Mozambique)
	Albizia versicolor **miombo woodlands**	Tanga-tanga	Mozambique (40 cm DBH), Tanzania.	655	First class timber (Mozambique)
	Amblygonocarpus andongensis **miombo woodlands**	Mutiria	Mozambique (40 cm DBH), Zambia, Zimbabwe	1,170	Second class timber (Mozambique)
	Baphia kirkii **coastal forests and thickets**	Large camwood	Mozambique, Tanzania (45cm DBH)	--	Vulnerable B1 + 2b (LOVETT & CLARKE, 2015). Exported to Asia from both Mozambique and Tanzania.
	Bobgunnia madagascarienis **miombo woodlands**	Pau-ferro	Mozambique (30 cm DBH), Tanzania (24 cm DBH)	995	Exported to Asia from both Mozambique and Tanzania. Precious timber (Mozambique).
	Brachystegia spiciformis **miombo woodlands**	Messassa	Mozambique (40 cm DBH), Tanzania (55 cm DBH)	735	Second class timber (Mozambique)
	Burkea africana **miombo woodlands**	Mucarala	Mozambique (40 cm DBH), Tanzania	865	Second class timber (Mozambique)
	Colophospermum mopane **mopane woodlands**	Mopane	Mozambique (30 cm DBH)	1,200	Exported to China from Mozambique. Considered a fourth class timber in Mozambique.
	Dalbergia melanoxylon **miombo woodlands and savanna**	Pau-preto	Mozambique (20 cm DBH), Tanzania (24cm DBH)	1,200	Exported internationally from Mozambique and Tanzania. Precious timber (Mozambique)
	Erythrophleum africanum **miombo woodlands**	Ordeal tree	Tanzania	960	Traded in local markets.
	Erythrophleum suaveolens **riverine forests**	Missanda	Mozambique (40 cm DBH)	960	First class timber (Mozambique)

Family	Species and Main vegetation type	Trade names	Countries where cut commercially and minimum legal dbh	Wood density (kg/m³) (from GOLDSMITH & CARTER, 1992)	Additional notes
	Guibourtia coleosperma **woodlands**	Chacate encarnado	Mozambique (40 cm DBH)	815	Third class timber (Mozambique)
	Guibourtia conjugata **miombo woodlands**	Chacate preto	Mozambique (40 cm DBH)	1,075	Exported to China from Mozambique on a large scale. Precious timber (Mozambique)
	Hymenaea verrucosa **dry evergreen forests and coastal woodlands**	Gum copal tree, mnyanza	Tanzania	--	Overexploited and in decline due to habitat loss.
	Julbernadia globulifera **miombo woodlands**	Massassa (same as *B. spiciformis)*	Mozambique (40 cm DBH)	800	Second class timber (Mozambique)
	Milettia stuhlmanii **miombo woodlands**	Jambirre, panga-panga	Mozambique (40 cm DBH), Tanzania	880	Exported to Asia from both Mozambique and Tanzania. First class timber (Mozambique)
	Pericopsis angolensis **miombo woodlands**		Malawi, Mozambique, Tanzania	930	Heavily overexploited in Malawi for woodcarvings.
	Pterocarpus angolensis **miombo woodlands**	Umbila	Mozambique (40 cm DBH)	640	Exported to Asia from both Mozambique and Tanzania. First class timber (Mozambique), **Lower Risk/near threatened**
	Pterocarpus tinctorius **miombo woodlands**	Mninga maji	Tanzania (55 cm DBH), Zambia		Look-alike species (synonyms P*. chrysothryx* and *P. stolzii*) mixed in with *P. angolensis* in Tanzania and Zambia.
Malvaceae	*Sterculia quinqueloba* **miombo woodlands and riverine forests**	Metonha	Mozambique (40 cm DBH)	465	Second class timber (Mozambique). Mainly traded as a local timber in Mozambique.
	Sterculia appendiculata **riverine forests**	Metil, mgude	Mozambique (50 cm DBH), Tanzania	705	Second class timber (Mozambique)
Meliaceae	*Ekebergia capensis* **riverine forests**	Inhamarre	Mozambique (50 cm DBH)	590	Precious timber (Mozambique)

