

# Assessment of traditional ecological knowledge and beliefs in the utilisation of important plant species: The case of Buhanga sacred forest, Rwanda



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Traditional ecological knowledge is an integrated part of the African people and indeed the Rwandese for cultural purpose. Buhanga sacred forest is a relict forest of tremendous ecological importance to Rwandan society located in Musanze District. The aim of this study was to assess the traditional ecological knowledge and belief in the utilisation of some important plant species for the conservation of Buhanga sacred forest. Ecological information about ethnomedicinal and traditional practices were collected following structured questionnaire through interview involving eight traditional healers and three focus group discussions. Data were collected from the natural habitats, home gardens, farmlands and roadsides of Buhanga sacred forest. A total of 45 botanical taxa belonging to 28 families were reported to be used by the local community. Species such as *Brillantaisia cicatricosa* and *Senna septemtrionalis* were the popular species cited by traditional healers to treat human and animal diseases and ailments, respectively. The results of the study indicated that because of the cultural norms and values associated with the sacred forest, this has led to non-exploitation. The study presents key sites and plant species in which their use and belief can lead to their conservation. However, not only is it imperative to conserve traditional local knowledge for biocultural conservation motives but there is also need to train traditional healers on how to domesticate indigenous species as conservation measure because some species have become susceptible to extinction.

**Conservation implications:** Highlighting indigenous species investigated in this research will provide a powerful tool for ensuring biodiversity conservation through community participation in a country of high population density in Africa. Some plant species that provided satisfactory Local Health Traditions among communities surrounding Buhanga can contribute as good material for further research in Rwanda.

## Introduction

Traditional ecological knowledge is defined as a cumulative body of knowledge, practice and belief. It is a mutual relationship between living beings (including humans) and its environment which evolves by adaptive processes and are handed down through generations by cultural transmission (Berkes 1999). Such knowledge has contributed to conservation of biodiversity (Gadgil, Berkes & Folke 1993), rare species (Colding 1998) and protected areas (Johannes 1998) as well as to sustainable resource use (Berkes 1999) from one area to another. In Africa, there are important elements to take into account regarding indigenous or traditional spirituality towards the nature. The value of traditional knowledge of natural resources is widely recognised among indigenous people because it was accumulated and transferred orally across generations. According to Charnley, Paige and Jones (2007) and Berkes, Colding and Folke (2000), the integral success of the traditional ecological knowledge into biodiversity conservation depends on active participation of the knowledge holders, such as indigenous communities and institutions. To avoid loss of biodiversity, traditional rules play an important role when developing conservation strategies for rare species by limiting illegal activities such as selective trees felling (Ormsby 2013). Some sacred species constitute excellent totems. Totems are often plants or animals that are a stand-in of its owner and their presence dissuade from illegal access to sacred areas. Furthermore, these sacred species contribute significantly in conservation by acting as umbrella species to the overall ecosystem (Ndimukaga 2009). Sacred place functions under the principle of faith and fear of god and other supernatural forces. This principle requires honesty, respect of ancestors and observation of moral values (Kamga-Kamdem 2008).

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## Rwandan culture history and forest

In many sub-Saharan African societies, the traditional ecological knowledge among indigenous people is synonymous with spirituality, which contributed to sustain the sacred forests. Rwanda, one of the smallest countries in the world with only 26, 338 km<sup>2</sup>, has a rich forest heritage. The value of Rwandan culture is based on oral history, ecology and nature, geographical sites and by *igitaramo*. *Igitaramo* constitutes a gathering of families, communities and friends with songs and dances. During pre-colonial time, Rwandan society was inherently linked to forest, which hides great lessons concerning rites, ancestral customs, taboos, arts, crafts, music, dance and many more. Such integral links led to the emergence of traditional medicine (Karangwa 1997). The Rwandese are aware of the existence of these traditional healers who provide home-based healthcare. Locally, they are known as *abavuzi gakondo* or *abapfumu*. The former denotes traditional healers involved in the use of plants and the latter denotes those who are involved especially in the ritual component of traditional medicine (Rwangabo 1993). But it has been said that sometimes *abapfumu* use leaves, roots or barks of plants to protect their clients in exchange for money (Adenkule 2007). As a matter of fact, traditional ecological knowledge is still very much alive in Rwanda because it contributes significantly to solve health problems. In Rwanda, cutting of certain tree species is seen as a taboo as well as killing of indigenous animal such as primates, elephants, leopards, birds, etc. According to Kimenyi (1989), this conservation emphasised the symbiotic and interdependence relationship between people, plants and animals. It is for these reasons that cultural values are an essential component of every society and they act as checks and balances in the management of natural resources (Verschuuren *et al.* 2010).

