MANAGEMENT PLAN OF A MEDICINAL PLANT SPECIES IN DEMAND: THE CASE OF BRACKENRIDGEA ZANGUEBARICA OLIV

Milingoni Peter Tshisikhawe
University of Venda, South Africa
tshisip@univen.ac.za

ABSTRACT

Studies on the impact of bark harvesting for medicinal purposes on Brackenridgea zanguebarica revealed a high degree of overexploitation. Conservation effort from all levels is highly welcomed since it will be contributing towards conservation of this indigenous medicinal plant. It is therefore clear that an integrated approach of taking best conservation practices from western as well as indigenous systems can be the way to go.

Formation of a Participatory Natural Resource Management Associations in areas where natural resources are being threatened by unsustainable harvesting practice can help in bringing together interested stakeholders into the mainstream of protecting such resources. Such associations should be governed by natural resource harvesting policies with clear objectives around documentation, monitoring and evaluation of harvesting. These policies should cover ecological, social, as well as economic concerns of stakeholders.

Keywords: Harvesting impact, integrated management, sustainable harvesting.

INTRODUCTION

The concepts of sustainability and sustainable development have come to the forefront of many ecological as well as political debates over the last few decades (Goodland, 1995). Sustainable development has become a widely accepted concept, although it used to be regarded as a poorly defined one (Dernbach, 2001; Kennedy, 2001). Hitherto, achieving sustainability still remains a problem. Sustainable utilization of resources should be seen as a cornerstone of conservation instead of being seen merely as a way of alleviating pressure on our natural resources. For conventional conservation to be efficient, reserve networks including large ecological reserves work best. However, establishing protected areas is associated with many conflicting issues because of the incompatibility of land uses as a result of the high human population growth rate (Nantel *et al.,* 1998; West and Brockington, 2006; Gaugris and Van Rooyen, 2010). It is therefore obvious that much, if not the majority of conservation efforts, have to be devoted to non-conserved areas (Smith *et al.,* 2006). Regarding the latter, it is especially important to retain landscape heterogeneity and to preserve a variety of natural habitats under anthropogenic disturbance regimes, but also to improve resource use and control resource extraction (Lindenmayer *et al.,* 2006; Naughton-Treves *et al.,* 2007).

The exploitation of *Brackenridgea zanguebarica* for medicinal purposes is currently very high in the Venda region. In South Africa, the species has been recorded to occur in an area called Thengwe which is located in Mutale Local municipality of Limpopo province. The region is within the Venda speaking people of South Africa. The species has been protected within a nature reserve proclaimed as a way of protecting the remaining population. Despite the reasonable number of seedlings that are established, the destruction rate of large trees is a point of concern. Bark harvesting for medicinal purpose is the major contributor to the loss of mature individuals. Depletion of individuals that were outside the proclaimed reserve has led to illegal harvesting of medicinal materials within the reserve (Tshisikhawe *et al.,* 2013). *B. zanguebarica* is not used for anything else except medicinal due to taboos associated with it (Tshisikhawe, 2002).

DISCUSSION

Sustainable harvesting and conservation

The idea that conservation and sustainable use are linked together is now widely accepted as is the belief of the inextricable link that exists between our survival and that of other species around us (Salafsky *et al.,* 2002; Heywood and Iriondo, 2003). The World Conservation Strategy defines conservation as the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations, while maintaining its potential to meet the needs and the aspirations of the future generation (IUCN/UNEP/WWF, 1980). It is also acknowledged that human harvesting of natural resources is not the sole cause of extinctions. There are other major unintended and irreversible ecological consequences of human activities that may lead to species extinction, through biodiversity loss such as by habitat loss or as a result of global climate change (Fisher and Krutilla, 1974; Johannes, 2002; Brooks *et al.,* 2002; Antoci *et al.,* 2005).

