



An Exploratory Study on Contributing Factors to the Extinction of Indigenous Plants in South Africa

Nyiko Faith Shibambu

Department of Sociology and Anthropology, University of Limpopo, Sovenga 0727, South Africa

Email: nyikofaith20@gmail.com

<http://dx.doi.org/10.47814/ijssrr.v5i9.620>

Abstract

The aim of this study was to explore the contributing factors to the extinction of indigenous plants in South Africa. This was due to the evident depletion and loss of indigenous plants in most rural areas in South Africa. This study adopted qualitative research approach with exploratory design. Seminal studies on this subject were purposely collected using keywords extracted from the research topic. Again, Textual Content Analysis was used to analyse the collected data. The results of this study, confirms that indigenous plants are threatened by the human-induced and natural factors. The most notable human factors are the methods of procuring the plant materials, whereas the natural factors are mainly erratic rainfall and rising temperature patterns This study recommends urgent conservation measures such as proper harvesting methods and documentation of indigenous knowledge to mention the least, should be introduced and those that already exist should be properly used in order to prevent the loss of indigenous plants. Advance initiatives are needed to inform policy on adaptation and coping with the factors that contribute to the extinction of indigenous plants.

Keywords: *Contributing Factors; Extinction; Indigenous Plants; South Africa*

1. Introduction

Southern Africa boasts of an amazing floral diversity, of which many are endemic to the region (Goldblatt, 1978). The distribution analysis of the medicinal plants shows that they are distributed across diverse habitats and landscape elements. (Dar et al., 2017). Distribution of medicinal plants associations in relation to environmental factors and human impacts at different habitats (El-Wahab et al., 2008)

Indigenous plants have important contributions in the primary healthcare system, food production and production of firewood amongst others in rural communities (Abbink, 1995). These indigenous plants are used for nutritional purposes, but believed to have medicinal and magical values, and also used for ritual practices (Abbink, 1995). About 27 million South Africans depend on traditional medicine for their

primary healthcare needs, and for income generation (Mander et al., 2007). Among these, over 700 species are traded in large quantities at informal indigenous plant markets (Moeng and Potgieter, 2011). It is a "hidden economy" which can improve the growth of the country (Moeng and Potgieter, 2011; McGaw et al. 2005; Williams, 1996). Between 35 000 and 70 000 tons of parts (roots, stem, bark, flowering top and fruits) are used. Moreover, millions of people earn a living as traditional healers or collectors or vendors of medicinal plants (Appelquist et al., 2020).

For example, 86% of the plant parts harvested resulted into death of the entire plants, which has significant implications for the sustainability of supply (Rasekgala, 2018). The supply of these high valued plants is becoming increasingly scarce and inaccessible to the indigenous plant markets due to extinction, and yet very little is being done to cultivate these plants (Mander, 1997; Tshisikhawe et al., 2012). Raimondo, (2009) and Tshisikhawe (2002) corroborate that there are a number of threatened plant species that have been over-exploited for traditional medicinal purposes in South Africa. These species are facing a serious threat of extinction as a result of overharvesting, climate change, urbanisation, illegal invasion and deforestation. Bark and rootbark collections from the wild have been the major methods of harvesting, and these practices result in damage and/or death of many trees (Tshisikhawe et al., 2012; Tshisikhawe, 2002).

However, there has been a lack of understanding in terms of the value of Conservation/protection/domesticating indigenous plants in South Africa (Moeng and Potgieter, 2011). Small-scale farmers, mainly from rural communal lands have not historically focused on farming indigenous plants (Moeng and Potgieter, 2011), which is likely to lead to the extinction of many valued plant species in their natural environments. Regeneration of these popular indigenous plant species have been adversely affected by seed coat dormancy which results in poor to search imbibitions and aeration. A serious constraint in the nursery is the delay or failure rootbark collections from the wild have been the major methods of harvesting, and these practices result in damage and/or death of many trees (Tshisikhawe et al., 2012; Tshisikhawe, 2002).

For the purpose of this study, selected indigenous plants in South Africa which are highly exploited and threatened by various factors were considered. Cultivation of these indigenous plant species through vegetative methods might be the best and/or the only solution to restore back these over-exploited plants.

