Pak. J. Bot., 56(1): 185-196, 2024. DOI: http://dx.doi.org/10.30848/PJB2024-1(12)

A REVIEW OF THREATENED PLANT SPECIES UTILIZATION, CONSERVATION STATUS, AND DISTRIBUTION IN THE VHEMBE BIOSPHERE RESERVE, LIMPOPO PROVINCE, SOUTH AFRICA

LUAMBO JEFFREY RAMARUMO[1,3*], ALFRED MAROYI[1], MILINGONI PETER TSHISIKHAWE[2] AND WILFRED OTANG-MBENG[3]

[1]Medicinal Plants and Economic Development (MPED) Research Centre, Department of Botany, Faculty of Science and Agriculture, University of Fort Hare, Private Bag X1314, Alice, 5700, South Africa
[2]Department of Biological Science, Faculty of Science, Engineering and Agriculture, University of Venda, Private Bag X5050, Thohoyandou, 0950, South Africa
[3]School of Biology and Environmental Science, Faculty of Science and Agriculture, University of Mpumalanga, Private Bag X11283, Mbombela, 1200, South Africa
**Corresponding author's email: luambo@safrica.com*

Abstract

Scientific evidence suggests that threatened plants are disappearing at an alarming rate. Over the last decades, government spending in the fight against species extinction risk has immensely increased, exceeding US$7.1 billion annually. However, the rate of species extinction worldwide is rapidly increasing, with no indications of slowing down soon. Scientific scholars, including botanists, ethnobotanists, economic-botanists, conservationists, and anthropologists, share a mutual interest in using indigenous knowledge for livelihoods, scientific and economic growth. As a result, there is a growing interest in indigenous knowledge research, particularly the research fields involving plant species utilization and conservation. Given that recent scientific evidence suggests that such studies are lacking in South African Biosphere Reserves, there is a burning need to critically review the literature about threatened plant species utilization, conservation status, and distribution in the Vhembe Biosphere Reserve. The literature search was conducted using various keywords in various electronic databases. The review findings demonstrate that *Brackenridgea zanguebarica, Prunus africana, Rhychosia vendae,* and *Warbugia salutaris* were being utilized for medicinal purposes in the Vhembe Biosphere Reserve, and their conservation status range from Vulnerable to Critical Endangered. So far, none of the literature studies conducted in the Vhembe Biosphere Reserve has specified the ailments that *P. africana, R. vendae,* and *W. salutaris* treat. The results revealed that many literature studies had reported on the distribution of threatened plant species in the Vhembe Region, at the national level or elsewhere. However, none of these studies have incorporated spatial information related to the exact locality of the species, except for *B. zanguebarica*. This review provides insights above utilized threatened plant species, their conservation statuses, and distribution in the Vhembe Biosphere Reserve.

Keywords: Conservation status; Extinction; Indigenous knowledge; Threatened plant utilization; Vhembe Biosphere Reserve.

Introduction

In South Africa, the authority for assessing or re-assessing the conservation status of threatened plant species is held by the South African Biodiversity Institute (SANBI), which is an affiliate of the International Union for Conservation of Nature (IUCN) (Moraswi *et al*., 2019; Bamigboye, 2019). The IUCN is an international organization holding international mandates and authority for categorizing threatened plant species according to their categories of threats and giving accreditations and directives to all its affiliates worldwide (Callmander *et al*., 2005; Rodrigues *et al*., 2006; Hoffmann *et al*., 2008). Threatened plants herein defined as those species that have been holistically assessed using Version 3.1 of the IUCN's Red List Categories and Criteria and consequently awarded the conservation status as either, Vulnerable (VU), Endangered (EN) or Critical Endangered (CR) (IUCN, 2012; Williams *et al*., 2013; Dzerefos *et al*., 2017; Du *et al*., 2018; Bamigboye & Tshisikhawe, 2020). Some scholars consider threatened plant species of high conservation concern (Keller & Bollmann, 2004; van Swaay *et al*., 2011; Tiawoun *et al*., 2018; Tiawoun *et al*., 2020). South Africa has endorsed many strict regulations to help conserve threatened plant species at the national level. These regulations include the Conservation of Agricultural Resources Act No. 43 of 1983, National Forests Act No. 84 of 1998, National Environmental Management Act No. 107 of 1999, and National Environmental Management: Biodiversity Act No. 10 of 2004 (Ndlela, 2004; Foden, 2007; Crouch & Smith, 2010; Knobel, 2015; Dzerefos *et al*., 2017; Bamigboye *et al*., 2017). However, scientific evidence suggests that such regulations in South Africa deny local people access to their surrounding wildlife and direct subsistence benefits (Reid *et al*., 2004). On the contrary, the United Nations (UN) endorse the international protection of threatened plant species through international treaties and conventions (Korsmo, 1991; Havens *et al*., 2006; Messer, 2010; Kahler & Gore, 2012; Biggs *et al*., 2017). Therefore, Article 1, 8 (j), and 10 of the UN Charter on the Convention for Biological Diversity gives full recognition to local indigenous people and their knowledge regarding sustainable uses of genetic resources (Talaat, 2013; Sinthumule & Mashau, 2020). The convention is devoted to access to genetic materials,

fairness and equitable sharing of benefits from natural resources (Buck & Hamilton, 2011; Flach *et al*., 2019; Knauf *et al*., 2019). Although this review is not intended to focus on the regulatory issues on threatened plant species, it is, therefore, arguable that South African regulations about plant species protection likely violate Article 1; 8 (j) and 10 of the UN's Charter on Convention for Biological Diversity (United Nations, 1992), and Section 24 of Chapter 2: Bill of Right, of the constitution of the Republic of South Africa (Constitution of South Africa, 1996).

Scientific evidence shows that many threatened plant species are disappearing at an alarming rate worldwide (Reed *et al*., 2011; Rivers *et al*., 2011; Maroyi, 2012; Tshisikhawe *et al*., 2013; Ibrahim *et al*., 2013; Borokini, 2014; Brummitt *et al*., 2015; Volis, 2016; Magee *et al*., 2017; Fox & Madsen, 2017; Davison *et al*., 2018; Pykälä, 2019; Bello *et al*., 2019). This is primarily influenced by varying factors, including climate change, agricultural land expansion, over-exploitation of biological resources for commercial purposes, alien invasive species, and habitat transformation due to ongoing urbanization (Baider & Florens, 2011; He & Hubbell, 2011; De Baan *et al*., 2013; Rey *et al*., 2016; Van Wyk & Prinsloo 2018; Tiawoun *et al*., 2019; Woinarski *et al*., 2019). The disappearance of plant species could, in turn, disrupt the provision of ecosystem services. This can negatively affect human well-being, livelihood chain, and sociocultural relations, especially in third-world countries, including South Africa (Scholes, 2016; Pascual *et al*., 2017; Liu & Krutovsky, 2018; Debnath *et al*., 2020). Many people in third-world countries are dependent on natural resources supplied as ecosystem services (Paudyal *et al*., 2017; Boone *et al*., 2018; Ngwenya *et al*., 2019; Castro-Díez *et al*., 2019; Chaplin-Kramer *et al*., 2019). Globally, scientists warn that ignorance to present species extinction can accumulate into a mass extinction event (Mitchell, 2018). Furthermore, although there are many predictions about the present species extinction rate (Lenzen *et al*., 2012; Pimm *et al*., 2014), scientists again warn that the pragmatic extinction rate could likely exceed the predicted rates (Valiente-Banuet *et al*., 2015). To counteract the risk of species extinction, the international community, through various government initiatives, has devoted to halting rather than minimizing human-induced extinctions (McCarthy *et al*., 2012). Due to this, governments worldwide are making the conservation of biological species, including threatened plants, mandatory and priority in all their spheres (Rossi *et al*., 2016; Brundu *et al*., 2017; Dzerefos *et al*., 2017). Over the last decades, government spending in the fight against species extinction has immensely increased (Ma *et al*., 2013). Therefore, Sheil *et al.* (2013) estimated that the global cost used in the fight against extinction exceeds US$7.1 billion annually. Regardless of the allocated budget to expedite the fight against extinction, the rate of species extinction worldwide is increasing rapidly with no indications of slowing down soon (Stern, 2008). Furthermore, conservation mechanisms and strict government protocols presently used to combat species extinction worldwide have proven not robust, inefficient, and ineffective (Stern, 2008). As a result, non-compliance with conservation protocols has become a common global challenge (Oldekop *et al*., 2016; Ofoegbu & Ifejika-Speranza, 2017). Similar, to the global failure, regarding the pledge to halt extinction threats by the year 2020 (McCarthy *et al*., 2012), the use of strict conservation protocols to enforce compliance in South Africa also produced no results (Ofoegbu & Chirwa, 2019). Therefore, this has raised many intriguing questions, one being whether scientific knowledge only could truthfully grant a sustainable future for species conservation or solutions to extinction threats.

Recent literature studies suggest that scientific knowledge could not be the only knowledge to grant a sustainable future and solution to conservation and species extinction (Sinthumule & Mashau, 2020). Moreover, scientific studies also suggest that indigenous people, through indigenous knowledge systems, have been engaged in biodiversity conservation and species monitoring since time immemorial (Thompson *et al*., 2020; Bahagia *et al*., 2020; Arshad, 2022; Rehman *et al.*, 2022). However, scientific literature also suggests that indigenous people are usually monitored to conserve natural resources for their benefit (Araia & Chirwa, 2019a; Thomson *et al*., 2020). Hence, Salafsky *et al*., (2002) and Heywood & Iriondo (2003) emphasized that the utilization and conservation of natural resources are interlinked and inextricable. Indigenous knowledge is defined as applied, cumulative knowledge and attributes inherited and passed through generational patterns (Mavhura *et al*., 2013; Bamigboye *et al*., 2017; Nkwanyana, 2018; Suwardi *et al*., 2020). Consequently, local people in some tribal areas, including dwellers of the Vhembe Biosphere Reserve, in the Limpopo Province, South Africa, have voluntarily taken the fight to minimize the risk of species extinction, using various indigenous conservation mechanisms (Ofoegbu & Chirwa, 2019; Araia & Chirwa, 2019a). However, much of indigenous conservation knowledge in the Vhembe Region is still transferred orally and remains undocumented. Despite the thriving literature about indigenous conservation practices worldwide (Fernández-Llamazares & Cabeza, 2018; Garnett *et al*., 2018), recent scientific evidence suggests that such studies remain lacking in South African Biosphere Reserves (Jauro *et al*., 2020). Consequently, many studies done in the Vhembe Biosphere Reverse likely focused their attention on indigenous medicinal aspects (Nelwamondo *et al*., 2013; Luseba & Tshisikhawe, 2013; Tshisikhawe *et al*., 2014; Magwede *et al*., 2014; Masevhe *et al*., 2015; Ramovha, 2016; Ramovha & van Wyk, 2016; Tshidzumba, 2018; Magwede *et al*., 2019a; Mokganya & Tshisikhawe, 2019), leaving the issue of indigenous conservation untapped. This has resulted in a minimal number of studies done about indigenous conservation, monitoring, and compliance in the region (Mutshinyalo & Siebert, 2010; Semenya *et al*., 2013a; Araia & Chirwa, 2019b; Sinthumule & Mashau, 2020). Lawmakers, conservation managers, and scientists are now considering integrating

indigenous conservation means into the mainstream conservation agenda (Araia & Chirwa, 2019a; Bahagia *et al*., 2020). This emphasizes the need to properly review documented information about indigenous conservation, monitoring, and management of threatened plant species in South African Biosphere Reserves, including the Vhembe Biosphere Reserve.