Some of the problems of bark harvesting for medicinal purposes can be addressed by simply following the correct procedures of harvesting as well as by adhering to the myths associated with medicinal bark collection wherein traditional healers believe that killing the plant may result in patients not getting healed. Promoting adherence to these myths amongst those who believe in them can go a long way in protecting biodiversity. Adherence to myths and taboos is also important to consider when proposing harvesting strategies because the use of bark for medicinal purposes is embedded in the mindsets of rural traditional healers and they may not use leaves which are harvested in a less destructive way even when proved to have the same compounds when compared to barks (Zschocke *et al.,* 2000a and b; Drewes *et al*., 2001; Geldenhuys, 2004a).

There are some mechanisms whereby species can show a degree of resilience towards bark harvesting. The ability to coppice or resprout is regarded as one method to afford some resilience against bark harvesting (Botha *et al.,* 2004;

Geldenhuys, 2004a). Another mechanism of resilience towards bark harvesting is the ability of the species to regrow its bark (Cunningham and Mbenkum, 1993; Cunningham, 1993; Delvaux *et al.,* 2009). This ability has been shown to be species-specific (Fasola and Egunyomi, 2005; Vermeulen, 2006; Geldenhuys *et al.,* 2007; Delvaux *et al.,* 2009). *Brackenridgea zanguebarica* show the ability to regrow their bark after being harvested. Bark regeneration is therefore very important for the survival of matured individuals within the population. There are a number of factors affecting the degree of bark regeneration. The intensity of the harvest seems to have a negative impact on the bark's regrowth potential. A relationship has also been demonstrated between tree size and bark regrowth, with larger trees more resilient to bark harvesting (Vermeulen and Geldenhuys, 2004). Furthermore, the degree of bark regrowth depends on the harvesting technique (Delvaux *et al.,* 2009). Removing a narrow strip of bark may improve the chances of healing the wound.

In spite of these mechanisms to improve the resilience of the species to bark harvesting, they do not guarantee sustainability of harvesting. As soon as the harvesting intensity exceeds the resilience capacity of the species it will be vulnerable to overharvesting. This has been demonstrated for Prunus africana, which has the ability to regrow its bark; however, populations are declining due to commercial harvesting of this species in Cameroon (Cunningham and Mbenkum, 1993; Stewart, 2009).

For a species such as *Brackenridgea zanguebarica* with a restricted distribution and specific habitat requirements, it is important to protect it *in situ* since its distribution is influenced by the surrounding environmental conditions. To ensure the species' survival, it is essential to protect a viable population (Tshisikhawe *et al.,* 2013).

For sustainability to be achieved, local resources should be controlled by local people. As is the case in Mafungabusi State Forest of Zimbabwe, involving local residents in management and control of protected areas has proved to be successful (Vermeulen, 1996). The approach of co-management with tribal authorities of the woodland vegetation in which *Brackenridgea zanguebarica* is found is promoted as was suggested by officials from Water Affairs and Forestry Department (Saidi and Tshipala-Ramatshimbila, 2006). This approach is appealing and extremely relevant since natural ecosystems are often closely associated with the history of human societies. The role of human communities should therefore be recognised because the future of ecosystems and human activities are closely intertwined (Thompson *et al.,* 2011).

INDIGENOUS CONSERVATION TECHNIQUES

Indigenous conservation techniques are informed by indigenous knowledge, which is defined as accumulated knowledge, skill and technology of local people. It is derived from their direct interaction with the environment (Verlinden and Dayot, 2005). Indigenous medicinal plants have always been harvested for medicinal purposes by traditional healers with reverence. The respect shown by

these traditional healers through indigenous techniques has made it possible for many plant species to survive all these years of exploitation. Taboos, myths, beliefs and rituals are generally used in the protection of indigenous medicinal plants in the Venda region.

It is generally regarded as a taboo by traditional healers to ring-bark a medicinal plant, during collection of medicinal material. This is due to the fact that if such a plant dies it is believed that the medicine may also become ineffective and even kill the patient instead of healing (Mabogo, 1990). It should therefore be noted that if traditional healers believe that a plant from which medicinal materials are harvested should not be killed as a result of harvesting impact, then it means that they will always exercise extreme caution when harvesting such material. Whether the myth that the medicinal materials may become ineffective is true or not, adhering to such a myth will always promote protection of the species concerned.