2. Literature Review

2.1 Factors Contributing to Indigenous Plants Extinction

According to Mander et al. (2007) the African Health Care System of South Africa has always been dependent of indigenous plants. Amjad et al. (2015) assert that in underdeveloped countries, the members of rural communities depend on native plants to acquire basic livelihood requirements. Due to the increase in human population, the demand of indigenous plants also increases (Williams et al., 2013).

It is caused directly or indirectly by anthropogenic activities that extract various environmental resources faster than they are replaced, thus depleting them (Huesemann et al., 2003). According to Zang et al. (2020) natural and human factors change the inherent gradient characteristics of soil moisture and salinity, which may lead to the gradual disappearance of the integrity of indigenous plants, leading to extinction. Endangered indigenous plants are scarce or only appear in fragile and limited habitats due to innate factors or the impact of human activities or natural disasters (Xu et al., 2022).

Knowledge of indigenous plants that people have can be affected by urbanisation (I.e. which involves recognising, naming, using, and managing species in that use category). The loss of this

indigenous knowledge and abandonment of indigenous plants could be seen as due to a decrease in agricultural, agroforestry, and forested areas, since the increase in human population reduces the areas for indigenous plant collection and destroys the existence of indigenous plants (Arjona-García et al., 2021). The trade of indigenous plants is currently greater than it was in the past because of the important indigenous values associated with indigenous plants, the high human population growth and rapid urbanisation (Wiersum et al., 2006).

Moreover, detrimental effects of climate change on medicinal plants and their users may obviously include decreases in availability, most dramatically in the extinction of species (Applequist, 2020). Habitat transformation, like the climate change also affects these plants, although minority of them (Maluleke and Shibambu, 2021). 48% of participants reported that many of the indigenous plants harvested to make preventive and curative medicine are seldom encountered, also due to decreases in rainfall (Rankoana, 2018).

Other contributing factors to the loss of indigenous plants at the reserves include medicinal plant and fuel-wood poaching, theft of fences and illegal dumping of building rubble and household waste (Dzerefos and Witkowski, 2001). Medicinal plant harvesting is not permitted to anyone since this often involves removal of subterranean parts (Dzerefos and Witkowski, 2001). Indigenous plants are currently endangered due to poaching (Li and Pritchard, 2009). Medicinal application appears as another leading cause for poaching as drug manufacturing and trade-medical applications also account for a high percentage of poaching in MoNR and LNR (Ndou et al., 2021).

These plants have been threatened leading to scarcity or even come to an extinction, this can be based to intensive use of nature resources, and stolen (Albrecht and McCue, 2010). As confirmed by the THPs, uprooting of plants should be regarded as the work of indigenous plants collectors (Magoro, 2008). THPs do not uproot plants, they focus on the soil covering the roots, and they do this gently revealing their root structure and setup. Equally, this method of harvesting does destroy the plant; it rather ensures that the plant re-emerges again since only side roots are removed, leaving the taproot untouched and allowing the plant to regenerate with ease. In other instances, roots are harvested during flowering period and during rainy season since this ensures sustainability of these plants (Magoro, 2008).

It is also recorded that of late, traditional health practitioners are no longer the only harvesters of plants, and this poses a serious problem on collection and usage of indigenous plants. The primary cause of loss of plant species at the local, regional and global level is the expansion of urban areas, and this is a problem to the entire community and ecosystems (Magoro, 2008). Accompanying the loss of habitat (Indigenous plants included) is the loss of associated indigenous knowledge. When people lose their indigenous knowledge, the resultant loss is that of plant species (Magoro, 2008). For centuries, traditional health practitioners in villages have been harvesting indigenous plants in their local environment in ways that ensure sustainable supply (Magoro, 2008).

Conservation and documentation of the traditional medicine and/or knowledge of existing indigenous plant species for curing human and animal diseases need to be given a high priority before they are completely eliminated from the wild due to over-exploitation (Joshi, 2003). Because of the great increase in over-exploitation of these wild species, many agencies have recommended that wild species should be brought into the cultivation system (BAH, 2004; Lambert et al., 1997; World Health Organization, 1993). Involvement of harvesters and harvesting communities of these indigenous plants in South Africa, in the development of propagation (cultivation) and management methods may kindle their interest in protecting the wild populations (Rasekgala, 2018).