The notion that conservation and sustainable utilization of natural resources are inextricable and interlinked is widely accepted (Heywood & Iriondo, 2003; Tshisikhawe, 2016). Global interest in indigenous knowledge research, significantly these involving utilization and conservation, is growing immensely (Kunz *et al*., 2012; Tareen *et al*., 2016; Ndhlovu *et al*., 2019; Astutik *et al*., 2019; Setshego *et al*., 2020). This clearly accentuates indigenous knowledge's positive impact in resolving issues affecting social life, including socio-ecological and socio-economic issues. Scientific scholars, including botanists, ethnobotanists, economic-botanists, conservationists, and anthropologists, all share a common interest in using indigenous knowledge for livelihoods, scientific and economic growth (Sinthumule & Mashau, 2020). During the last decade, the documentation of African indigenous knowledge associated with the conservation and utilization of natural resources has shown tremendous growth (Maroyi, 2013a; Williams *et al*., 2013; Borokini, 2014; Leonard & Viljoen, 2015; Cunningham *et al*., 2016; Dzerefos *et al*., 2017; Semenya & Maroyi, 2019a). Local people in the Southern African Region, including the Vhembe Biosphere Reserve dwellers in Limpopo Province, South Africa, have been conserving botanical resources to obtain maximum subsistence benefits for many years (Araia & Chirwa, 2019b). Therefore, scientific evidence shows that some of these benefits were obtained from threatened botanical resources distributed in the region (Mabogo, 1990; Magwede *et al*., 2019b). However, in this region, local indigenous knowledge associated with using threatened plant species for subsistence rather than livelihoods and economic growth has not been fully explored. Ethnobotanical studies about using threatened plant species in this region mainly focused on *Brackenridgea zanguebarica* Olive. (Tshisikhawe & Van Rooyen, 2012; Tshisikhawe, 2016; Tiawoun *et al*., 2018; Tiawoun *et al*., 2020). This has raised many exciting questions on whether *B. zanguebarica* is the only utilized threatened plant species in the entire region or not?; if not, what are the other utilized threatened plants in the region?; where are the other utilized threatened plant species distributed in the region?; what is their conservation status?; and what are they used for by local people? Literature suggests that local people of the Vhembe Biosphere Reserve in Limpopo Province, South Africa, have been adjusting their subsistence needs with biodiversity conservation and sustainable utilization of natural resources since immemorial (Araia & Chirwa, 2019b). However, little remains are known about the indigenous conservation mechanisms used by local people in the region (Araia & Chirwa, 2019a). Spatial information about the local distribution of many threatened plant species in the region and their actual or specific uses are also unknown. Therefore, scientific evidence suggests that lack of spatial information about the distribution of certain species or species of high conservation concern can negatively impact the management and monitoring plan of these species (Brodnig & Mayer-Schönberger, 2000; Meredith *et al*., 2002; Driver *et al*., 2005; Bottero *et al*., 2013; Selig *et al*., 2014; Garnett *et al*., 2018; Harlio *et al*., 2019; Van der Biest *et al*., 2020). As a result, this could hinder the conservation efforts devoted to sustainability of threatened plant species in the region, regardless of whether the effort is conventional or non-conventional. This study aimed at reviewing the literature about threatened plant species utilization, conservation status, and distribution in the Vhembe Biosphere Reserve, Limpopo Province, South Africa. In this review, we hypothesized that detailed knowledge about threatened plant utilization, conservation status and distribution could suggest appropriate conservation measures.

Materials and Methods

Information about threatened plant species, utilization, and distribution range was attained through intensive reviewing of published literature on electronic databases, including Google Scholar, Wiley Online Library, Sabinet, Springer, Research-Gate, Science Direct, MedPub, Scopus, and other Research Websites. Furthermore, the IUCN ‘s Red List of Threatened Species (Version 2019-2) and SANBI ‘s Red List of South African Plants (Version 2017.1) databases were also used to comprehend the conservation status and threats posed to those plant species in the region. The International Plant Names Index (IPNI) database was also used to validate authorities on the botanical names of threatened plant species. The literature search lasted 31 months, from March 2018 until September 2020. Therefore, the following keywords were amongst those used during relevant literature searching biosphere reserves; conservation, conservation status; distribution range; disappearing; indigenous uses; indigenous knowledge; livelihood; local people; location; red list; Soutpansberg; species extinction; threatened plant species; useful plants; utilization; Vhembe Biosphere Reserve and Vhembe District Municipality. The exploration of literature included searching and screening relevant scientific reports, books, research papers, theses, review papers, and conference proceedings, all published in English; therefore, about 832 articles were identified. However, only 446 articles were likely found to be relevant and were rigorously surveyed to identify those that have assessed threatened plant species utilization, distribution, and conservation issues. Most of the qualitative literature data were converted into numeric and then entered into a spreadsheet of Microsoft Office 2010 and analyzed in tables, graphs, and statistically using the one-way analysis of variance (Commonly known as Anova: Single factor). Anova was essential for providing an overall test of equality amongst the group means. Cramer *et al*., (2016) indicated that Anova can control the overall type I error rates.

Results and Discussion

Of 446 academic papers, 81 investigated threatened plant species utilization, conservation status, and distribution. Out of the 80 yielded papers or papers that have investigated threatened plants, only 24 (<30%) of them recorded utilization of threatened plant species in the Vhembe Biosphere Reserve, Limpopo Province, South Africa. The recorded threatened plant species included *Brackenridgea zanguebarica* Olive, *Prunus africana* (Hook.f.) Kalkman, *Rhynchosia vendae* C.H.Stirt., *Warburgia salutaris* (G. Bertol.) Chiov and their conservation status ranged from VU to CR. The recorded species belong to different plant families, including Ochnaceae, Canellaceae, Rosaceae, and Fabaceae. All the recorded threatened plant species in the Vhembe Biosphere Reserve were utilized only for medicinal purposes (Table 1). The Vhembe Biosphere Reserve of the Limpopo Province, South Africa, is biodiversity refugia and a hotspot for many indigenous, rare and endemic plant species (Hahn, 2017). Although there are many threatened plant species distributed in the Vhembe Biosphere Reserve of the Limpopo Province, South Africa (Raimondo *et al*., 2009; Moraswi *et al*., 2019), The utilization of *B. zanguebarica, P. africana, R. vendae,* and *W. salutaris* only, in this region proves the fact that there is a dearth of scientific studies about threatened plant species utilization, conservation status and distribution in the Vhembe Biosphere Reserve. Our findings support the study by Jauro *et al*., (2020), who emphasizes that there is a lack of knowledge about biodiversity values for human benefits or development in the context of socioeconomic, sociocultural, and socio-ecological aspects in South Africa Biosphere Reserves. Literature search results show that few studies have reported utilization of *R. vendae* and, therefore, those studies were locally based and restricted to Vhembe Biosphere Reserve only. *Rhynchosia vendae* is rare and not well-known, although the species is endemic to this region. The findings of this review were endorsed by Hahn (2017), who uttered that *R. vendae*'s association with other species within its genus remains unknown.

Results in this review show that a high number of academic papers have recorded utilization of *B. zanguebarica* at the local level (n=21) rather than the national level (n=2) and elsewhere (n=17). Furthermore, the results in the current review also showed that utilization of *P. africana* was primarily recorded in studies done elsewhere (n=13), followed by those done at the national level (n=12), and lastly, were those done at the local level (n=3). Academic papers used in this review show equal records for the utilization of *W. salutaris* elsewhere (n=11) and at the national level (n=11), with few papers reporting its utilization at the local level (n=7) (Fig. 1A). Although there is visible difference amongst number of studies that have reported the utilization of threatened plant species at all levels, including, studies done locally, nationally, and elsewhere (Fig. 1A), statistical results show no significant difference ($p>0.05$) amongst number studies recorded utilization of those species at all levels (Fig. 1C). A considerable percentage of studies done locally (in the Vhembe Biosphere Reserve), never specified the medicinal uses of certain threatened plant species, including *P. africana* > 66.7% (none specificity) < 33.3% (specificity), *W. salutaris* >71.4% (none specificity) < 28.6% (specificity). Literature search reveals that, although *R. vendae* is documented among the medicinal plants used in the Vhembe Biosphere Reserve, nothing is known about its specific medicinal usage or ailments that it treats, as illustrated in Fig. 1B. On the contrary, more than enough local studies have recorded the specific usage of *B. zanguebarica* > 57.1% (specificity) < 42.9% (none specificity) (Fig. 1B).

Although none of the national studies in this review have neither shown the specified nor unspecified record of medicinal usage of *R. vendae*, many studies done at the same level have specified the medicinal uses of threatened plant species, including *P. africana* > 84.6% (specificity) < 15.4% (none specificity) and *W. salutaris* > 90.9% (specificity) < 9.1% (none specificity), with equal records of specified (50%) and non-specified (50%) medicinal use of *B. zanguebarica*. Many studies done elsewhere also show a higher percentage of specified than non-specified medicinal uses of threatened species such as *B. zanguebarica* > 70.6% (specificity) < 29.4% (none specificity) and *W. salutaris* > 63.6% (none specificity), whereas, fewer studies have specified the medicinal uses of *P. africana* < 38.5% (specificity) > 61.5% (none specificity), with neither study specified, nor unspecified the medicinal use of *R. vendae* (Fig. 1B). Many literature studies have documented and specify the utilization of *B. zanguebarica* at both local level and elsewhere, particularly in the Southern African Development and Economic Community (SADEC). This demonstrates that the distribution of *B. zanguebarica* is widespread. It further demonstrates the existence of common knowledge about its uses amongst many related tribal communities in the SADEC Region, including dwellers within the Great Limpopo Trans-Frontier Conservation Area, which extends to some parts of the Vhembe Biosphere Reserve in South Africa, Mozambique, and Zimbabwe (Nicosia *et al*., 2020). The historical studies confirm that tribal communities in Southern Africa, especially the Vhavenḓa Tribe in the Vhembe Biosphere Reserve, South Africa, and those in Zimbabwe (previously known as Rhodesia), Mozambique, Zambia, Malawi, and Tanzania are closely related, and they share common traditional customs (Lowe & Moores, 1972; Whittaker & Lowe, 1976; Schutte, 1978; Loubser, 1989; Nettleton 1992), not limited to plants that they utilize. Nevertheless, many literature studies have noted and specified the medicinal uses of *P. africana* and *W. salutaris*. However, analysis in this review demonstrated that many of those studies were not locally based or done at the local level. Therefore, their findings do not reflect the local usage of *P. africana* and *W. salutaris*. Atakpama *et al*., (2012) and Kébenzikato *et al*., (2015) emphasize that the use of certain plant species differs from one ethnic group to another. Moreover, the minimal number of scientific studies about the utilization of *P. africana* and *W. salutaris* at the local level confirms that there could be an undiscovered wealth of knowledge in the Vhembe Biosphere Reserve. The study by Maroyi (2013b) and Lawal *et al*., (2014) confirms the existing gap in the literature about the therapeutic preparation methods of *W. salutaris*, its administration processes to patients, and the dosage used during the administration process.