According to tradition, medicinal material from the stem may only be collected from opposite sides. Collection from the north facing side is accompanied by collection from the opposite southern side of the stem. If collection is done on the eastern side, the same removal is done on the western side. Such a type of collection technique is further promoted by the belief held by traditional healers that winds which blow from different directions carry healing powers (Mabogo, 1990). During collection of roots only lateral roots may be removed and the place from which they are removed should be covered again for the plant to be able to recover (Mabogo, 1990; Tshisikhawe, 2002).

Collection of medicinal material from *Brackenridgea zanguebarica* has always been accompanied by the performance of rituals (Netshiungani and Van Wyk, 1980; Mabogo, 1990). In the case of *Brackenridgea zanguebarica* there is a dedicated person from the Vhatavhatsindi clan who is responsible for the collection of medicinal material from the plant for those in need of medicinal materials.

Traditional woodland management is still seen as a good way of resource management in the area where the *Brackenridgea zanguebarica* population occurs (Saidi and Tshipala-Ramatshimbila, 2006). The Department of Water Affairs and Forestry (currently the Department of Agriculture, Forestry and Fisheries) in South Africa believes that co-management of the woodland with the tribal authorities can be the best way of protecting it. Community based approaches that build on local medicinal knowledge system of the species must be encouraged with supportive policies and legislative measures at provincial, national and global levels (Shukla and Gardner, 2006).

CONVENTIONAL CONSERVATION TECHNIQUES

Orthodox conservation techniques can also play a major role in conserving endangered species through law enforcement. Reserves have always played a pivotal role in conservation of biodiversity especially in areas where resources

can still be obtained outside them. It is however becoming a challenge in situations where resources may be exhausted outside the reserve area.

The Vhembe district Municipality has been declared by UNESCO as a Biosphere region (UNESCO, 2009). This programme of protecting biodiversity will also go a long way in promoting sustainable utilisation of resources since all the inhabitants of the region will be guided by biosphere principles in their daily lives.

In the case of Brackenridgea zanguebarica the individuals outside the reserve have been depleted, even amidst law enforcement by the tribal authority. The tribal authority monitored the collection of medicinal materials from those *B. zanguebarica* individuals that were left outside the Brackenridgea Nature Reserve. They did that by accompanying collectors of medicinal material to the field and making sure that they collected enough, but in a sustainable way. They also monitored the development of the population by prohibiting collection to allow the population to recover. However, illegal collection of medicinal material has since occurred and depleted the population outside the reserve. Illegal collection of medicinal material, which is usually done during odd hours, has also extended into the reserve area and is now threatening the population of *B. zanguebarica* within the reserve.

An alternative conventional conservation technique would be *ex situ* conservation in botanical gardens or in medicinal plant gardens (Wiersum *et al.,* 2006; Schippmann *et al.,* 2006). In a botanical garden medicinal plant species that are being threatened with overharvesting can be propagated and taken good care of. The propagation programme within the botanical garden can extend its service to the community of users by providing them with seedlings to plant in their homestead. It is important to note that although traditional healers do not prefer to obtain medicinal materials from gardens they are willing and prepared to propagate medicinal plants in their own yards (Tshisikhawe, 2002).

Some progress has been made towards improving the harvesting techniques applied to specific species. Depending on the extent and the rate of wound closure a strategy could be developed for those species that qualify for strip harvesting (Vermeulen, 2006; Delvaux *et al.,* 2009). Key aspects of the harvest strategy would include strip width and length, harvest rotation, minimum diameter of harvested trees, percentage of the trees in the population to be exposed to bark harvesting and the number and rotation of strips on selected trees (Vermeulen, 2006).

Even though it has been shown that leaves could contain the same compounds as bark (Zschocke *et al.,* 2000a and b; Drewes *et al*., 2001; Geldenhuys, 2004a) using the leaves for traditional medicine is not acceptable to the traditional healer community. Traditional healers believe that if a plant is initially utilised for its medicinal bark such can hardly be substituted with leaves since according to them they may not have the same strength.