2.2 Probable Scarcity of Indigenous Plants

Most of the people who reside in Africa rely on plants for primary health care. Indigenous plants are the largest single grouping of plants. Approximately 30 000 species fall within this group globally, and about thirty-three percent (33%) are said to be trees (Ganeshiaiah et al, 1998). From six thousand three hundred and seventy-seven (6,377) plant species used in 'Tropical Africa', about two thousand and seventy-four (2,074) have medicinal applications. However, this is not only regarded as their principal use, only one thousand nine hundred and seventy-five (1,975) are primarily used as indigenous plants (Magoro, 2008).

From a cultural perspective, the healing and spiritual qualities of plants are adopted. Nevertheless, the work of 'African Traditional Health Practitioners (ATHPs) and South Africa's Traditional Healing Folklore (SATHF)' has been disturbed by Western medicine practices; this area is however reportedly diminishing (Street and Prinsloo, 2013). The THPs are finding it difficult to find indigenous plants within their immediate surroundings; these plants are under threats of overexploitation and extinctions. Overexploitation of indigenous plants is a serious threat to the availability of these plants and this is due to the intensive harvesting in relation to high demand (Street and Prinsloo, 2013).

Despite these pressing challenges, the use of indigenous plants is still a thriving industry across South Africa (Magoro, 2008). Majority of South African rural communities still prefer the use of indigenous plants for the purposes of their primary health care, in spite of all the availability and accessibility of western medical care services provided by the government (Williams et al., 2013). De Wet et al., (2013) also state that majority of South African population in South Africa have access to the western health care facilities, however they still preferred to use indigenous plants as the primary health care for the treatment of various diseases. Majority of people who uses indigenous plants prefer them because of their affordability, easy accessibility and cultural acceptability (Maroyi, 2013).

Ethnobotanical knowledge is common amongst people in South Africa and also play an important role among the communities the rest of South Africa (Rasekgala, 2018). These days few effort has so far been made to document local knowledge on the utilization of indigenous plants despite the continuation of deforestation as well as environmental degradation in the province (Rasekgala, 2018). There is however, a need for immediate ethnobotanical and ecological surveys in order to rescue indigenous plants and the knowledge associated with them from further loss (Rasekgala, 2018). The majority of communities residing in rural areas are partially or fully dependent on the natural resources in order to meet their daily requirements (Slater and Twyman, 2003).

It has been recorded that about Ten (10) indigenous plant species revealed remain essential in the livelihoods of people in South Africa (Magoro, 2008). The need to harvest indigenous plants to ensure rural sustainability should be highly considered, and aided with development of strategies to effectively address existing impacts of forest harvesting. The importance of indigenous plants should be acknowledged and better understood as a distinctive epistemology, coupled with uniqueness to the local THPs. various resources should also be geared towards preservation and protection of indigenous plants (Magoro, 2008).

Table 1: Notable Indigenous Plants Coming To An Extinct.

Scientific names	Common names	Part of the plant used	Used for
<i>Acacia gerrardii</i> <i>Benth. var. gerrardii</i>	<i>Nsasani</i>	brunches	Firewood
<i>Amaranthus cruentus</i> <i>L. (Liengme 100)</i>	<i>Nhlaba Ya Fole</i>	Flowering top	Medicine
<i>Amaranthus thunbergii</i> Moq	<i>Thyeka</i>	Leaves	Food
<i>Aptosimum lineare</i> <i>Marloth & Engl</i>	<i>Ximahlomahlwane</i>	Leaves	Medicine
<i>Acacia nigrescens</i> <i>Oliv.</i>	<i>Nkaya/Nkayi</i>	Branches	Firewood
<i>Asclepias burchelli</i> <i>Schltr</i>	<i>Kotoni</i>	Roots	Medicine
<i>A rachis hypogea</i> L.*	<i>Manga</i>	Fruits	Food
<i>Capparis tomentosa</i> <i>Lam.</i>	<i>Mukorongwe</i>	Roots	Medicine
<i>Blumea aurita</i> (L.f.) <i>DC</i>	<i>Munywane</i>	Leaves	Medicine
<i>Bridelia micrantha</i> <i>(Hochst.) Baill</i>	<i>Mundzere</i>	Fruits	Medicine

(Barbosa et al., 2020).