Table 1. Utilized threatened plant species and their conservation status in the Vhembe Biosphere Reserve, Limpopo Province, South Africa.

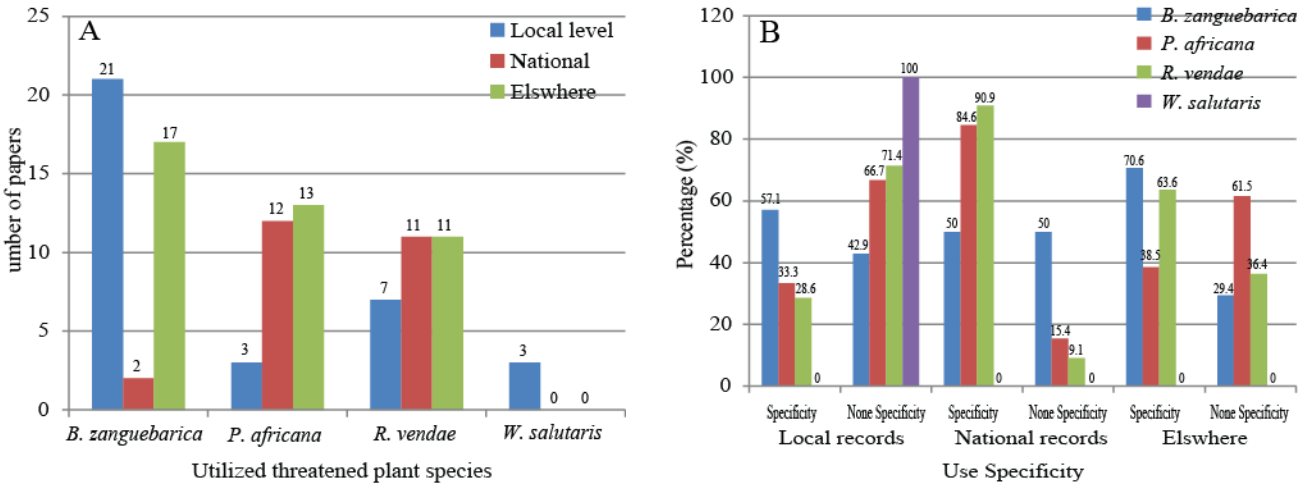
Plant names	Conservation status		Habit	Utilization categories	Utilized parts	Utilization records		
	IUCN	SANBI				A: Local records	B: National records	C: Records elsewhere
Brackenridgea zanguebarica Olive. (Family: Ochnaceae)	-	CR	Tree	Medicinal	Bark and root	A_1; A_2; A_3; A_5; A_6; A_7; A_8; A_9; A_{10}; A_{11}; A_{12}; A_{13}; A_{15}; A_{16}; A_{17}; A_{18}; A_{19}; A_{20}; A_{21}; A_{22}; A_{23};	B_1; B_{13}	C_{19}; C_{20}; C_{21}; C_{22}; C_{23}; C_{24}; C_{25}; C_{26}; C_{27}; C_{28}; C_{29}; C_{30}; C_{31}; C_{32}; C_{33}; C_{34}; C_{35}
Prunus africana (Hook.f.) Kalkman (Family: Rosaceae)	-	VU	Tree	Medicinal	Bark	A_1; A_2; A_{23}	B_8; B_9; B_{10}; B_{11}; B_{12}; B_{13}; B_{14}; B_{15}; B_{16}; B_{17}; B_{18}; B_{19}	C_9; C_{10}; C_{11}; C_{12}; C_{13}; C_{14}; C_{15}; C_{16}; C_{17}; C_{18}; C_{22}; C_{29}; C_{35}
Rhynchosia vendae C.H. Stirt. (Family: Fabaceae)	-	VU	Climber	Medicinal	Root tuber	A_1; A_{14}; A_{23}	-	-
Warburgia salutaris (G. Bertol.) Chiov. (Family: Canellaceae)	EN	EN	Tree	Medicinal	Bark	A_1; A_2; A_3; A_4; A_5; A_{23}; A_{24}	B_1; B_2; B_3; B_4; B_5; B_6; B_7; B_{17}; B_{19}; B_{20}; B_{21}	C_1; C_2; C_3; C_4; C_5; C_6; C_7; C_8; C_{22}; C_{33}; C_{36}

[Keys: -: None; CR: Critical Endangered; EN: Endangered; VU: Vulnerable; A_1: Magwede *et al.*, (2019a); A_2: Mphephu (2017); A_3: Nefhere (2019); A_4: Mashimbye *et al.*, (1999); A_5: Mabogo (1990); A_6: Van Wyk & Van Wyk (1997); A_7: Ojelade (2018); A_8: Tshisikhawe (2013); A_9: Tshisikhawe & Van Rooyen (2012); A_{10}: Tshisikhawe (2016); A_{11}: Tiawoun *et al.*, (2018); A_{12}: Tiawoun *et al.*, (2020); A_{13}: Constant & Tshisikhawe (2018); A_{14}: Hahn (2002); A_{15}: Arnold & Gulumian (1984); A_{16}: Tshisikhawe (2002); A_{17}: Van Wyk *et al.*, (1997); A_{18}: Netshiungani & Van Wyk (1980); A_{19}: Van Wyk & Van Wyk (1997); A_{20}: Tshisikhawe *et al.*, (2013); A_{21}: Sobiecki (2002); A_{22}: Ndhlovu *et al.*, (2019); A_{23}: Magwede (2018); A_{24}: Masevhe *et al.*, (2015); B_1: Semenya & Maroyi (2019a); B_2: Clark (1997); B_3: Nyaba *et al.*, (2018); B_4: Kotina *et al.*, (2014); B_5: Maroyi (2014); B_6: Botha *et al.*, (2004); B_7: Maroyi (2013b); B_8: Stewart (2003); B_9: Rasethe *et al.*, (2019); B_{10}: Semenya *et al.*, (2013b); B_{11}: Semenya & Maroyi (2019b); B_{12}: Williams *et al.*, (2007); B_{13}: Williams *et al.*, (2013); B_{14}: Gail *et al.*, (2015); B_{15}: Schoeman *et al.*, (2019); B_{16}: Lawal *et al.*, (2014); B_{17}: Van Wyk & Prinsloo (2019); B_{18}: Coopoosamy & Naidoo (2012); B_{19}: Moyo *et al.*, (2015); B_{20}: Xego *et al.*, (2016); B_{21}: Swemmer *et al.*, (2011); C1: Senkoro *et al.*, (2019); C_2: Veeman *et al.*, (2014); C_3: Augustino *et al.*, (2011); C_4: Maroyi (2000); C_5: Brown (2013); C_6: Dludlu *et al.*, (2017); C_7: Maroyi (2012); C_8: Simelane (2009); C_9: Cunningham & Mbenkum (1993); C_{10}: Ndam & Marcelin (2004); C_{11}: Tolessa (2019); C_{12}: Mugula *et al.*, (2010); C_{13}: Bellewang (2005); C_{14}: Neimark (2010); C_{15}: Giliba & Yengoh (2020); C_{16}: Gyau *et al.*, (2012); C_{17}: Mwitari *et al.*, (2013); C_{18}: Bandeira *et al.*, (2001); C_{19}: Chhabara *et al.*, (1990); C_{20}: Neuwinger (2000); C_{21}: Möller *et al.*, (2006); C_{22}: Veldman *et al.*, (2020); C_{23}: Singo (2007); C_{24}: Clarke & Dickinson (1995); C_{25}: Bruschi *et al.*, (2011); C_{26}: Palgrave *et al.*, (2007); C_{27}: Conde *et al.*, (2014); C_{28}: Osmaston (1968); C_{29}: Timberlake *et al.*, (2009); C_{30} Timberlake *et al.*, (2016); C_{31}: Marston *et al.*, (1996); C_{32}: Hostettmann & Marston (2001); C_{33}: Chidhakwa (2003); C_{34}: Nicosia *et al.*, (2020); C_{35}: Bundschuh *et al.*, (2010); C_{36}: Opio *et al.*, (2017)]

Table 2. Distribution records of *B. zanguebarica*, *P. africana*, *W. salutaris* and *R. vendae* in the Vhembe Biosphere Reserve, countrywide and elsewhere.

Plant names	Recorded area of distribution in the Vhembe Biosphere Reserve		Recorded area of distribution in other Provinces countrywide		Recorded countries of distribution	References
	Name	Coordinates of location records	Name	Coordinates of location records		
B. zanguebarica	Thengwe Village	Range from: -22° 24′ 0.0" and -23° 36′ 0.0" S to 29° 12′ 0.0" and 31° 12′ 0.0" E	-	-	Tanzania; Kenya; Mozambique; Uganda; Zimbabwe and Malawi	R_1; R_3; R_4; R_5; R_{11}; R_{12}; R_{15}; R_{16}; R_{19}; R_{20}; R_{21}; R_{26}; R_{27}; R_{28}; R_{32}
P. africana	Soutpansberg	-	Eastern Cape, Gauteng, KwaZulu-Natal, Mpumalanga and North-West Province	-	Madagascar; Tanzania; Uganda; Kenya; Cameroon; Ethopia and Mozambique	R_1; R_6; R_7; R_8; R_9; R_{10}; R_{17}; R_{18}; R_{30}; R_{31};
R. vendae	Eastern Soutpansberg and Thengwe	-	-	-	-	R_1; R_2
W. salutaris	Soutpansberg	-	North-eastern KwaZulu-Natal and Mpumalanga Province	-	Mozambique; Eswatini/ Swaziland; Zimbabwe; Tanzania; Uganda and Kenya	R_1; R_6; R_{13}; R_{14}; R_{22}; R_{23}; R_{24}; R_{25}; R_{26}; R_{29}; R_{33}; R_{34}

[Keys: -: None; R_1: Raimondo *et al.*, (2009); R_2: Hahn (2002); R_3: Tshisikhawe (2013); R_4: Tiawoun *et al.*, (2018); R_5: Tiawoun *et al.*, (2019); R_6: Mwitari *et al.*, (2013); R_7: Ndam & Marcelin (2004); R_8: Bellewang (2005); R_9: Cunningham & Mbenkum (1993); R_{10}: Gyau *et al.*, (2012); R_{11}: Nicosia *et al.*, (2020); R_{12}: Palgrave *et al.*, (2007); R_{13}: Opio *et al.*, (2017); R_{14}: Senkoro *et al.*, (2019); R_{15}: Timberlake *et al.*, (2016); R_{16}: Timberlake, *et al.*, (2009); R_{17}: Tolessa (2019); R_{18}: Bandeira *et al.*, (2001); R_{19}: Bruschi *et al.*, (2011); R_{20}: Conde *et al.*, (2014); R_{21}: Singo (2007); R_{22}: Maroyi (2013b); R_{23}: Maroyi (2012); R_{24}: Augustino *et al.*, (2011); R_{25}: Brown (2013); R_{26}: Chidhakwa (2003); R_{27}: Chhabara *et al.*, (1990); R_{28}: Clarke & Dickinson (1995); R_{29}: Clark & Appleton (1997); R_{30}: Neimark (2010); R_{31}: Mugula *et al.*, (2010); R_{32}: Osmaston (1968); R_{33}: Veeman *et al.*, (2014); R_{34}: Dludlu *et al.*, (2017)]



Anova: Single Factor Summary

Groups	Count	Sum	Average	Variance	F	P-value
Brackenridgea zanguebarica	3	40	13.33333333	100.33333333	2.346922462	0.148885047
Prunus africana	3	28	9.33333333	30.33333333		
Rhychosia vendae	3	3	1	3		
Warbugia salutaris	3	29	9.66666666	5.33333333		

Fig. 1. Records of studies about *Brackenridgea zanguebarica, Prunus africana, Rhychosia vendae,* and *Warbugia salutaris* at various levels, their specific usage and statistical comparison.