A number of indigenous medicinal plant species have been successfully propagated after investigating a number of horticultural techniques on those species

that may be difficult to propagate. To enhance the germination of woody plant species, a seed coat cracking pretreatment, as a way of breaking dormancy of hard-seeded species, improved germination by 62% (Netshiluvhi, 1999). Tissue culture techniques have also successfully been used to propagate indigenous medicinal plants for commercial purposes (Rout *et al.,* 2000). Micropropagation of indigenous medicinal plants is also seen as a way of protecting wild populations from overexploitation (Moyo *et al.,* 2011). Cultivation of medicinal plants may therefore in the long-term remove pressure from the forests and divert it to the production sites outside forest sites (Tshisikhawe, 2002; Geldenhuys, 2004b). While looking forward to this medium to long-term solution, efforts should focus on integrated management of the remaining populations of species that are threatened with harvesting as part of the short-term solution. The integrated management should involve the use of western approach as well as the indigenous approach which is led by the tribal authority.

THE INTEGRATED MANAGEMENT OF *BRACKENRIDGEA ZANGUEBARICA*

The protection of *Brackenridgea zanguebarica*, which is a species in demand due to its medicinal value, will require an integrated management approach. The approach should draw best practices in conservation from western as well as indigenous conservation techniques. The system must also enjoy a buy in from the communities that are utilising the plant resources. It therefore calls for ecological solidarity in the fight against their demise. The concept of ecological solidarity is based on the notion that individuals become united around a common goal and that they are conscious of their common interests and shared responsibility (Thompson *et al.,* 2011). Ecological solidarity in this case will require the community to use the best of western as well as indigenous approach of conservation for the achievement of sustainable utilisation of the resources that they need. Whether it is towards the use of natural resources, which may include the use of traditional medicine, to the protection of a threatened species, human societies can contribute to the preservation of biodiversity where no monetary value can be identified. Human communities must be reminded of them being part of nature and that the future of nature lies in their capable hands. Integrated conservation and development, which must involve all relevant stakeholders from the start, should therefore have multiple targets related to both conserving biodiversity and improving human welfare (Salafsky *et al*., 2002; Geldenhuys, 2004b). Integrated concept should allow for sustainable utilisation of resources by community members.

This integrated conservation concept becomes relevant in the Vhembe District Municipality where the study of this research was based because of the area being declared by UNESCO as a Vhembe Biosphere Reserve. It is acknowledged that UNESCO's Man and the Biosphere (MAB) strategy of implementing biosphere reserves might constitute an appropriate planning tool in as far as conservation is concerned. Zonations in biosphere reserves allow for traditional forest use areas, traditional agriculture and settlements, and recreational zones (Bucking, 2003; Zafra-Calvo *et al.,* 2010). In fact biosphere reserve is another

model of integrating different types of forest protection and use together (Bucking, 2003).

The biosphere concept therefore offers the communities and the whole fraternity of stakeholders within Vhembe District Municipality the opportunity to engage with one another in a holistic approach to conservation. The ecological solidarity concept within the biosphere can work very well with systematic conservation planning, since it will attempt to represent and maintain all the biodiversity within the Vhembe Biosphere region. Complementary systematic conservation planning will provide numerous benefits over the *ad hoc* planning approaches (Lombard *et al.,* 2003; Sarkar *et al.,* 2006; Zafra-Calvo *et al.,* 2010). Conservation plans should ideally use approaches that combine land classification data with that of the species. Conservation planning should therefore not only concern the location and design of reserves that represent the biodiversity of a region, but it should at the same time enable the persistence of that diversity by sustaining key ecological and evolutionary processes (Desmet *et al*., 2002; Cowling *et al*., 2003). However, successful implementation will be possible only if the planning incorporates socio-economic considerations (Berliner, 2005) and identification of a general need to develop conservation landscapes that allow the maintenance of biodiversity whilst minimizing impacts on the livelihoods of local people (Driver *et al.,* 2003).