The mentioned species in table 1 are remains important in curing various diseases, for food purposes and firewood purposes. However, their roots for harvestation make them vulnerable, as they are also not properly harvested timely, making it impossible to grow back adequately. Notable practices relate to continuous land-clearance, involving removal of vegetation from its roots, wood collection, deforestation, drought and veld fires, owing to urbanisation and related developmental challenges pressures (Magoro, 2008). Magoro (2008) further shares that that communal land is the source of traditional medicine. However, the current disparaging harvesting methods, involving unprincipled intermediaries in the collection of these plants without creating any safety space for protections and preservations of indigenous plants remains a challenge.

3. Methodology

This article used the non-empirical research design: Systematic review. Dan (2017) states that this research design is meant to review progress in a specific study field [an exploratory study of contributing factors to the extinction of indigenous plants in South Africa]. While, this research design aims to identify, evaluate and summarise the findings of the reviewed research studies by making available evidence more accessible to decision-makers (Yannascoli et al., 2013) and Bwanga (2020). To develop understanding and obtaining the relevant information on this subject, the collected data stemmed from relevant websites such as ResearchGate (RG), Science.gov, PubMed, and Mendeley. Moreover, the following electronic databases – Google Scholar, EbcHost, Emerald Insight, Jstor, ProQuest, Sabinet, Sage Online and Science Direct, were also visited (Maluleke, 2020), following set predetermined steps of this research design. Keywords were used to obtain relevant information on this subject, using non-probability: Purposefully sampling. The analysed grey literature and primary research studies from the indicated peer-reviewed and published databases were restricted to 1978-2021 [Not in order of sequence nor importance], while exercising the exclusion and inclusion criteria throughout this process. The

PRISMA and CASP were employed to ensure trustworthiness, relevance and examinations of the findings of this study.

4. Results and Discussion

4.1 factors Contributing to Indigenous Plants Extinction

There are various factors that contribute to the extinction of indigenous plants. These include human-induced and non-human factors. This is supported by Zang et al. (2020) that natural and human factors change the inherent gradient characteristics of soil moisture and salinity, which may lead to the gradual disappearance of the integrity of indigenous plants, leading to extinction.

4.1.1 Human-Induced Factors

The extinction of indigenous plants is one factor responsible for environmental degradation attributed to human overpopulation, continued human population growth and over consumption of natural resources (Bulte and Van Kooten, 2000). Humankind had a greater impact on the status of biodiversity than on any of the other components of the natural environment (Willis, 2006; Van Wyk, 2011).

- Harvesting Methods

According to Magoro (2008) for centuries, traditional health practitioners in villages have been harvesting indigenous plants in their local environment in ways that ensure sustainable supply. Rasekgala (2018) confirmed that involvement of harvesters and harvesting communities of these indigenous plants in South Africa, in the development of propagation (cultivation) and management methods may kindle their interest in protecting the wild populations. Tshisikhawe et al. (2012) and Tshisikhawe (2002) corroborate that bark and rootbark collections from the wild have been the major methods of harvesting, and these practices result in damage and/or death of many trees. The results on harvesting methods clearly state that indeed indigenous plants are threatened with a possibility of extinction due to the methods that community members use to harvest these plants.

- Medicinal Uses-

About 27 million South Africans depend on traditional medicine for their primary healthcare needs, and for income generation (Mander et al., 2007). Magoro (2008) corroborate that for centuries, traditional health practitioners in villages have been harvesting indigenous plants in their local environment in ways that ensure sustainable supply. De Wet et al., (2013) also stated that majority of South African population in South Arica have access to the western health care facilities, however they still preferred to use indigenous plants as the primary health care for the treatment of various diseases. Barbosa et al. (2020) stated that in terms of harvesting methods plants such as *Amaranthus cruentus* L. (Liengme 100), *Aptosimum lineare* Marloth & Engl, *Asclepias burchelli* Schltr, *Capparis tomentosa* Lam. *Blumea aurita* (L.f.) DC, *Bridelia micrantha* (Hochst.) Baill (refer to table 1) are under threat of extinction as they are in demand for medical purposes. In this notion indigenous plant are proven to be source of primary health care in most rural communities, exposing them to overharvesting.