Table 2 demonstrates the distribution range of *B. zanguebarica, P. africana, R. vendae,* and *W. salutaris* in the Vhembe Biosphere Reserve, countrywide and elsewhere. Despite *B. zanguebarica* 's restricted geographical distribution in Thengwe Village of the Vhembe Biosphere Reserve, Limpopo Province, South Africa, a substantial number of scientific studies have confirmed its distribution and usage elsewhere, in countries including Kenya, Malawi, Mozambique, Tanzania, Uganda, and Zimbabwe. Scientific evidence also shows that the distribution of *R. vendae* is restricted to two geographic areas within the Vhembe Biosphere Reserve only. However, such evidence lacks information about its locality coordinates of the location. The distribution of *P. africana* and *W. salutaris* is widespread in many African countries, including Cameroon, Eswatini/ Swaziland, Ethiopia, Kenya, Madagascar, Mozambique, Uganda, and Tanzania. In South Africa, *P. africana* and *W. salutaris* are distributed in the Soutpansberg site of the Vhembe Biosphere Reserve, in Limpopo Province, the Eastern Cape, Gauteng, KwaZulu-Natal, Mpumalanga, and North-West Provinces. However, scientific studies reviewed show no record of information about their exact locality or coordinates of locations. The analysis in this review illustrates that many literature studies contain information about the general distribution of *B. zanguebarica, P. africana, R. vendae,* and *W. salutaris* in either the Vhembe Biosphere Reserve nationwide or elsewhere. However, none of them, particularly studies that have reported the distribution of *P. africana, R. vendae,* and *W. salutaris,* lacks details for spatial information about their exact locations. This could be among many other factors that constitute poor management and monitoring of threatened plant species in the Vhembe Biosphere Reserve, countrywide and elsewhere.

Nevertheless, Van der Biest *et al*., (2020) emphasize the importance of spatial information, mainly information about location, in systematically conserving and monitoring natural resources. In contrast, Underwood *et al*., (2003) and Gredzens *et al*., (2014) referred to spatial information about species' locations as the baseline for better conservation and monitoring. Based on the study done by Nagendra *et al*., (2013) and Biró *et al*., (2014), it is clear that detailed knowledge about threatened plant distribution, conservation status, and utilizations is essential for appropriate conservation and monitoring measures.

Conclusion

The current review provides insights above utilized threatened plant species, their conservation status, and distribution range in the Vhembe Biosphere Reserve. This review could serve as a vantage point for many similar studies. Dispute many threatened plant species distributed in the Vhembe Biosphere Reserve, Limpopo Province, South Africa, the literature studies illustrate that only four species, including *B. zanguebarica*, *P. africana*, *R. vendae*, and *W. salutaris*, are being utilized across the region. Although many literature studies demonstrated that threatened plant species in the region were being used for medicinal purposes; however, none of these studies have specified the ailments that *P. africana, R. vendae*, and *W. salutaris* remedies at the local level. Nevertheless, no literature study has recorded spatial information related to the exact locality of where these species are distributed in the Vhembe Biosphere Reserve, neither at the national level nor elsewhere. Since some literature studies illustrate that utilization and conservation of plant species are interlinked together and inextricable, this review suggests that detailed information about threatened plant species utilization could form part of the strategic conservation planning in South African biosphere reserves, including in the Vhembe Biosphere Reserve, in the Limpopo Province. The current literature survey

highlighted a gap in scientific studies about threatened plant species, their utilization, conservation status, and distribution in the Vhembe Biosphere Reserve and almost all South African biosphere reserves.

Acknowledgment

The authors would like to convey their indubitable gratitude to the anonymous referees for their constructive comments on our manuscript. This study was funded by the National Research Foundation of South Africa (NRF Grant no. 112976) through the Govan Mbeki Research and Development Centre (GMRDC) at the University of Fort Hare. The article processing fees was funded by the University of Venda 's Directorate of Research, Innovation and Postgraduate Studies and the University of Mpumalanga's Division of Research, Innovation and Partnership.

References

Araia, M.G. and P.W. Chirwa. 2019a. Nurturing Forest resources in the Vhavenda community, South Africa: factors influencing non-compliance behaviour of local people to state conservation rules. *South For. J. For. Sci.*, 81(4): 357-366.

Araia, M.G. and P.W. Chirwa. 2019b. Revealing the predominance of culture over the ecological abundance of resources in shaping local people's forest and tree species use behavior: The Case of the Vhavenda People, South Africa. *Sustainability*, 11(11): 3143.

Arnold, H.J. and M. Gulumian. 1984. Pharmacopoeia of traditional medicine in Venda. *J. Ethnopharmacol.*, 12: 35-74.

Arshad, B. 2022. Repurposed traditional medicinal plants as an important weapon for fighting against COVID-19: Pakistani perspective. *Pak. J. Bot., 54*(4): 1495-1505.

Astutik, S., J. Pretzsch and J. Ndzifon Kimengsi. 2019. Asian medicinal plants' production and utilization potentials: a review. *Sustainability*, 11(19): 5483.

Atakpama, W., K. Batawila, M. Dourma, H. Pereki, K. Wala, K. Dimobe, K. Akpagana and M. Gbeassor. 2012. Ethnobotanical knowledge of Sterculia setigera Del. in the Sudanian zone of Togo (West Africa). *Int. Sch. Res. Notices*, 2012: 1-8.

Augustino, S., J.B. Hall, F.B. Makonda and R.C. Ishengoma. 2011. Medicinal resources of the Miombo woodlands of Urumwa, Tanzania: plants and its uses. *J. Med. Plant Res.*, 5(27): 6352-6372.

Bahagia, B., F.M. Mangunjaya, R. Wibowo, Z. Rangkuti, M. Sa'dyah and M.A. Alwahid. 2020. Leuit and prohibition forest: Indigenous knowledge of an Urug community resilience. *Harm. Sos. J. Pendidikan IPS*, 7(2): 130-140.

Baider, C. and F.V. Florens. 2011. Control of invasive alien weeds averts imminent plant extinction. *Biol. Invas.*, 13(12): 2641-2646.

Bamigboye, O.S., M.P. Tshisikhawe and J.P. Taylor. 2017. Detecting threats to *Encephalartos transvenosus* (Limpopo cycad) in Limpopo Province, South Africa through indigenous knowledge. *Ind. J. Trad. Knowl.*, 16(2): 251-255.

Bamigboye, S. and M.P. Tshisikhawe. 2020. The impacts of bark harvesting on a population of *Encephalartos transvenosus* (Limpopo cycad), in Limpopo Province, South Africa. *Biodiversitas*, 21(1): 8-13.

Bamigboye, S.O. 2019. Conservation status and threats to endemic plant species of Griqualand west of South Africa. *J. Plant Dev.*, 26: 117-121.

Bandeira, S.O., F. Gaspar and F.P. Pagula. 2001. African ethnobotany and healthcare: Emphasis on Mozambique. *Pharm. Biol.*, 39(1): 70-73.

Bellewang, E.N. 2005. Socio-economic impact of *Prunus africana* management in the Mount Cameroon region. *A case study of the Bokwoango community. Department of Urban Planning and Environment*. Masters Dissertation. Kungliga Tekniska Högskolan Royal Institute of Technology, Sweden.

Bello, A., S. Jamaladdeen, M.T. Elder, S.S. Yaradua, S.S. Kankara, N.H. Wagini, C.H. Stirton and M. Muasya. 2019. Threatened medicinal and economic plants of the Sudan Savanna in Katsina State, northwestern Nigeria. *Bothalia-Afr. Biodiv. Conserv.*, 49(1): 1-17.

Biggs, D., R. Cooney, D. Roe, H.T. Dublin, J.R. Allan, D.W. Challender, D.W. and D. Skinner. 2017. Developing a theory of change for a community-based response to illegal wildlife trade. *Conserv. Biol.*, 31(1): 5-12.

Biró, É., D. Babai, J. Bódis and Z. Molnár. 2014. Lack of knowledge or loss of knowledge? Traditional ecological knowledge of population dynamics of threatened plant species in East-Central Europe. *J. Nat. Conserv.*, 22(4): 318-325.

Boone, R.B., R.T. Conant, J. Sircely, P.K. Thornton and M. Herrero. 2018. Climate change impacts on selected global rangeland ecosystem services. *Glob. Chang. Biol.*, 24(3): 1382-1393.

Borokini, T.I. 2014. A systematic compilation of IUCN red-listed threatened plant species in Nigeria. *Int. J. Environ. Sci.*, 3(3): 104-133.

Botha, J., E.T.F. Witkowski and C.M. Shackleton. 2004. The impact of commercial harvesting on *Warburgia salutaris* ('pepper-bark tree') in Mpumalanga, South Africa. *Biodiv. Conserv.*, 13(9): 1675-1698.

Bottero, M., E. Comino, M. Duriavig, V. Ferretti and S. Pomarico. 2013. The application of a Multicriteria Spatial Decision Support System (MCSDSS) for the assessment of biodiversity conservation in the Province of Varese (Italy). *Land Use Policy*, 30(1): 730-738.

Brodnig, G. and V. Mayer-Schönberger. 2000. Bridging the gap: the role of spatial information technologies in the integration of traditional environmental knowledge and western science. *J. Inf. Syst. Dev. Ctries.*, 1(1): 1-15.

Brown, J.A. 2013. *Potential Active Ingredients of Selected Priority Medicinal Trees Zanthoxylum chalybeum, Warburgia salutaris, Cassia abbreviata* and *Zahna africana*. Masters' Dissertation. University of Dodoma, Tanzania.