Family	Species and Main vegetation type	Trade names	Countries where cut commercially and minimum legal dbh	Wood density (kg/m³) (from GOLDSMITH & CARTER, 1992)	Additional notes
	Entandrophragma caudatum **woodlands**	Mbuti	Mozambique (50 cm DBH)	735	Precious timber (Mozambique)
	Khaya antotheca **riverine forests**		Mozambique, Tanzania (55 cm DBH)		Commercially extinct in parts of Tanzania.
	Khaya nyasica **riverine forests**	Umbáua	Mozambique (50 cm DBH)	590	First class timber (Mozambique)
	Trichilia emetica **coastal woodlands**	Natal mahogany, Mafurreira	Mozambique (50 cm DBH)	670	Second class timber (Mozambique)
Moraceae	*Milicia excelsa* **remnant patches of moist forests**	Tule, mvuli, iroko	Mozambique (50 cm DBH)	610	Now severely depleted in East Africa. Precious timber (Mozambique)
Picrodendraceae	*Androstachys johnsonii* **monodominant in dry woodlands**	Lebombo ironwood, mecrusse	Mozambique (30 cm DBH)	1,170	Used for local construction in Mozambique and milled for parquet flooring. First class timber (Mozambique)
Rhamnaceae	*Berchemia discolor* **riverine woodlands and termitaria in miombo woodland**	Bird plum, brown ivory		975	Not listed in Forestry regulations in Mozambique. Used for turning high quality bowls in Mozambique.
	Berchemia zeyheri **savanna**	Pau-rosa, pink ivory, red ivory	Mozambique (30 cm DBH), South Africa	1,100	In high demand as a tonewood. Precious timber (Mozambique)
Rutaceae	*Zanthoxylum chalybeum* **dry coastal forests and forest patches in savanna**	Mjafari	Tanzania	--	

Appendix 2. A list of timber species showing „non-timber“ uses and livelihood impacts due to over-exploitation for timber.

Family	Species	Livelihood values to local people in addition to sawn timber	Livelihood implications of timber overexploitation
Asteraceae	*Brachylaena huillensis*	Originally cut for parquet flooring in East Africa, the major use shifting in Kenya in the 1960's to commercial woodcarving.	Lower income due to high costs of getting wood. Kenyan middlemen travel to the Somali border and to Tanzania to get *B. huillensis* to supply carvers in Mombasa and Malindi for the export trade and sales to tourists.
Combretaceae	*Combretum imberbe*	Edible gum, medicinal and a tree of great cultural importance in parts of southern Africa (particularly Namibia). Used for local construction, including for tourist lodge support posts. Used for the pestle for grinding mortars.	There are alternative woods for pestles, but the density and long lasting wood for pounding grain make depletion a concern to local women.
	Terminalia species (T. sericea, T. stenostachya & T. stuhlmannii)	Edible gum, leaves as a tea substitute, all parts are used medicinally. The main wood for hoe and axe handles. Bark for dye.	Overexploitation is unlikely due to good recruitment in settled areas where there is grazing and less fire. Resilient due to vigorous sprouting and fast growth rates.
Ebenaceae	*Diospyros kirkii*	Edible fruits are popular. Basketry dye from roots.	Minor loss of dietary diversity (particularly for children).
	Diospyros mespiliformis	Popular edible fruits that are eaten fresh or dried for later use (and sale). Commercial felling breaks traditional conservation practices. Timber is used for dug-out canoes. Medicinal roots and twigs used for dental care.	Increased risk of food insecurity due to loss of edible fruits. There are other trees that can be used to make dug-out canoes (e.g: *Afzelia quanzensis*, *Pterocarpus angolensis*) but there are being heavily logged, so food insecurity increases (potentially lower fish catches, less efficient river transport).
Euphorbiaceae	*Spirostachys africana*	Toxic sap, occasionally used as a fish poison. Powdered wood used as a traditional perfume. Important commercial woodcarving species in southern Africa, including Kenya and Mozambique.	Loss of income from woodcarving due to depletion of larger trees in Kenya and parts of Mozambique.
	Spirostachys venenifera	Commercially carved in Kenya.	Loss of income from woodcarving due to depletion of larger trees.
Fabaceae	*Acacia nigrescens*	Bark used as chord in local house construction (but this can kill the tree). One of the first Acacia species to flower in spring and an important honeybee plant. Important browse for game and livestock.	Reduced browse for livestock.