- Edible Plant Materials-

These indigenous plants are used for nutritional purposes, but believed to have medicinal and magical values, and also used for ritual practices (Abbink, 1995). Barbosa et al. (2020) mentioned that in most rural areas in South Africa plants such as *Amaranthus thunbergii* Moq, *A rachis hypogea* L.* (refer to table 1) are used as a source of food and some of the harvesting methods that are used threaten them with extinction.

- Technological Uses-

According to Barbosa et al. (2020) *Acacia gerrardii* Benth. var. *gerrardii*, *Acacia nigrescens* Oliv (refer to table 1) are viewed to be indigenous plants that are used in most rural communities as a source of firewood, for building and they are also often used for making pestles. Most rural communities in South Africa rely on indigenous plants to fulfil their technological needs.

- Increase in Human Population

In terms of population increase, Williams et al. (2013) presented that due to the increase in human population, the demand of indigenous plants also increases. Street and Prinsloo (2013) confirmed that overexploitation of indigenous plants is a serious threat to the availability of these plants and this is due to the intensive harvesting in relation to high demand. Arjona-García et al. (2021) continues to support that there is a loss of this indigenous knowledge and abandonment of indigenous plants could be seen as due to a decrease in agricultural, agroforestry, and forested areas, since the increase in human population reduces the areas for indigenous plant collection and destroys the existence of indigenous plants. This proves that the increase in human population contribute the loss and extinction of indigenous plants in South Africa. The researchers present that as human population increases so is the indigenous plants demand, and this put strain on these indigenous plants leading them to extinction.

- Plant Poaching

Ndou et al. (2021) presented that medicinal application appears as another leading cause for poaching as drug manufacturing and trado-medical applications also account for a high percentage of poaching in MoNR and LNR. Dzerefos and Witkowski (2001) argued that there are other contributing factors to the loss of indigenous plants at the reserves which include medicinal plant and fuel-wood poaching, theft of fences and illegal dumping of building rubble and household waste. Li and Pritchard (2009) corroborated that indigenous plants are currently endangered due to poaching. The scholars proves that indigenous plants that include medicinal plants that are preserved in reserve banks are being poached, this lead to great loss of these plants. One of the major reasons for medicinal plants to be preserved is that there is a high demand of these plants and are very scares in the wild, therefore collection of medicinal plants in the reserves is not permitted to anyone, which means that people who wants these plants invade the reserves illegally.

- Loss of Indigenous Knowledge

According to Joshi et al. (2003) conservation and documentation of the traditional medicine and/or indigenous knowledge of existing indigenous plant species for curing human and animal diseases need to be given a high priority before they are completely eliminated from the wild due to over-exploitation. Magoro (2008) argued that accompanying the loss of habitat (Indigenous plants included) is the loss of associated indigenous knowledge. He continues to state that when people lose their indigenous knowledge, the resultant loss is that of plant species.in this notion in confirms that indigenous knowledge is important in order to prevent indigenous plants from extinction. However, due to the lack of indigenous knowledge on how to protect indigenous plants it places these plants under threat of extinction.

4.1.2 Non-Human Factors

- Climate Change

In terms of climate change Tshisikhawe et al. (2012) and Tshisikhawe (2002) presented that even though indigenous plants are facing a serious threat of extinction as a result of overharvesting, urbanisation, illegal invasion and deforestation, climate change is also one of the contributing factors

causing indigenous plants extinction. Moreover, Applequist (2020) argued that detrimental effects of climate change on medicinal plants and their users may obviously include decreases in availability, most dramatically in the extinction of species. Bark and rootbark collections from the wild have been the major methods of harvesting, and these practices result in damage and/or death of many trees. Rankoana (2018) that many of the indigenous plants harvested to make preventive and curative medicine are seldom encountered, also due to decreases in rainfall. Moreover, habitat transformation, like the climate change also affects indigenous plants, although minority of them as supported by Maluleke and Shibambu (2021). In this notion, the researchers present that indeed there is a loss of indigenous plants in South Africa. They continue to present that there loss of these plants due to climate change is minimal because most of the plants are found in the wild and can withstand harsh weather conditions.