Brummitt, N.A., S.P. Bachman, J. Griffiths-Lee, M. Lutz, J.F. Moat, A. Farjon, J.S. Donaldson, C.H. Taylor, T.R. Meagher, S. Albuquerque and E. Aletrari. 2015. Green plants in the red: A baseline global assessment for the IUCN sampled Red List Index for plants. *PloS One*, 10(8): e0135152.

Brundu, G., L. Peruzzi, G. Domina, F. Bartolucci, G. Galasso, S. Peccenini, F.M. Raimondo, A. Albano, A. Alessandrini, E. Banfi and G. Barberis. 2017. At the intersection of cultural and natural heritage: Distribution and conservation of the type localities of Italian endemic vascular plants. *Biol. Conserv.*, 214: 109-118.

Bruschi, P., M. Morganti, M. Mancini and M.A. Signorini. 2011. Traditional healers and laypeople: a qualitative and quantitative approach to local knowledge on medicinal plants in Muda (Mozambique). *J. Ethnopharmacol.*, 138(2): 543-563.

Buck, M. and C. Hamilton. 2011. The Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization to the Convention on Biological Diversity. *Rev. Eur. Comm. Int. Environ. Law.*, 20(1): 47-61.

Bundschuh, T.V., R. Wittig and K. Hahn. 2010. Effects of human impact on miombo woodland in northern Malawi. *Flora et Veg. Sudano-Sambesica.*, 13: 22-34.

Callmander, M.W., G.E. Schatz and P.P. Lowry. 2005. IUCN Red List assessment and the Global Strategy for Plant Conservation: taxonomists must act now. *Taxon*, 54(4): 1047-1050.

Castro-Díez, P., A.S. Vaz, J.S. Silva, M. Van Loo, A. Alonso, C. Aponte, Á. Bayón, P.J. Bellingham, M.C. Chiuffo, N. DiManno and K. Julian. 2019. Global effects of non-native tree species on multiple ecosystem services. *Biol. Rev.*, 94(4): 1477-1501.

Chaplin-Kramer, R., R.P. Sharp, C. Weil, E.M. Bennett, U. Pascual, K.K. Arkema, K.A. Brauman, B.P. Bryant, A.D. Guerry, N.M. Haddad and M. Hamann. 2019. Global modeling of nature's contributions to people. *Sci.*, 366(6462): 255-258.

Chhabara S.C., R.L.A. Mahunnah and R.N. Mshiu. 1990. Plants used in traditional medicine in Eastern Tanzania, III. Angiosperms (*Mimosaceae to Papilionaceae*). *J. Ethnopharmacol.*, 29: 295-323.

Chidhakwa, Z. 2003. Traditional institutions manage their Nyakwaa and Chizire forests in Chimanimani, Zimbabwe. *Policy Matters*, 12: 132-140.

Clark, T.E. and C.C. Appleton. 1997. The molluscicidal activity of Apodytes dimidiata E. Meyer ex Arn (Icacinaceae), *Gardenia thunbergia* Lf (Rubiaceae) and *Warburgia salutaris* (Bertol. F.) Chiov. (Cannelaceae), three South African plants. *J. Ethnopharmacol.*, 56(1): 15-30.

Clarke, G.P. and A. Dickinson. 1995. *Status Reports for 11 Coastal Forests in Coast Region, Tanzania. Frontier-Tanzania Technical Report No. 17.* The Society for Environmental Exploration Publication. Tanzania.

Conde, P., R. Figueira, S. Saraiva, L. Catarino, M. Romeiras and M.C. Duarte. 2014. Mission to Mozambique (1942-1948): contributions to the knowledge of the medicinal flora of Mozambique. *Hist. Cienc. Saude – Manguinhos.*, 21(2): 1-47.

Constant, N.L. and M.P. Tshisikhawe. 2018. Hierarchies of knowledge: ethnobotanical knowledge, practices and beliefs of the Vhavenda in South Africa for biodiversity conservation. *J. Ethnobiol. Ethnomed.*, 14(1): 56.

Constitution of South Africa. 1996. The Constitution of the Republic of South Africa. *Bill of Rights Paragraph*, 27. Available [online] from: <http://www.justice.gov.za/ legislation/ constitution/ SAConstitution-web-eng-02.pdf> [Accessed: 15th February 2018].

Coopoosamy, R.M. and K.K. Naidoo. 2012. An ethnobotanical study of medicinal plants used by traditional healers in Durban, South Africa. *Afr. J. Pharm. Pharmacol.*, 6(11): 818-823.

Cramer, A.O., D. van Ravenzwaaij, D. Matzke, H. Steingroever, R. Wetzels, R.P. Grasman, L.J. Waldorp and E.J. Wagenmakers. 2016. Hidden multiplicity in exploratory multiway ANOVA: Prevalence and remedies. *Psychon. Bull. Rev.*, 23(2): 640-647.

Crouch, N. and G. Smith. 2010. The implications of South Africa's bioprospecting legislation (NEMBA, Act 10 of 2004): local lessons for global benefit. *Planta Med.*, 76(12): S_2.

Cunningham, A., V.F. Anoncho and T. Sunderland. 2016. Power, policy and the *Prunus africana* bark trade, 1972-2015. *J. Ethnopharmacol.*, 178: 323-333.

Cunningham, A.B. and F.T. Mbenkum. 1993. Sustainability of harvesting *Prunus africana* bark in Cameroon. *People and Plants Working Paper*, 2: 28.

Davison, G.W.H., Y. Cai, T.J. Li and W.H. Lim. 2018. Integrated research, conservation and management of Nee Soon freshwater swamp forest, Singapore: hydrology and biodiversity. *Gard. Bull. Singapore.*, 70(1): 1-7.

De Baan, L., C.L. Mutel, M. Curran, S. Hellweg and T. Koellner. 2013. Land use in life cycle assessment: global characterization factors based on regional and global potential species extinction. *Environ. Sci. Technol.*, 47(16): 9281-9290.

Debnath, P., S. Rathore, S. Walia, Kumar, M., Devi, R. and R. Kumar. 2020. *Picrorhiza kurroa*: A promising traditional therapeutic herb from higher altitude of western Himalayas. *J. Herb. Med.*, 23: 100358.

Dludlu, M.N., P.S. Dlamini, G.F. Sibandze, V.S. Vilane and C.S. Dlamini. 2017. Distribution and conservation status of the Endangered pepperbark tree *Warburgia salutaris* (Canellaceae) in Swaziland. *Oryx.*, 51(3): 451-454.

Driver, A., K. Maze, M. Rouget, A.T. Lombard, J. Nel, J.K. Turpie, R.M. Cowling, P. Desmet, P. Goodman, J. Harris and Z. Jonas. 2005. *National spatial biodiversity assessment 2004: priorities for biodiversity conservation in South Africa*. South African Biodiversity Institute, Pretoria, South Africa.

Du, B., Y. Zheng, J. Liu and D. Mao. 2018. Threatened plants in China's Sanjiang plain: hotspot distributions and gap analysis. *Sustain.*, 10(1): 194.

Dzerefos, C.M., E.T. Witkowski and S. Kremer-Köhne. 2017. Aiming for the biodiversity target with the social welfare arrow: medicinal and other useful plants from a Critically Endangered grassland ecosystem in Limpopo Province, South Africa. *Int. J. Sustain. Dev.*, 24(1): 52-64.

Fernández-Llamazares, Á. and M. Cabeza. 2018. Rediscovering the potential of indigenous storytelling for conservation practice. *Conserv. Lett.*, 11(3): e12398.

Flach, J., C.D.S. Ribeiro, M.B. van der Waal, R.X. van der Waal, E. Claassen and L.H. van de Burgwal. 2019. The nagoya protocol on access to genetic resources and benefit sharing: Best practices for users of lactic acid bacteria. *Pharm. Nutr.*, 9: 100158.

Foden, W. 2007. South Africa's threatened species legislation: What stands between our plants and extinction? *S. Afr. J. Bot.*, 73(2): 288-288.

Fox, A.D. and J. Madsen. 2017. Threatened species to super-abundance: The unexpected international implications of successful goose conservation. *Ambio.*, 46(2): 179-187.

Gail, H., B. Tarryn, A. Oluwaseyi, D. Denver, M. Oluchi and G. Diana. 2015. An ethnobotanical survey of medicinal plants used by traditional health practitioners to manage HIV and its related opportunistic infections in Mpoza, Eastern Cape Province, South Africa. *J. Ethnopharmacol.*, 171: 109-115.

Garnett, S.T., N.D. Burgess, J.E. Fa, A. Fernández-Llamazares, Z. Molnár, C.J. Robinson, J.E. Watson, K.K. Zander, B. Austin, E.S. Brondizio and N.F. Collier. 2018. A spatial overview of the global importance of Indigenous lands for conservation. *Nat. Sustain.*, 1(7): 369.

Giliba, R.A. and G.T. Yengoh. 2020. Predicting Suitable Habitats of the African Cherry (*Prunus africana*) under Climate Change in Tanzania. *Atmosphere.*, 11(9): 988.

Gredzens, C., H. Marsh, M.M. Fuentes, C.J. Limpus, T. Shimada and M. Hamann. 2014. Satellite tracking of sympatric marine megafauna can inform the biological basis for species co-management. *PloS One*, 9(6): e98944.

Gyau, A., M. Chiatoh, S. Franzel, E. Asaah and J. Donovan. 2012. Determinants of farmers' tree planting behaviour in the north-west region of Cameroon: the case of *Prunus africana*. *Int. For. Rev.*, 14(3): 265-274.

Hahn, N. 2002. *Endemic flora of the Soutpansberg*. Masters' Dissertation. University of KwaZulu-Natal, South Africa.

Hahn, N., 2017. Endemic flora of the Soutpansberg, Blouberg and Makgabeng. *S. Afr. J. Bot.*, 113: 324-336.

Harlio, A., M. Kuussaari, R.K. Heikkinen and A. Arponen. 2019. Incorporating landscape heterogeneity into multi-objective spatial planning improves biodiversity conservation of semi-natural grasslands. *J. Nat. Conserv.*, 49: 37-44.

Havens, K., P. Vitt, M. Maunder, E.O. Guerrant and K. Dixon. 2006. *Ex situ* plant conservation and beyond. *Biol. Sci.*, 56(6): 525-531.

He, F. and S.P. Hubbell. 2011. Species–area relationships always overestimate extinction rates from habitat loss. *Nature*, 473(7347): 368-371.

Heywood, V.H. and J.M. Iriondo. 2003. Plant Conservation: Old Problems, New Perspectives. *Biol. Conserv.*, 113: 321-335.

Hoffmann, M., T.M. Brooks, G.A.B. Da Fonseca, C. Gascon, A.F.A. Hawkins R.E. James, P. Langhammer, R.A. Mittermeier, J.D. Pilgrim, A.S.L. Rodrigues and J.M.C. Silva. 2008. Conservation planning and the IUCN Red List. *Endanger. Species Res.*, 6(2): 113-125.