The ecological solidarity concept will go well with community based natural resource management (CBNRM), which clearly affirms management system of resources that existed amongst indigenous communities. Because of their reliance on natural resources, indigenous communities adhered to management of resources approaches that were meted out by traditional institutions such as chiefs, headmen and healers (Fabricius, 2004). Community participation form the core of CBNRM and it should enable them to regain control over natural resources while at the same time strengthening their decision making skills (Wainwright and Wehrmeyer, 1998). The Thengwe tribal authority institutions will set boundaries that controlled natural resource utilisation. Revival and adherence to these tribal institutions and their practices can play an important ecological role towards promotion and sustenance of biodiversity. Carrying out rural development initiatives within a legal framework and effective institutional structures is one of the four components that need to be integrated in order to achieve sustainability of natural resource use. Other components to be integrated include ecological, social, and economical aspects (Geldenhuys, 2004a).

The integrated approach will therefore only prosper when commitment is provided by all sectors of the community. Failing to provide support by all the sectors concerned may lead to the downfall of the integrated management approach. Its strength is that everybody becomes the custodian of the natural resources in this people centered approach to resource management. Communication between different stakeholders is essential for the participatory management approach and the continued sustainability of natural resources (Geldenhuys, 2004b). Any information generated on studies of natural resources should be shared amongst different stakeholders.

CONCLUSIONS AND RECOMMENDATIONS

It is clear that indigenous conservation techniques (ICT) and orthodox conservation play major roles in the conservation of indigenous medicinal plants. It is therefore important to acknowledge the two approaches in the conservation model that should be put into place by the Provincial Department of Environment and the tribal authority institutions of Thengwe area where *Brackenridgea zanguebarica* occurs. Instead of focusing only on law enforcement initiatives, efforts should be made that will also focus on the mentality of the communities. People around Thengwe should be made to understand the real meaning of having a species that is considered to be rare growing in their area. The Provincial Department of Environment and the tribal authority institution should make the immediate communities feel the sense of ownership in reality.

The feeling of ownership within the Vhatavhatsindi clan in the case of B. zanguebarica must cascade down to every member of the community around the area where the species is growing. The information that the species is only found in the Thengwe area of Limpopo province in the whole of South Africa must be communicated to all members of surrounding communities in order for them to understand its place in global, national, provincial as well as local environmental management plans. It is therefore important to inform people that our own welfare, the survival of other species and the resilience of global life support systems are all intertwined and at risk of extinction threats (Aronson *et al.,* 2006). More than ever before it means that people are part of nature and must practise ecological conservation and restoration since it matters in our lives.

REFERENCES

Antoci, A., Borghesi, S. and Russu, P. (2005). Biodiversity and Economic Growth: Trade-offs Between Stabilization of the Ecological System and Preservation of Natural Dynamics. *Ecological Modelling,* 189: 333-346.

Aronson, J., Milton, S.J., Blignaut, J.N. and Clewell, A.F. (2006). Nature Conservation as if People Mattered. *Journal for Nature Conservation,* 14: 260-263.

Berliner, D. (2005). *Systematic Conservation Planning for the Forest Biome of South Africa. Approach, Methods and Results of the Selection of Priority Forests for Conservation Action, Water and Forestry Support Programme*. Department of Water Affairs and Forestry. Pretoria.

Botha, J., Witkowski, E.T.F. and Shackleton, C.M. (2004). The Impact of Commercial Harvesting on Warburgia Salutaris ('Pepper-bark Tree') in Mpumalanga, South Africa. *Biodiversity and Conservation,* 13: 1675-1698.

Brooks, T.M., Mittelmeier, R.A., Mittelmeier, C.G., Da Fonseca, G.A.B., Rylands, A.B., Constant, W.R., Flick, P., Pilgrim, J., Oldfield, S., Magin, G. and Hilton-Taylor, C. (2002). Habitat Loss and Extinction in Hotspots of Biodiversity. *Conservation Biology,* 16: 909-923.

Bucking, W. (2003). Are There Threshold Numbers for Protected Forests? *Journal of Environmental Management,* 67: 37-45.

Cowling, R.M., Pressey, R.L., Rouget, M. and Lombard, A.T. (2003). A Conservation Plan for a Global Biodiversity Hotspot – The Cape Floristic Region. South Africa. *Biological Conservation*, 112: 191-216.