4.2 Probable Scarcity of Indigenous Plants

This section present the results in terms of the probable scarcity of indigenous plants. Street and Prinsloo (2013) stated that the work of 'African Traditional Health Practitioners (ATHPs) and South Africa's Traditional Healing Folklore (SATHF)' has been disturbed by Western medicine practices; this area is however reportedly diminishing. Mander et al. (2007) presented that the African Health Care System of South Africa has always been dependent of indigenous plants. From a cultural perspective, the healing and spiritual qualities of plants are adopted for the sustainability of their livelihoods. Hence, Williams et al. (2013) supports that majority of South African rural communities still prefer the use of indigenous plants for the purposes of their primary health care, in spite of all the availability and accessibility of western medical care services provided by the government. Williams et al. (2013) corroborated that due to the increase in human population, the demand of indigenous plants also increases. Magoro (2008) argued that despite all the pressing challenges, the use of indigenous plants is still a thriving industry across South Africa. The researchers presented that the population increase put a strain on the existing indigenous plants, although in cases of some people depend largely on the use of western medicine, use electricity and buy food in stores, in rural villages people still prefer the indigenous methods.

Moreover, Street and Prinsloo (2013) presented that overexploitation of indigenous plants is a serious threat to the availability of these plants and this is due to the intensive harvesting in relation to high demand. Rasekgala (2018) reported that these days little efforts has so far been made to document local knowledge on the utilization of indigenous plants despite the continuation of deforestation as well as environmental degradation in the province. In this notion the researchers reported that less information is being recorded about indigenous plants and this leads to plants being destroyed during deforestation because of lack of knowledge.

5. Study Impact

Advance initiatives are needed to inform policy on adaptation and coping with the factors that contribute to extinction of indigenous plants. This study reported that there should be efforts made to document local knowledge on the utilization of indigenous plants despite the continuation of deforestation as well as environmental degradation in South Africa.

Conclusion and Recommendations

The aim of this study was to explore the contributing factors to the extinction of indigenous plants in South Africa. From this study's main aim of exploring study of contributing factors to the extinction of indigenous plants in South Africa, it was recognised that there are various factors that contribute to the loss of indigenous plants these factors include, human population increase, loss of indigenous knowledge,

climate change and indigenous plants poaching. Moreover, the objective of this study was to view the probable scarcity of indigenous plants in South Africa. According to the findings of this study, indeed there is a great loss of indigenous plants caused by various reasons which include high demand of medicinal plants, overexploitation, and deforestation amongst others. Thus, the issue of extinction of medicinal plants is recognised as a major problem in South Africa.

In Conclusion, the purpose of this study was to study explore the contributing factors to the extinction of indigenous plants in South Africa and also to view the probable scarcity of indigenous plants in South Africa. The issue loss of indigenous plants has been proven to be the existing problem. The research recommends that although some of the factors that contribute to extinction of indigenous plants are non-human, effectively using the conservation methods to protect these indigenous plants must be put into action.