Hostettmann, K. and A. Marston. 2001. Countercurrent chromatography in the preparative separation of plant-derived natural products. *J. Liq. Chromatogr. Relat. Technol.*, 24(11-12): 1711-21.

Ibrahim, M.A., M. Na, J. Oh, R.F. Schinazi, T.R. McBrayer, T. Whitaker, R.J. Doerksen, D.J. Newman, L.G. Zachos and M.T. Hamann. 2013. Significance of endangered and threatened plant natural products in the control of human disease. *Proc. Natl. Acad. Sci.*, 110(42): 16832-16837.

IUCN. 2012. *IUCN Red List Categories and Criteria: Version 3.1., Second edition*. IUCN, Gland, Switzerland and Cambridge, UK.

Jauro, T.I., S.G. Tesfamichael and I.T. and Rampedi. 2020. Tracking conservation effectiveness in the Vhembe Biosphere Reserve in South Africa using Landsat imagery. *Environ. Monit. Assess.*, 192(7): 1-22.

Kahler, J.S. and M.L. Gore. 2012. Beyond the cooking pot and pocket book: Factors influencing noncompliance with wildlife poaching rules. *Int. J. Comp. Appl. Crim.*, 36(2): 103-120.

Kébenzikato, A.B., K. Wala, W. Atakpama, K. Dimobé, M. Dourma, A.Y. Woégan, K. Batawila and K. Akpagana. 2015. Connaissances ethnobotaniques du baobab (*Adansonia digitata* L.) au Togo. *Biotechnol. Agron. Soc. Environ.*, 19(3): 247-261.

Keller, V. and K. Bollmann. 2004. From red lists to species of conservation concern. *Conserv. Biol.*, 18(6): 1636-1644.

Knauf, S., L. Abel and L.K. Hallmaier-Wacker. 2019. The Nagoya protocol and research on emerging infectious diseases. *Bull. World Health Organ.*, 97(6): 379.

Knobel, J.C. 2015. The bald and golden eagle protection act, species-based legal protection and the danger of misidentification. *Potch. Electron. Law J.*, 18(7): 2605-2641.

Korsmo, H. 1991. Conserving Coniferous Forest in Norway: A Critical Time for International Environmental Obligations. *Ambio.*, 238-243.

Kotina, E.L., B.E. Van Wyk and P.M. Tilney. 2014. Anatomy of the leaf and bark of *Warburgia salutaris* (Canellaceae), an important medicinal plant from South Africa. *S. Afr. J. Bot.*, 94: 177-181.

Kunz, N.S., M.T. Hoffman and B. Weber. 2012. Effects of heuweltjies and utilization on vegetation patterns in the Succulent Karoo, South Africa. *J. Arid Environ.*, 87: 198-205.

Lawal, I.O., D.S. Grierson and A.J. Afolayan. 2014. Phytotherapeutic information on plants used for the treatment of tuberculosis in Eastern Cape Province, South Africa. *Evid. Based Compl. Altern. Med.*, 2014: 11.

Lawal, O.A., I.A. Ogunwande, A.R. Opoku, A.A. Kasali and A.O. Oyedeji. 2014. Chemical composition and antibacterial activities of essential oil of *Warburgia salutaris* (Bertol. F.) Chiov. From South Africa. *J. Biol. Act. Prod. Nat.*, 4(4): 272-277.

Lenzen, M., D. Moran, K. Kanemoto, B. Foran, L.A. Lobefaro and C. Geschke. 2012. International trade drives biodiversity threats in developing nations. *Nature*, 486(7401): 109-112.

Leonard, C.M. and A.M. Viljoen. 2015. *Warburgia*: A comprehensive review of the botany, traditional uses and phytochemistry. *J. Ethnopharmacol.*, 165: 260-285.

Liu, C.L.C., O. Kuchma and K.V. Krutovsky. 2018. Mixed-species versus monocultures in plantation forestry: Development, benefits, ecosystem services and perspectives for the future. *Glob. Ecol. Conserv.*, 15: e00419.

Loubser, J.H. 1989. Archaeology and early Venda history. *Goodwin Ser.*, 6: 54-61.

Lowe, R.F. and P.P. Moores. 1972. S–s–U–Red Cell Factor in Africans of Rhodesia, Malawi, Mozambique and Natal. *Human Heredity*, 22(4): 344-350.

Luseba, D. and M.P. Tshisikhawe. 2013. Medicinal plants used in the treatment of livestock diseases in Vhembe region, Limpopo province, South Africa. *J. Med. Plants Res.*, 7(10): 593-601.

Ma, Y., G. Chen, R.E. Grumbine, Z. Dao, W. Sun and H. Guo. 2013. Conserving plant species with extremely small populations (PSESP) in China. *Biodiv. Conserv.*, 22(3): 803-809.

Mabogo, D.E.N. 1990. *Ethnobotany of the Vhavenḓa*. Masters Dissertation. University of Pretoria, South Africa.

Magee, A.R., I. Ebrahim, R. Koopman and L. von Staden. 2017. *Marasmodes* (Asteraceae, Anthemideae), the most threatened plant genus of the Cape Floristic Region, South Africa: Conservation and taxonomy. *S. Afr. J. Bot.*, 111: 371-386.

Magwede, K. 2018. *A quantitative survey of traditional plant use of the Vhavenḓa, Limpopo Province, South Africa.* Doctoral Dissertation. University of Johannesburg, South Africa.

Magwede, K., B.E. Van Wyk and A.E. Van Wyk. 2019a. An inventory of Vhavenḓa useful plants. *S. Afr. J. Bot.*, 122: 57-89.

Magwede, K., L.I. Ramovha, D.E. Mabogo, A.E. van Wyk and B.E. van Wyk. 2019b. Traditional uses of the remarkable root bark hairs of *Lannea schweinfurthii* var. *stuhlmannii* (Anacardiaceae) by the Vhavenḓa, South Africa. *S. Afr. J. Bot.*, 122: 529-534.

Magwede, K., M.P. Tshisikhawe, D. Luseba and R.T. Bhat. 2014. Ethnobotanical survey of medicinal plants used in treatment of ticks. *Phyton Intern J. Experiem. Bot.*, 83: 155-165.

Maroyi, A. 2000. Options for the recovery of *Warburgia salutaris* (pepperbark tree) populations in Zimbabwe. *Zimb. Sci. News.*, 34(3): 54-60.

Maroyi, A. 2012. Community attitudes towards the reintroduction programme for the Endangered pepperbark tree *Warburgia salutaris*: implications for plant conservation in south-east Zimbabwe. *Oryx.*, 46(2): 213-218.

Maroyi, A. 2013a. Use and management of homegarden plants in Zvishavane district, Zimbabwe. *Trop. Ecol.*, 54(2): 191-203.

Maroyi, A. 2013b. *Warburgia salutaris* (Bertol. f.) Chiov.: A multi-use ethnomedicinal plant species. *J. Med. Plants Res.*, 7(2): 53-60.

Maroyi, A. 2014. The genus *Warburgia*: A review of its traditional uses and pharmacology. *Pharm. Biol.*, 52(3): 378-391.

Marston, A., J.D. Msonthi and K. Hostettmann. 1996. Polyphenolic Constituents of *Brackenridgea zanguebarica* (Ochnaceae) and Their Biological Activities. In *Chemistry, Biological and Pharmacological Properties of African Medicinal Plants*, Proceedings of the First International IOCD-Symposium, Victoria Falls, Zimbabwe, February 25-28, 1996, (Eds.): Hostettmann, K., F. Chinyanganya, M. Maillard, J.-L. Wolfender. University of Zimbabwe Publications, Zimbabwe: 253-259.

Masevhe, N.A., L.J. McGaw and J.N. Eloff. 2015. The

traditional use of plants to manage candidiasis and related infections in Venda, South Africa. *J. Ethnopharmacol.*, 168: 364-372.

Mashimbye, M.J., M.C. Maumela and S.E. Drewes. 1999. Novel and bioactive metabolites of *Warburgia salutaris* indigenous to the Northern Province, South Africa. *Niger. J. Nat. Prod. Med.*, 3: 28-30.

Mavhura, E., S.B. Manyena, A.E. Collins and D. Manatsa. 2013. Indigenous knowledge, coping strategies and resilience to floods in Muzarabani, Zimbabwe. *Int. J. Disaster Risk Reduct.*, 5: 38-48.

McCarthy, D.P., P.F. Donald, J.P. Scharlemann, G.M. Buchanan, A. Balmford, J.M. Green, L.A. Bennun, N.D. Burgess, L.D. Fishpool, S.T. Garnett and D.L. Leonard. 2012. Financial costs of meeting global biodiversity conservation targets: current spending and unmet needs. *Sci.*, 338(6109): 946-949.

Meredith, T., G.G. Yetman and G. Frias. 2002. *Mexican and Canadian case studies of community-based spatial information management for biodiversity conservation*. Taylor and Francis, London, United Kingdom.

Messer, K.D. 2010. Protecting endangered species: When are shoot-on-sight policies the only viable option to stop poaching?. *Ecol. Econ.*, 69(12): 2334-2340.

Mitchell, A. 2018. Revitalizing laws,(re)-making treaties, dismantling violence: Indigenous resurgence against 'the sixth mass extinction'. *Soc. Cult. Geogr.*, 21(7): 909-924.

Mokganya, M.G. and M.P. Tshisikhawe. 2019. Medicinal uses of selected wild edible vegetables consumed by Vhavenda of the Vhembe District Municipality, South Africa. *S. Afr. J. Bot.*, 122: 184-188.

Möller, M., U. Suschke, S. Nolkemper, J. Schneele, M. Distl, F. Sporer, J. Reichling and M. Wink. 2006. Antibacterial, antiviral, antiproliferative and apoptosis-inducing properties of *Brackenridgea zanguebarica* (Ochnaceae). *J. Pharm. Pharmacol.*, 58(8): 1131-1138.

Moraswi, I., S.O. Bamigboye and M.P. Tshisikhawe. 2019. Conservation status and threats to vascular plant species endemic to Soutpansberg Mountain range in Limpopo Province, South Africa. *Int. J. Plant Biol.*, 10(1): 7978.

Moyo, M., A.O. Aremu and J. Van Staden. 2015. Medicinal plants: an invaluable, dwindling resource in sub-Saharan Africa. *J. Ethnopharmacol.*, 174: 595-606.

Mphephu, T.S. 2017. *Sustainable natural resource utilisation: a case study of ethnobotanically important plant taxa in the Thulamela Local Municipality, Limpopo Province.* Masters Dissertation. University of Johannesburg, South Africa.

Mugula, B.B., B.J. de Vries and S.W. Bingi. 2010. Mechanisms for sustainable use of biodiversity in and beyond natural ecosystems: A study on conservation and commercial production of *P. africana* in Uganda. *Int. J. Biodiv. Conserv.*, 2(7): 180-185.

Mutshinyalo, T.T. and S.J. Siebert. 2010. Myth as a biodiversity conservation strategy for the Vhavenda, South Africa. *Afr. J. Indigen. Knowl Systems.*, 9(2): 151-171.