Cunningham, A.B. (1993). *African Medicinal Plants: Setting Priorities at the Interface Between Conservation and Primary Healthcare*. UNESCO, Paris.

Cunningham, A.B. and Mbenkum, F.T. (1993). *Sustainability of Harvesting Prunus Africana Bark in Cameroon: A Medicinal Plant in International Trade.* UNESCO, Paris.

Delvaux, C., Sinsin, B., Darchambeau, F. and Van Damme, P. (2009). Recovery From Bark Harvesting of 12 Medicinal Tree Species in Benin, West Africa. *Journal of Applied Ecology,* 46: 703-712.

Dernbach, J. (2001). *From Rio to Johannesburg, Implementing Sustainable Development at the Global and Local Scale*. Report from the second National Conference on Science, Policy and Environment. National Council for Science and the Environment. Smithsonian National Museum of Natural History, Washington, DC.

Desmet, P.G., Cowling, R.M., Ellis, A.G. and Pressey, R.L. (2002). Integrating Biosystematics Data into Conservation Planning: Perspectives from Southern Africa's Succulent Karoo. *Systematic Biology,* 51: 317-330.

Drewes, S.E., Crouch, N.R., Mashimbye, M.J., De Leeuw, B.M. and Horn, M.M. (2001). A Phytochemical Basis for the Potential Use of Warburgia Salutaris (Pepper-bark Tree) Leaves in the Place of Bark. *South African Journal of Science,* 97: 383-386.

Driver, A., Cowling, R.M. and Maze, K.E. (2003). *Planning for Living Landscapes: Perspectives and Lessons from South Africa.* Botanical Society of South Africa, Cape Town.

Fabricius, C. (2004). *The Fundamentals of Community-based Natural Resource Management. In Rights, Resources and Rural Development Community-based Natural Resource Management in Southern Africa*. Fabricius, C., Koch, E., Magome, H. and Turner, S. (eds). Earthscan Publishers, USA.

Fasola, T.R. and Egunyomi, A. (2005). Nigerian Usage of Bark in Phytomedecine. *Ethnobotany Research and Applications,* 3: 73-77.

Fisher, A.C. and Krutilla, J.V. (1974). Valuing Long Run Ecological Consequences and Irreversibilities. *Journal of Environmental Economics and Management,* 1: 96-108.

Gaugris, J.Y. and Van Rooyen, M.W. (2010). Evaluating the Adequacy of Reserves in the Tembe – Tshanini Complex: A Case Study in Maputaland, South Africa. *Oryx,* 44: 399-410.

Geldenhuys, C.J. (2004a). *Meeting the Demand for Ocotea Bullata Bark: Implications for the Conservation of High Value and Medicinal Tree Species. In: Indigenous Forests and Woodlands in South Africa – Policy, People and Practice.* Lawes, M.J., Eeley, H.A.C., Shackleton, C.M. and Geach. B.G.S. (eds). Pietermaritzburg: University of Kwazulu-Natal Press, pp. 517-550.

Geldenhuys, C.J. (2004b). Bark Harvesting for Traditional Medicine: From Illegal Resource Degradation to Participatory Management. *Scandinavian Journal of Forest Research,* 19: 103-115.

Geldenhuys, C.J., Syampungani, S., Meke, G.S. and Vermeulen, W.J. (2007). Response of Different Species to Bark Harvesting for Traditional Medicine in Southern Africa. In Bester, A.J.J., Seydack, H.W., Vorster, T., Van der Merwe I.J. and Dzivhani, S. (eds). *Multiple Use Management of Natural Forests and Woodlands: Policy Refinement and Scientific Progress*. pp. 55-62. Department of Water Affairs and Forestry, Pretoria, South Africa.

Goodland, R. (1995). The Concept of Environmental Sustainability. *Annual Review of Ecology and Systematics,* 26:1-24.

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

IUCN/UNEP/WWF. (1980). *World Conservation Strategy: Living Resource Conservation for Sustainable Development*. International Union for the Conservation of Nature, Gland.

Johannes, R.E. (2002). Did Indigenous Conservation Ethics Exist? *SPC Traditional Marine Resource Management and Knowledge Information Bulletin,* 14: 3-7.