Family	Species	Livelihood values to local people in addition to sawn timber	Livelihood implications of timber overexploitation
	Afzelia quanzensis	Used for dug-out canoes and grain-stamping mortars. Medicinal roots and seeds. Major commercial woodcarving species.	Loss of local income to woodcarvers (men). Higher costs of grain processing mortars. Decreased food security due to loss replacement dug-out canoes (for fishing and transport)
	Bobgunnia madagascarienis	Saponin-rich fruits are an important fish poison and are also eaten by livestock. Widespread but scattered, with poor recruitment.	Decreased food security. Less protein (catching small fish by women and children during the dry season).
	Brachystegia spiciformis	Bark used for traditional beehives. Flowers an important honey source.	Common tree, so depletion due to direct harvest unlikely. Main threat is clearing for farmland.
	Colophospermum mopane	Multi-use tree (fuel, construction, bark twine, fodder) and browse by livestock.	Trees resprout from the rootstock, so livelihood impacts are reduced. Loss of tall “gallery” mopane woodland is a conservation concern.
	Dalbergia melanoxylon	Wood used to carve culturally important snuff containers. Medicinal roots. Important species for commercial carving for the tourist trade.	Overharvesting (including by woodcarvers) means reduced income to some woodcarvers.
	Erythrophleum suaveolens	Highly toxic medicinal bark and flowers produce honey that causes diarrhea. Edible caterpillars are collected from this tree and are eaten after gut contents are removed.	Minor livelihood impacts.
	Guibourtia coleosperma	Edible arils an important famine food for !Khwe San (Namibia). Seed oil used in cooking and in traditional cosmetics.	Serious consequences due to reduced food security amongst some severely disadvantaged people in southern Africa will result from overexploitation. Commercial logging continues in Namibia despite this being a “protected” species.
	Julbernadia globulifera	Bark used for traditional beehives. Flowers an important honey source.	Common tree, so depletion due to direct harvest unlikely. Main threat is clearing for farmland.
	Milettia stuhlmanii	Bark used for containers. Stems cut for termite resistant poles for local housing.	Minor increase in low cost housing due to the need to shift to using other species that are less resistant to termite attack.

Family	Species	Livelihood values to local people in addition to sawn timber	Livelihood implications of timber overexploitation
	Pterocarpus angolensis	Red exudate is medicinal and is used to treat sore eyes. Bark and roots are medicinal. One of the best woods for making dug-out canoes, also used for drums and grain stamping mortars.	Commercial logging of large trees increases the costs (or time and effort) used to get *P. angolensis* to make canoes, grain stamping mortars and drums.
Meliaceae	*Ekebergia capensis*	Bark traditionally used for tanning and to treat dysentery. Roots used to treat headaches and leaves to treat internal parasites.	Widespread and these uses are available from smaller trees that are not logged.
	Trichilia emetica	Edible aril, popular with sweet potatoes. Commercial oil seed. Popular softwood for carvings for sale to tourists.	Trees are planted by local people and are valued for shade. Overharvest unlikely.
Rhamnaceae	*Berchemia discolor*	Very popular edible fruit. Eaten fresh or dried, stored and traded. Major dye for basketry from bark and roots. Valuable for wood turning. Trees traditionally conserved.	Reduced food security.
	Berchemia zeyheri	Popular edible fruit. Trees traditionally conserved.	Reduced food security.

Appendix 3. Companies that have various forms of FSC certification for *Dalbergia melanoxylon* (data from http://info.fsc.org/certificate.php).