Mwitari, P.G., P.A. Ayeka, J. Ondicho, E.N. Matu and C.C. Bii. 2013. Antimicrobial activity and probable mechanisms of action of medicinal plants of Kenya: Withania somnifera, *Warbugia ugandensis, Prunus africana* and *Plectrunthus barbatus*. *PloS One*, 8(6): e65619.

Nagendra, H., R. Lucas, J.P. Honrado, R.H. Jongman, C. Tarantino, M. Adamo and P. Mairota. 2013. Remote sensing for conservation monitoring: Assessing protected areas, habitat extent, habitat condition, species diversity, and threats. *Ecol. Indic.*, 33: 45-59.

Ndam, N. and M.T. Marcelin. 2004. Chop, but no broke pot': the Case of *Prunus africana* on Mount Cameroon. *Forest products, livelihoods and conservation. Case Stud. Non-Timber For. Prod. Systems*, 2: 37-52.

Ndhlovu, P.T., O. Mooki, W.O. Mbeng and A.O Aremu. 2019. Plant species used for cosmetic and cosmeceutical purposes by the Vhavenda women in Vhembe District municipality, Limpopo, South Africa. *S. Afr. J. Bot.*, 122: 422-431.

Ndlela, N.E. 2004. *The challenges of forest policy implementation on small-scale commercial timber growers: a case study of Forestry South Africa in the Midlands region, KwaZulu-Natal.* Masters Dissertation. University of KwaZulu-Natal, South Africa.

Nefhere, K.V. 2019. *Perceptions of traditional healers regarding ethnobotanical importance and conservation status of indigenous medicinal plants of Thulamela, Limpopo.* Masters Dissertation. University of South Africa, South Africa.

Neimark, B. 2010. Subverting regulatory protection of 'natural commodities': The *Prunus Africana* in Madagascar. *Dev. Change*, 41(5): 929-954.

Nelwamondo, M.C., T.M. Mulaudzi and N.A. Masevhe. 2013. An ethnobotanical survey of medicinal plants used in the treatment of pneumonia in Vhembe District Municipality, Limpopo Province, South Africa. *S. Afr. J. Bot.*, 86: 179.

Netshiungani, E.N. and A.E. Van Wyk. 1980. Mutavhasindi mysterious plant from Venda. *Veld and Flora*, 66(3): 87-90

Nettleton, A. 1992. Ethnic and gender identities in Venda Domba statues. *Afr. Stud.*, 51(2): 203-230.

Neuwinger, H.D. 2000. *African traditional medicine - a dictionary of plant use and applications*. Medpharm GmbH Scientific Publishers, Stuttgart, Germany.

Ngwenya, S.J., E. Torquebiau and J.W.H. Ferguson. 2019. Mountains as a critical source of ecosystem services: the case of the Drakensberg, South Africa. *Environ. Dev. Sustain.*, 21(2): 1035-1052.

Nicosia, E., R. Valenti, A. Guillet, L. Malatesta, G. Tallone, T.D.S.M. Mondlane and F. Attorre. 2020. ABS Provides Opportunities for Indigenous and Local Communities in the Limpopo National Park. An ethnobotanical survey of plants used by the Changana community, Limpopo National Park, Mozambique. *Res. Square*, DOI: 10.21203/rs.3.rs-51722/v1.

Nkwanyana, S.M. 2018. Conserving cultural heritage and the usage of indigenous knowledge: A case study of the Zululand District Municipality, Kwazulu-Natal. *Afr. J. Hosp. Tour. Leis.*, 7(2): 1-12.

Nyaba, Z.N., P. Murambiwa, A.R. Opoku, S. Mukaratirwa, F.O. Shode and M.B. Simelane. 2018. Isolation, characterization, and biological evaluation of a potent anti-malarial drimane sesquiterpene from *Warburgia salutaris* stem bark. *Malar. J.*, 17(1): 296.

Ofoegbu, C. and C. Ifejika-Speranza. 2017. Assessing rural peoples' intention to adopt sustainable forest use and management practices in South Africa. *J. Sustain. For.*, 36(7): 729-746.

Ofoegbu, C. and P.W. Chirwa. 2019. Analysis of rural people's attitude towards the management of tribal forests in South Africa. *J. Sustain. For.*, 38(4): 396-411.

Ojelade, B.S. 2018. *Regeneration potential of selected medicinal plants used to treat human and livestock diseases in Limpopo Province of South Africa.* Masters Dissertation. University of Venda, South Africa.

Oldekop, J.A., G. Holmes, W.E. Harris and K.L. Evans. 2016. A global assessment of the social and conservation outcomes of protected areas. *Conserv. Biol.*, 30(1): 133-141.

Opio, D.R., E. Andama and G.T. Kureh. 2017. Ethnobotanical survey of antimalarial plants in areas of: Abukamola, Angeta, Oculokori and Omarari of Alebtong district in Northern Uganda. *European J. Med. Plants*, 21(4): 1-14.

Osmaston, H.A. 1968. Uganda. *Acta. Phytogeogr. Suec.*, 54: 148-151.

Palgrave, M.C., A.E. Van Wyk, M. Jordaan, J.A. White and P. Sweet. 2007. A reconnaissance survey of the woody flora and vegetation of the Catapú logging concession, Cheringoma District, Mozambique. *Bothalia*, 37(1): 57-73.

Pascual, U., I. Palomo, W.M. Adams, K.M., Chan, T.M. Daw, E. Garmendia, E. Gómez-Baggethun, R.S. De Groot, G.M., Mace, B. Martín-López and J. Phelps. 2017. Off-stage ecosystem service burdens: a blind spot for global sustainability. *Environ. Res. Lett.*, 12(7): 075001.

Paudyal, K., H. Baral, L. Putzel, S. Bhandari and R.J. Keenan. 2017. Change in land use and ecosystem services delivery from community-based forest landscape restoration in the Phewa Lake watershed, Nepal. *Int. For. Rev.*, 19(4): 88-101.

Pimm, S.L., C.N. Jenkins, R. Abell, T.M. Brooks, J.L. Gittleman, L.N. Joppa, P.H Raven, C.M. Roberts and J.O. Sexton. 2014. The biodiversity of species and their rates of extinction, distribution, and protection. *Sci.*, 344: 1246752.

Pykälä, J. 2019. Habitat loss and deterioration explain the disappearance of populations of threatened vascular plants, bryophytes and lichens in a hemiboreal landscape. *Glob. Ecol. Conserv.*, 18: e00610.

Raimondo, D., L. von Staden, W. Foden, J.E. Victor, N.A. Helme, R.C. Turner, D.A. Kamundi and P.A. Manyama. 2009. *Red List of South African Plants. Strelitzia 25*. South African National Biodiversity Institute, South Africa.

Ramovha, L.I. 2016. *Ethnoveterinary Plant Medicines of the Vhavenḓa*. Doctoral Dissertation. University of Pretoria, South Africa.

Ramovha, L.I. and A.E. van Wyk. 2016. Ethnoveterinary practices of the Vhavenḓa, South Africa, in the treatment of redwater (mali) in cattle. *Indilinga Afr. J. Indigen. Knowl. Systems*, 15(3): 314-327.

Rasethe, M.T., S.S. Semenya and A. Maroyi. 2019. Medicinal plants traded in informal herbal medicine markets of the Limpopo Province, South Africa. *Evid. Based Complement. Altern. Med.*, 2019: 11.

Reed, B.M., V. Sarasan, M. Kane, E. Bunn and V.C. Pence. 2011. Biodiversity conservation and conservation biotechnology tools. *In Vitro Cell. Dev. Biol. Plant.*, 47(1): 1-4.

Rehman, K.U., M. Hamayun, Z.A. Butt, T. Yaseen, S.H. Shah and S. Wali. 2022. *In vitro* anticancer, antioxidants, and phytotoxic efficacy of the *Hedera helix* and *Moringa oleifera* extracts. *Pak. J. Bot., 54*(5): 1981-1986.

Reid, H., D. Fig, H. Magome and N. Leader-Williams. 2004. Co-management of contractual national parks in South Africa: Lessons from Australia. *Conserv. Soc.*, 8: 377-409.

Rey, K., R. Amiot, F. Fourel, T. Rigaudier, F. Abdala, M.O. Day, V. Fernandez, F. Fluteau, C. France-Lanord, B.S. Rubidge and R.M. Smith. 2016. Global climate perturbations during the Permo-Triassic mass extinctions recorded by continental tetrapods from South Africa. *Gondwana Res.*, 37: 384-396.

Rivers, M.C., L. Taylor, N.A. Brummitt, T.R. Meagher, D.L. Roberts. and E.N. Lughadha. 2011. How many herbarium specimens are needed to detect threatened species?. *Biol. Conserv.*, 144(10): 2541-2547.

Rodrigues, A.S., J.D. Pilgrim, J.F. Lamoreux, M. Hoffmann and T.M. Brooks. 2006. The value of the IUCN Red List for conservation. *Trends Ecol. Evol.*, 21(2): 71-76.

Rossi, G., S. Orsenigo, C. Montagnani, G. Fenu, D. Gargano, L.O.R.E.N.Z.O. Peruzzi, R.P. Wagensommer, B. Foggi, G. Bacchetta, G., Domina and F. Conti. 2016. Is legal protection sufficient to ensure plant conservation? The Italian Red List of policy species as a case study. *Oryx.*, 50(3): 431-436.

Salafsky, N., R. Margoluis, K.H. Redford and J.G. Robinson. 2002. Improving the Practice of Conservation: A Conceptual Framework and Research Agenda for Conservation Science. *Conserv. Biol.*, 16: 1469-1479.

Schoeman, M.H., B. Aub, J. Burrows, G. Hall and S. Woodborne. 2019. Past Climatic Conditions for Bokoni at Buffelskloof, Mpumalanga, Using δ13C Analysis of *Prunus africana* and *Pittosporum viridiflorum* Tree Rings. *J. Afr. Archaeol.*, 1: 1-12.

Scholes, R.J. 2016. Climate change and ecosystem services. *Wiley Interdisciplinary Reviews: Clim. Change*, 7(4): 537-550.

Schutte, A.G. 1978. Mwali in Venda. *J. Religion Africa*, 9(2): 109-122.

Selig, E.R., W.R. Turner, S. Troëng, B.P. Wallace, B.S. Halpern, K. Kaschner, B.G. Lascelles, K.E. Carpenter and R.A. Mittermeier. 2014. Global priorities for marine biodiversity conservation. *PloS One.*, 9(1): e82898.

Semenya, S.S. and A. Maroyi. 2019a. Ethnobotanical survey of plants used by Bapedi traditional healers to treat tuberculosis and its opportunistic infections in the Limpopo Province, South Africa. *S. Afr. J. Bot.*, 122: 401-421.

Semenya, S.S. and A. Maroyi. 2019b. Source, harvesting, conservation status, threats and management of indigenous plant used for respiratory infections and related symptoms in the Limpopo Province, South Africa. *Biodiversitas.*, 20(3): 789-810.