References

- Abbink, J., (1995). Medicinal and ritual plants of the Ethiopian Southwest: an account of recent research. *Indigenous knowledge and development monitor*, 3(2), pp.6-8.
- Albrecht, M.A., and McCue, K.A. (2010). Changes in demographic processes over long time scales reveal the challenge of restoring an endangered plant. *Restoration Ecology*, 18, pp.235-243.
- Amjad, M. S., Arshad, M., & Qureshi, R. (2015). Ethnobotanical inventory and folk uses of indigenous plants from Pir Nasoora National Park, Azad Jammu and Kashmir. *Asian Pacific Journal of Tropical Biomedicine*, 5(3), 234-241.
- Appelquist, W. L., Brinckmann, J. A., Cunningham, A. B., Hart, R. E., Heinrich, M., Katerere, D. R., & Van Andel, T. (2020). Scientists' warning on climate change and medicinal plants. *Planta medica*, 86(01), 10-18.
- Arjona-García, C., Blancas, J., Beltrán-Rodríguez, L., López Binnqüist, C., Colín Bahena, H., Moreno-Calles, A.I., Sierra-Huelsz, J.A. and López-Medellín, X. (2021). How does urbanization affect perceptions and traditional knowledge of medicinal plants?. *Journal of Ethnobiology and Ethnomedicine*, 17(1), pp.1-26.
- BAH, (2004). Herbal medicines today: scientific knowledge and medicinal conditions; Inventory and perspectives. 4th ed. Bundesfachverband der Arzneimittelhersteller (BAH), Bonn, Germany.
- Barbosa, F., Hlashwayo, D., Sevastyanov, V., Chichava, V., Mataveia, A., Boane, E. and Cala, A. (2020). Medicinal plants sold for treatment of bacterial and parasitic diseases in humans in Maputo city markets, Mozambique. *BMC Complementary Medicine and Therapies*, 20(1), pp.1-13.
- Bulte, E., & Van Kooten, G. C. (2000). Economic science, endangered species, and biodiversity loss. *Conservation Biology*, 14(1), 113-119.
- Bwanga, O. (2020). How to conduct a qualitative systematic review to guide evidence-based practice in Radiography? *International Journal of Sciences: Basic and Applied Research*, 52 (1):205-213.
- Dan, V. (2017). Empirical and non-empirical methods. Accessed August 08, 2021, [https://www.lsl.ifkw.uni-muenchen.de/personen/wiss_ma/dan_viorela/ ...](https://www.lsl.ifkw.uni-muenchen.de/personen/wiss_ma/dan_viorela/)

- Dar, R.A., Shah Nawaz, M. and Qazi, P.H., 2017. General overview of medicinal plants: A review. *The journal of phytopharmacology*, 6(6), pp.349-351.
- De Wet, H., Nciki, S., & van Vuuren, S. F. (2013). Medicinal plants used for the treatment of various skin disorders by a rural community in northern Maputaland, South Africa. *Journal of Ethnobiology and Ethnomedicine*, 9(1), 1-10.
- Dzerefos, C.M. and Witkowski, E.T.F. (2001). Density and potential utilisation of medicinal grassland plants from Abe Bailey Nature Reserve, South Africa. *Biodiversity & Conservation*, 10(11), pp.1875-1896.
- El-Wahab, R.H.A., Zaghoul, M.S., Kamel, W.M. and Moustafa, A.R.A., 2008. Diversity and distribution of medicinal plants in North Sinai, Egypt. *African Journal of Environmental Science and Technology*, 2(7), pp.157-171.
- Ganeshiah, K.N., Shaanker, R.U., Murali, K.S., Shankar, U & Bawa, K.S. (1998). Extraction of non-timber forest products in the forests of Biligiri Rangan Hills, India. *Economic Botany*, 52(3), 316-319.
- Goldblatt, P. (1978). An analysis of the flora of southern Africa: its characteristics, relationships, and origins. *Annals of the Missouri Botanical Garden*, pp.369-436.
- Huesemann, M. H., Bartha, R., Hausmann, T. S., & Benemann, J. R. (2003). An innovative approach for screening marine microalgae for maximum flue gas CO₂ biofixation potential. In *Second Annual Conference on Carbon Sequestration, US Dep. of Energy, Alexandria, Va.*
- Joshi, A.R. (2003). Environmental management and sustainable development at the crossroad. AnKuS.
- Lambert, J., Srivastava, J. and Vietmeyer, N. (1997). Medicinal plants: rescuing a global heritage (Vol. 355). World Bank Publications.
- Li, D.Z. and Pritchard, H.W. (2009). The science and economics of ex situ plant conservation. *Trends in plant science*, 14(11), pp.614-621.
- Magoro, M.D. (2008). Traditional health practitioners and the sustainability of extinction-prone traditional indigenous plants. *International Journal of African Renaissance Studies - Multi- Inter- and Transdisciplinary*, 5(2):229-241.
- Maluleke, W. (2020). The African scare of Fall Armyworm: Are South African farmers immune? *International Journal of Social Sciences and Humanity Studies*, 12 (1), 207-221.
- Maluleke, W. and Shibambu, N.F. (2021). Exploring illegal harvesting and theft of the selected South African endangered indigenous plants on the Red data list: Case studies of rural areas. *ADRRRI Journal of Arts and Social Sciences*, 18(3 (6) October-December), pp.244-295.
- Mander, M., Ntuli, L., Diederichs, N. and Mavundla, K. (2007). Economics of the traditional medicine trade in South Africa care delivery. *South African health review*, 2007(1), pp.189-196.