Kennedy, D. (2001). *Sustainability: Problems, Science and Solutions*. Report from the second National Conference on Science, Policy and Environment. National Council for Science and the Environment. Smithsonian National Museum of Natural History, Washington, DC.

Lindenmayer, D.B., Franklin, J.F. and Fischer, J. (2006). General Management Principles and a Checklist of Strategies to Guide Forest Biodiversity Conservation. *Biological Conservation,* 131: 433-441.

Lombard, A.T., Cowling, R.M., Pressey, R.L. and Rebelo A.G. (2003). Effectiveness of Land Classes as Surrogates for Species in Conservation Planning for the Cape Floristic Region. *Biological Conservation,* 112: 45-62.

Mabogo, D.E.N. (1990). *The Ethnobotany of the Vhavenda. Master of Science Thesis.* University of Pretoria, Pretoria, South Africa.

Moyo, M., Bairu, M.W., Amoo, S.O. and Van Staden, J. (2011). Plant Biotechnology in South Africa: Micropropagation Research Endeavours, Prospects and Challenges. *South African Journal of Botany,* 77: 996-1011.

Nantel, P., Bouchard, A., Brouillet, L. and Hay, S. (1998). Selection of Areas for Protecting Rare Plants With Integration of Land Use Conflicts: A Case Study for the West Coast of Newfoundland, Canada. *Biological Conservation,* 84: 223-234.

Naughton-Treves, L., Kammen, D.M. and Chapman, C. (2007). Burning Biodiversity: Woody Biomass Use by Commercial and Subsistence Groups in Western Uganda's Forests. *Biological Conservation,* 134: 232-241.

Netshiluvhi, T.R. (1999). Demand, Propagation and Seedling Establishment of Selected Medicinal Trees. *South African Journal of Botany,* 65: 331-338.

Netshiungani, E.N. and Van Wyk, A.E. (1980). Mutavhatsindi – Mysterious Plant from Venda. *Veld and Flora,* 66: 87-89.

Rout, G.R., Samantaray, S. and Das P. (2000). *In Vitro* Manipulation and Propagation of Medicinal Plants. *Biotechnology Advances,* 18: 91-120.

Saidi, T.A. and Tshipala-Ramatshimbila, T.V. (2006). Ecology and Management of Remnant Brachystegia Spiciformis (Miombo) Woodland in Northeastern Soutpansberg, Limpopo Province. *South African Geographical Journal,* 88: 205-212.

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

Sarkar, S., Pressey, R.L., Faith, D.P., Margules, C.R., Fuller, T., Stoms, D.M., Moffet, A., Wilson, K.A., Williams, K.J., Williams, P.H. and Andelman, S.

(2006). Biodiversity Conservation Planning Tools: Present Status and Challenges for the Future. *Annual Reviews of Environment and Resources,* 31: 123-159.

Schippmann, U., Leaman, D. and Cunningham, A.B. (2006). A Comparison of Cultivation and Wild Collection of Medicinal and Aromatic Plants Under Sustainability Aspects. In Bogers, R.J., Craker, L.E., Lange, D. (eds). *Medicinal and Aromatic Plants, Agricultural, Commercial, Ecological, Legal, Pharmacological and Social Aspects,* pp. 75-95. Springer, Dordrecht, the Netherlands (Wageningen UR Frontis Series 17).

Shukla, S. and Gardner, J. (2006). Local Knowledge in Community Based Approaches to Medicinal Plant Conservation: Lessons From India. *Journal of Ethnobiology and Ethnomedicine,* 2: 20-24.

Smith, R.J., Goodman, P.S. and Matthews, W. (2006). Systematic Conservation Planning: A Review of Perceived Limitations and an Illustration of the Benefits, Using a Case Study from Maputaland, South Africa. *Oryx,* 40: 400-410.

Stewart, K. (2009). Effects of Bark Harvest and Other Human Activities on Populations of the African Cherry (Prunus Africana) on Mount Oku, Cameroon. *Forest Ecology and Management,* 258: 1121-1128.