Semenya, S.S., A. Maroyi, M.J. Potgieter and L.J.C. Erasmus. 2013a. Herbal medicines used by Bapedi traditional healers to treat reproductive ailments in the Limpopo Province, South Africa. *Afr. J. Tradit. Complement. Altern. Med.*, 10(2): 331-339.

Semenya, S.S., M.J. Potgieter and M.P. Tshisikhawe. 2013b. Use, conservation and present availability status of ethnomedicinal plants of Matebele-Village in the Limpopo Province, South Africa. *Afr. J. Biotechnol.*, 12(18): 2392-2405.

Senkoro, A.M., C.M. Shackleton, R.A. Voeks and A.I. Ribeiro. 2019. Uses, Knowledge, and Management of the Threatened Pepper-Bark Tree (*Warburgia salutaris*) in Southern Mozambique. *Econ. Bot.*, 73(3): 304-324.

Setshego, M.V., A.O. Aremu, O. Mooki and W. Otang-Mbeng. 2020. Natural resources used as folk cosmeceuticals among rural communities in Vhembe district municipality, Limpopo province, South Africa. *B.M.C. Complement Altern. Med. Ther.*, 20(1): 1-16.

Sheil, D., E.E. Meijaard, A. Angelsen, J. Sayer and J. Vanclay. 2013. Sharing future conservation costs. *Sci.*, 339: 270-271.

Simelane, Z.P. 2009. *Indigenous knowledge on tree conservation in Swaziland.* Masters Dissertation. University of the Witwatersrand, South Africa.

Singo, I.K.M. 2007. *Effect of human activities on composition and regeneration of woody species in Morogoro fuelwood reserve, Morogoro, Tanzania*. Masters Dissertation. Sokoine University of Agriculture, Tanzania.

Sinthumule, N.I. and M.L. Mashau. 2020. Traditional ecological knowledge and practices for forest conservation in Thathe Vondo in Limpopo Province, South Africa. *Glob. Ecol. Conserv.*, 22: e00910.

Sobiecki, J.F. 2002. A preliminary inventory of plants used for psychoactive purposes in southern African healing traditions. *Trans. R. Soc. S. Afr.*, 57(1-2): 1-24.

Stern, M.J. 2008. Coercion, voluntary compliance and protest: the role of trust and legitimacy in combating local opposition to protected areas. *Environ. Conserv.*, 35(3): 200-210.

Stewart, K.M. 2003. The African cherry (*Prunus africana*): Can lessons be learned from an over-exploited medicinal tree?. *J. Ethnopharmacol.*, 89(1): 3-13.

Suwardi, A.B., Z.I. Navia, T. Harmawan and E. Mukhtar. 2020. Ethnobotany and conservation of indigenous edible fruit plants in South Aceh, Indonesia. *Biodiversitas.*, 21(5): 1850-1860.

Swemmer, L., K. Scheepers and W.J. Vermeulen. 2011. Applying adaptive management in resource use in South African National Parks: a case study approach: essay. *Koedoe. Afr. Protect. Area Conserv. Sci.*, 53(2): 1-14.

Talaat, W.I.A.W. 2013. Protection of the associated traditional knowledge on genetic resources: beyond the Nagoya Protocol. *Procedia. Soc. Behav Sci.*, 91: 673-678.

Tareen, N.M., M.A. Saeed-ur-Rehman, Z.K. Shinwari and T.A.H.I.R.A Bibi. 2016. Ethnomedicinal utilization of wild edible vegetables in district Harnai of Balochistan Province-Pakistan. *Pak. J. Bot.*, 48(3): 1159-1171.

Thompson, K.L., T. Lantz and N. Ban. 2020. A review of Indigenous knowledge and participation in environmental monitoring. *Ecol. Soc.*, 25(2): 10.

Tiawoun, M.A.P., M.P. Tshisikhawe and E.T. Gwata. 2018. A Review on Yellow Peeling Plane (*Brackenridgea zanguebarica* Oliv.): A Critically Endangered Endemic Plant Species. *Ann. Res. Rev. Biol.*, 29(5): 1-13.

Tiawoun, M.A.P., M.P. Tshisikhawe and E.T. Gwata. 2019. Investigation of current threats to the existence of *Brackenridgea zanguebarica* in a small geographic area in Vhembe, Limpopo Province, South Africa. *Biodiversitas.*, 20(6): 1487-1495.

Tiawoun, M.A.P., M.P. Tshisikhawe and E.T. Gwata. 2020. Propagation potential for the conservation of Brackenridgea zanguebarica Oliv., a critically endangered plant species endemic to Vhembe District in Limpopo Province (South Africa). *J. Appl. Bot. Food Qual.*, 93: 59-65.

Timberlake, J.R., F. Dowsett-Lemaire, J. Bayliss, T. Alves, S. Baena, C., Bento, K. Cook, J. Francisco, T. Harris, P. Smith and C. de Sousa. 2009. Mt Namuli, Mozambique: biodiversity and conservation. *Rep. Darwin Initiat. Award*, 15: 036.

Timberlake, J.R., I. Darbyshire, M. Cheek, A. Banze, V. Fijamo, J. Massunde, H. Chipanga and D. Muassinar. 2016. Plant conservation in communities on the Chimanimani footslopes, *Mozambique Rep. Darwin Initiat. Award*, 1: 2380.

Tolessa, T. 2019. The socioeconomic benefits of fragmented forests to local communities: A case study in the central highlands of Ethiopia. *Small-scale For.*, 18(4): 373-391.

Tshidzumba, P.W. 2018. *An inventory and pharmacological evaluation of medicinal plants used as anti-diabetes and anti-arthritis in Vhembe District Municipality, Limpopo Province*. Masters Dissertation. University of Venda, South Africa.

Tshisikhawe, M.P. 2002. Trade of indigenous medicinal plants in the Limpopo Province, Venda Region: their Ethnobotanical importance and sustainable use. Masters Dissertation. University of Venda, South Africa.

Tshisikhawe, M.P. 2013. *An ecological evaluation of the sustainability of bark harvesting of medicinal plant species in the Venda region, Limpopo province, South Africa.* Doctoral dissertation. University of Pretoria, South Africa.

Tshisikhawe, M.P. 2016. Management plan of a medicinal plant species in demand: the case *of Brackenridgea zanguebarica* Oliv. *Indilinga Afr. J. Indigen. Knowl. Systems*, 15(1): 123-135.

Tshisikhawe, M.P. and M.W. Van Rooyen. 2012. Population biology of *Brackenridgea zanguebarica* in the presence of harvesting. *J. Med. Plants Res.*, 6(46): 5748-5756.

Tshisikhawe, M.P., M.W. Van Rooyen and J.Y. Gaugris. 2013. Is the present Brackenridgea Nature Reserve large enough to ensure the survival of *Brackenridgea zanguebarica* Oliv.?. *Koedoe.*, 55(1): 1-5.

Tshisikhawe, M.P., N.A. Masevhe, T.A. Netshivhulana and A. Samie. 2014. Perceptions of traditional healers on the treatment of diarrhoea in Vhembe District Municipality of Limpopo Province, South Africa. *Indilinga Afr. J. Indigen. Knowl. Systems*, 13(2): 292-299.

Underwood, E., S. Ustin and D. DiPietro. 2003. Mapping nonnative plants using hyperspectral imagery. *Remote Sens. Environ.*, 86(2): 150-161.

United Nation. 1992. *Convention on Biological Diversity*. Available [online] from: https://www.cbd.int/doc/legal/cbd-en.pdf [Accessed: 20th February 2018].

Valiente-Banuet, A., M.A. Aizen, J.M. Alcántara, J. Arroyo, A. Cocucci, M. Galetti, M.B. García, D. García, J.M. Gómez, P. Jordano and R. Medel. 2015. Beyond species loss: the extinction of ecological interactions in a changing world. *Funct. Ecol.*, 29(3): 299-307.

Van der Biest, K., P. Meire, T. Schellekens, B. D'hondt, D. Bonte, T. Vanagt and T. Ysebaert. 2020. Aligning biodiversity conservation and ecosystem services in spatial planning: Focus on ecosystem processes. *Sci. Total Environ.*, 712: 136350.

van Swaay, C., D. Maes, S. Collins, M.L. Munguira, M. Šašić, J. Settele, R. Verovnik, M. Warren, M., Wiemers, I. Wynhoff and A. Cuttelod. 2011. Applying IUCN criteria to invertebrates: How red is the Red List of European butterflies? *Biol. Conserv.*, 144(1): 470-478.

Van Wyk, A.S. and G. Prinsloo. 2018. Medicinal plant harvesting, sustainability and cultivation in South Africa. *Biol. Conserv.*, 227: 335-342.

Van Wyk, A.S. and G. Prinsloo. 2019. A review of the ethnobotanical uses, pharmacology, toxicology, management and cultivation of selected South African protected multi-purpose tree species. *S. Afr. J. Bot.*, 124: 258-269.

Van Wyk, B. and P. Van Wyk. 1997. *Field guide to trees of Southern Africa*. Struik Publication, South Africa.

Van Wyk, B.E., B. Van Oudshoorn and N. Gericke. 1997. *Medicinal plants of South Africa*. Briza Publication, South Africa.

Veeman, T.S., A.B. CunninghamW. Kozanayi and D. Maingi. 2014. The Economics of Production of a Rare Medicinal Species Reintroduced in Southeastern Zimbabwe: *Warburgia salutaris*. *Adv. Econ. Bot.*, 17: 179-188.

Veldman, S., Y. Ju, J.N. Otieno, S. Abihudi, C. Posthouwer, B. Gravendeel, T.R. van Andel and H.J. de Boer. 2020. DNA barcoding augments conventional methods for identification of medicinal plant species traded at Tanzanian markets. *J. Ethnopharmacol.*, 250: 112495.

Volis, S. 2016. How to conserve threatened Chinese plant species with extremely small populations?. *Plant Divers.*, 38(1): 45-52.

Whittaker, M. and R.F. Lowe. 1976. The cholinesterase variants found in some African tribes living in Rhodesia. *Hum. Hered.*, 26(5): 380-393.

Williams, V.L., E.T.F. Witkowski and K. Balkwill. 2007. Relationship between bark thickness and diameter at breast height for six tree species used medicinally in South Africa. *S. Afr. J. Bot.*, 73(3): 449-465.

Williams, V.L., J.E. Victor and N.R. Crouch. 2013. Red listed medicinal plants of South Africa: status, trends, and assessment challenges. *S. Afr. J. Bot.*, 86: 23-35.

Woinarski, J.C., M.F. Braby, A.A. Burbidge, D. Coates, S.T. Garnett, R.J. Fensham, S.M. Legge, N.L. McKenzie, J.L. Silcock and B.P. Murphy. 2019. Reading the black book: the number, timing, distribution and causes of listed extinctions in Australia. *Biol. Conserv.*, 239: 108261.

Xego, S., L. Kambizi and F. Nchu. 2016. Threatened medicinal plants of South Africa: case of the family *Hyacinthaceae*. *Afr. J. Tradit. Complement. Altern. Med.*, 13(3): 169-180.

(Received for publication 15 September 2021)