- Mander, M. (1997). Medicinal plant marketing in Bushbuckridge and Mpumalanga: A market survey and recommended strategies for sustaining the supply of plants in the region. Unpublished report, Danish Cooperation for Environment and Development, Danish Environment Protection Agency, Strandgade.
- Maroyi, A. (2013). Traditional use of medicinal plants in south-central Zimbabwe: review and perspectives. *Journal of ethnobiology and ethnomedicine*, 9(1), 1-18.
- McGaw, L., Jager, A., Grace, O., Fennell, C. and van Staden, J. (2005). Medicinal plants. In: van Niekerk, A. (Ed.), *Ethics in Agriculture An African Perspective*. Springer, Dordrecht, The Netherlands, pp. 67-83.
- Moeng, E.T. and Potgieter, M.J., 2011. The trade of medicinal plants by muthi shops and street vendors in the Limpopo Province, South Africa. *Journal of Medicinal Plants Research*, 5(4), pp.558-564.
- Ndou, T.M., Stam, E.M., Tshisikhawe, M.P., Alabi, M.A. and Adeeyo, A.O. (2021). Poaching of *Encephalartos transvenosus*, in the Limpopo Province, South Africa. *Resources*, 10(12), p.119.
- Raimondo, D. (2009). Red list of South African plants 2009. South African National Biodiversity Institute.
- Rankoana, S.A. (2018). Human perception of climate change. *Weather*, 73(11), pp.367-370.
- Rasekgala, M.T. (2018). The ethno-ecological assessment of *Cassia abbreviata* Oliv. at Matsa village, Limpopo province, South Africa (Doctoral dissertation).
- Slater, R., & Twyman, C. (2003). *Hidden Livelihoods?: Natural Resource-dependent Livelihoods and Urban Development Policy*. London: Overseas Development Institute.
- Street, R. A., & Prinsloo, G. (2013). Commercially important medicinal plants of South Africa: a review. *Journal of chemistry*, 2013.
- Tshisikhawe, M.P. and Van Rooyen, M.W. (2012). Population biology of *Brackenridgea zanguebarica* in the presence of harvesting. *Journal of Medicinal Plants Research*, 6(46), pp.5748-5756.
- Tshisikhawe, M.P. (2002). Trade of indigenous medicinal plants in the Limpopo province, Venda region; their ethnobotanical importance and sustainable use M.Sc Thesis. University of Venda, Thohoyandou.
- Van Wyk, B. E. (2011). The potential of South African plants in the development of new medicinal products. *South African Journal of Botany*, 77(4), 812-829.
- Wiersum, K.F., Dold, A.P., Husselman, M. and Cocks, M. (2006). Cultivation of medicinal plants as a tool for biodiversity conservation and poverty alleviation in the Amatola region, South Africa. *Frontis*, pp.43-57.
- Williams, V.L., Victor, J.E. and Crouch, N.R. (2013). Red listed medicinal plants of South Africa: status, trends, and assessment challenges. *South African Journal of Botany*, 86, pp.23-35.
- Williams, V.L. (1996). The Witwatersrand muti trade. *Veld & Flora*, 82(1), p.12.

- Willis, C. K. (2006). *Conserving South Africa's plants: a South African response to the global strategy for plant conservation*. South African National Biodiversity Institute.
- World Health Organization, (1993). *Guidelines on the conservation of medicinal plants*. Gland: International Union for Conservation of Nature and Natural Resources.
- Xu, J., Xiao, P., Li, T., & Wang, Z. (2022). Research Progress on endangered plants: a bibliometric analysis. *Biodiversity and Conservation*, 1-23.
- Yannascoli, SM., Schenker & Baldwin, K. (2013). How to write a systematic review: A step-by-step guide? Accessed November 10, 2021, <https://www.semanticscholar.org/paper ...>
- Zang, Z., Wu, X., Niu, Y., & Mao, G. (2020). Analysis of the contributions of human factors and natural factors affecting the vegetation pattern in coastal wetlands. *Ecosystem Health and Sustainability*, 6(1), 1827982.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).