## The context of Buhanga sacred forest

Buhanga sacred forest is a relict forest of tremendous ecological importance to Rwandan's society for cultural purposes. It lies in volcanic belt and has one of the highest population density in Rwanda and Africa, with up to 500–700 people per km<sup>2</sup> (NISR 2012; Plumptre, Masozera & Vedder 2001). Buhanga relict forest contains sacred water-spring, marshland, medicinal plants, native trees and even a last refuge for arboreal, migratory birds. For example, African Pitta *Pitta angolensis* is a migrant bird that breeds in central Tanzania, Malawi, southeast Democratic Republic of Congo, eastern Zambia, Zimbabwe and possibly northern South Africa that was sighted in Buhanga sacred forest (BirdLife International Africa Partnership e-bulletin 2008). Unfortunately, reports indicate that this relict forest is facing many threats as a result of human interference on the environment in various ways, such as harvesting of firewood and agriculture (MINITERE & CGIS-NUR 2007; REMA 2009). In fact, high pressure of disturbance of natural reserves in Rwanda was noticed until the resettlement of refugees after the genocide during the year 1997–1998 where people both settled and farmed within many natural reserves (Plumptre *et al.* 2001). It should be mentioned that in most cases natural resources are still viewed as limitless

in the mind of the resource-poor local communities in Rwanda as a source of income. However, it should be seen furthermore that without any practical actions for sustainable utilisation of so-called 'limitless resources' and usage of traditional ecological knowledge, there is a risk of genetic loss and lack of traditional information from generation with time.

To address the issue of loss of this critical cultural forest in Rwanda, the goal of this study is to document the traditional ecological knowledge and belief in the utilisation of some important plant species of Buhanga sacred forest. Hence, there is a need for such information and documentation with the help of local communities to develop comprehensive and useful strategies for public awareness but also to formulate recommendations for monitoring natural resources for better future (Figure 1).