Thompson, J.D., Mathevet, R., Delanoe, O., Gil-Fourie, C., Bonnin, M. and Cheylan, M. (2011). Ecological Solidarity as a Conceptual Tool for Rethinking Ecological and Social Interdependence in Conservation Policy for Protected Areas and Their Surrounding Landscape. *Comptes Rendus Biologiques,* 334: 412-419.

Tshisikhawe, MP. (2002). *Trade of Indigenous Medicinal Plants in the Northern Province, Venda Region: Their Ethnobotanical Importance and Sustainable Use*. M.Sc Dissertation, University of Venda for Science and Technology, Thohoyandou, South Africa.

Tshisikhawe, M.P. (2005). Synthesis on Medicinal Plants of the Soutpansberg Region. Available at: *http://www.soutpansberg.com/workshop/synthesis/medicinalplants.htm. Accessed on: 19 November 2015.*

Tshisikhawe, M.P., van Rooyen, M.W. and Gaugris, J.Y. (2013). Is the Present Brackenridgea Nature Reserve Large Enough to Ensure the Survival of Brackenridgea zanguebarica Oliv? *Koedoe,* 55(1): 1-5.

UNESCO. (2009). 22 New Biosphere Reserves Selected by UNESCO. Available at: *http://www.unesco.org*. Accessed on: 19 November 2015.

Verlinden, A. and Dayot, B. (2005). A Comparison Between Indigenous Environmental Knowledge and a Conventional Vegetation Analysis in North Central Namibia. *Journal of Arid Environments,* 62: 143-175.

Vermeulen, S.J. (1996). Cutting Trees by Local Residents in a Communal Area and an Adjacent State Forest in Zimbabwe. *Forest Ecology and Management,* 81: 101-111.

Vermeulen, W.J. (2006). Sustainable Harvesting for Medicinal Use: Matching Species to Prescriptions. In Bester, J.J., Seydack, A.H.W., Voster, T., Van Der Merwe, I.J. and Dzivhani, S. (eds). Multiple Use Management of Natural Forests and Woodlands: Policy Refinements and Scientific Progress: Symposium on Natural Forests and Savanna Woodlands, Symposium IV. Available at: *http://www2.dwaf.gov.za/webapp/resource centre/Documents/Reports/4259_Day1_session3_item4.pdf.* Accessed on: 19 October 2015.

Vermeulen, W.J. and Geldenhuys, C.J. (2004). Experimental Protocols and Lessons Learnt From Strip Harvesting of Bark for Medicinal Use in the Southern Cape forests. London: DIFID.

Wainwright, W. and Wehrmeyer, W. (1998). Success in Integrating Conservation and Development? A Study from Zambia. *World Development,* 26: 933-944.

West, P. and Brockington, D. (2006). An Anthropological Perspective on Some Unexpected Consequences of Protected Areas. *Conservation Biology,* 20: 609-616.

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. In: Bogers, R.J., Craker, L.E., Lange, D. (eds). *Medicinal and Aromatic Plants, Agricultural, Commercial, Ecological, Legal, Pharmacological and Social Aspects*, pp. 43-57. Springer, Dordrecht, the Netherlands (Wageningen UR Frontis Series 17).

Zafra-Calvo, N., Cerro, R., Fuller, T., Lobo, J.M., Rodriguez, M.A. and Sarkar, S. (2010). Prioritizing Areas for Conservation and Vegetation Restoration in Post-agricultural Landscapes: A Biosphere Reserve Plan for Bioko, Equatorial Guinea. *Biological Conservation,* 143: 787-794.

Zschocke, S., Drewes, S.E., Paulus, K., Bauer, R. and Van Staden, J. (2000a). Analytical and Pharmacological Investigation of Ocotea Bullata (Black Stinkwood) Bark and Leaves. *Journal of Ethnopharmacology,* 71: 219-230.

Zschocke, S., Rabe, T., Taylor, J.L.S., Jäger A.K. and Van Staden, J. (2000b). Plant Part Substitution – A Way to Conserve Endangered Medicinal Plants? *Journal of Ethnopharmacology,* 71: 281-292.