Country	Company	Main activity category	Main output category	FSC Certificate Number
Austria	Holzpartner Handelsgesellschaft m.b.H. Villach; with 9 group members, all in Austria.	Brokers/traders without physical possession.	FSC Mix; FSC 100%	FSC-C11700
China	Fujian Weiijia Living Goods Manufacturing Cp., Ltd	Secondary processor of indoor furniture and table goods.	FSC Mix; FSC 100%	FSC-C125715
Germany	Hagebau Handelsgesellschaft für Baustoffe mbH & Co, KG	Brokers/traders without physical possession (of solid wood, flitches and boules)	FSC Mix; FSC 100%	FSC-C017751
	GD Holz Service GmbH; over 37 members in different companies have the same FSC certificate number	Brokers/traders with physical possession.	FSC Controlled Wood; FSC Mix; FSC 100%	FSC-C108302
	Topstyle Flooring GmbH, Babensham/Neudeck	Brokers/traders without physical possession. Wood for stairs, flooring, mouldings, door frames	FSC Mix; FSC 100%; FSC Recycled	FSC-C124264
	ZEUS- Zentrale für Einkauf und Service GmbH & Co. KG, Soltau	Brokers/traders without physical possession. Solid wood, flitches and boules.	FSC Mix; FSC 100%	FSC-C044136
India	Coast to Coast Designs (Pvt) Ltd., Delhi	Distributor/wholesaler	FSC Mix; FSC 100%; FSC Recycled	FSC C108207
Mozambique	Mpingo Madeiras, Montepuez	Primary processor	FSC Controlled Wood; FSC Mix; FSC 100%	FSC-C104756
Spain	Madinter Trade, S.L, Madrid	Secondary processor, musical instruments, including parts of guitars	FSC controlled wood	FSC-C019919
	Maderas Barber S.L., Paterna	Secondary processor, Musical instruments and parts of musical instruments	FSC Controlled Wood; FSC 100%	FSC-C092704
	Tonewoods S.L., Valencia	Secondary processor. Solid wood, veneer, musical instruments	FSC 100%	FSC C114406
Switzerland	Theodor Nagel Basel GmbH, Basel	Brokers/traders with physical possession	FSC Controlled wood	FSC-C017751
Tanzania	Mpingo Conservation and Development Initiative (group certificate for 11 members)	Logging	FSC 100%	FSC-C012607

Appendix 4. Companies that have various forms of FSC certification for *Pterocarpus angolensis* (data from http://info.fsc.org/certificate.php).

Country	Company	Main activity category	Main output category	FSC Certificate Number
Austria	Holzpartner Handelsgesellschaft m.b.H.; with 9 group members, all in Austria.	Brokers/traders without physical possession.	FSC Mix; FSC 100%	FSC-C11700
Australia	Mathews Timber Pty Ltd (Vermont, Victoria.	Secondary processor. Solid wood and planks.	FSC Controlled Wood; FSC Mix; FSC 100%	FSC-C004682
Bosnia and Herzegovina	Drvodom d.o.o, Sarajevo	Brokers/traders with physical possession.	FSC Controlled Wood; FSC Mix; FSC 100%	FSC-C125151
	JAFA-JASE 4 d.o.o., Špionica-Srebrenik	Primary processor.	FSC 100%	FSC-C123153
China	SHANGHAI XINHONGYA WOOD CO., LTD, Shanghai	Brokers/traders without physical possession (of roundwood logs).	FSC Mix; FSC 100%	FSC-C115443
	Macrola Home Furniture & Home Decoration (Fujian) Co., Ltd in Fuzhou	Primary processor. Indoor furniture and cabinets.	FSC 100%	FSC-C122655
	Midfield Hong Kong Limited. Hong Kong	Brokers/traders without physical possession (of solid wood).	FSC Mix; FSC 100%	FSC-C044157
Germany	Espen, HG, Bad Vilbel	Brokers/traders without physical possession (of solid wood).	FSC 100%	FSC-C116242
	Schmidt GmbH, Neuwied	Secondary processor.	FSC Mix; FSC 100%	FSC-C007174
	Topstyle Flooring GmbH, Babensham/Neudeck	Brokers/traders without physical possession. Wood for stairs, flooring, mouldings, door frames.	FSC Mix; FSC 100%; FSC Recycled	FSC124264
Mozambique	LevasFlor Lda., Beira	Logging.	FSC Controlled Wood; FSC 100%	FSC-C005219
Tanzania	Mpingo Conservation and Development Initiative; group certificate for 11 members	Logging.	100% FSC	FSC-C012607