## Material and methods

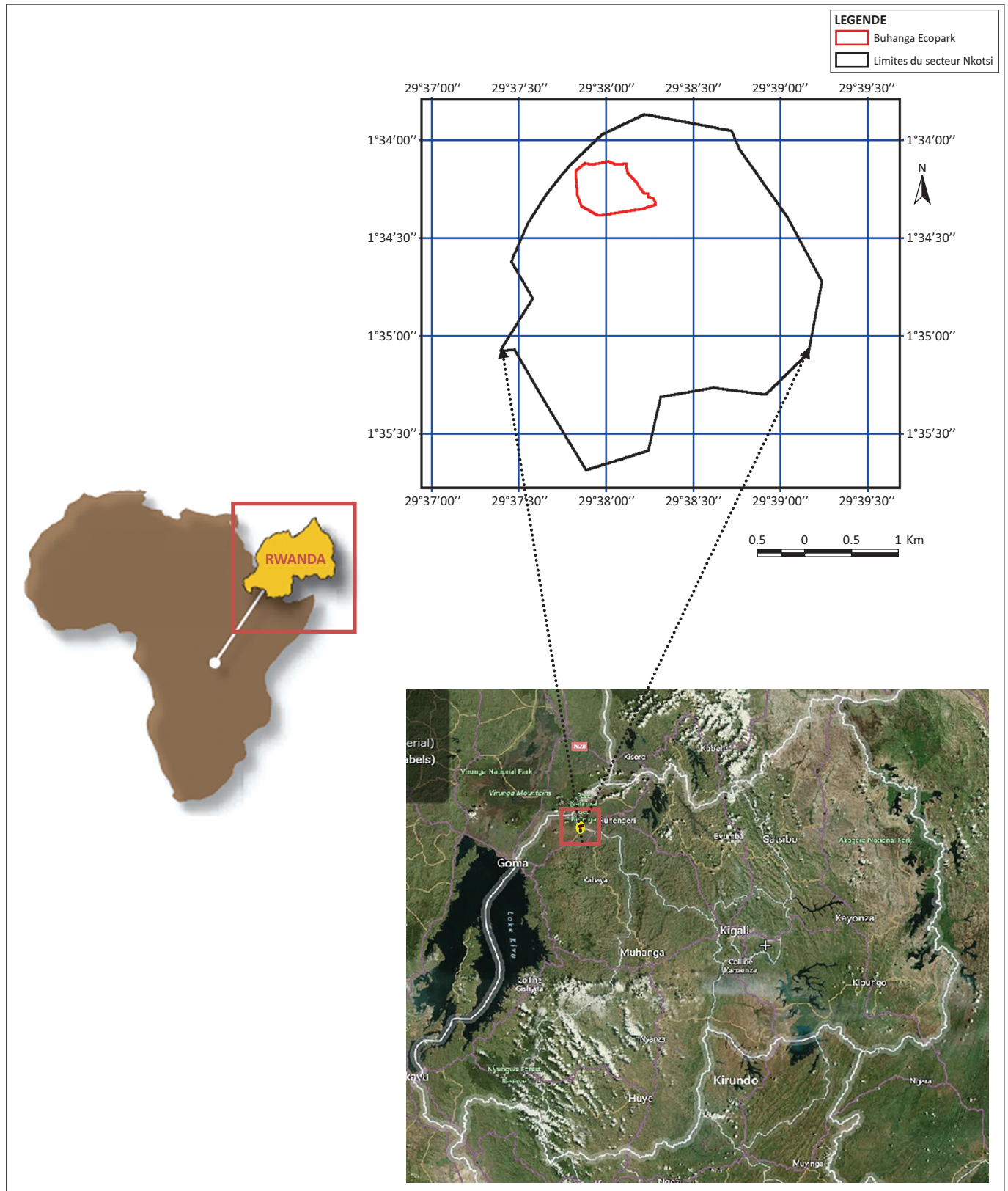
### Geo-ethnographical overview of the study area

Buhanga sacred forest is an archaic forest located in Northern Province, District of Musanze, Nkotsi sector and Bikara cell, at the right side of the road that leads towards Vunga business centre. The site is situated at approximately 114 km from Kigali, the capital city of Rwanda and covers an area of 33.252 ha, of which 16.0011 ha is still intact and located between 1°34'00" and 1°34'30" South latitude and 29°34'30" and 29°37'30" East longitude at an altitude ranging between 1623 m a.s.l. and 1657 m a.s.l. Geo-climatically the area falls within the tropical rainforest of the volcano massif where climate is controlled by various factors such as altitude, latitude and vegetation. The climate is cool and wet and temperatures fluctuate around 20 °C during the day. Most of the lands surrounding Buhanga sacred forest are used for agriculture subsistence. Near subsistence agriculture, coffee, tea and pyrethrum plantations are prominent land uses as cash crop generating local employment. Projects funds from government and international non-governmental organisations have been used for a range of activities from environment protection (tree planting, soil erosion control and beekeeping) to limit access in the sacred forest (Figure 2).



Source: Association for the Conservation of Nature in Rwanda, 2008

**FIGURE 1:** View of Buhanga sacred forest.



Source: Google Earth and GPS points by Iraguha, 2004

**FIGURE 2:** Map of the study area.



## Ethnobotanical survey

Our study was carried out during the period of 26–31 May, 2008. A reconnaissance survey was conducted in *Abadahemuka* cooperative at *Nkotsi-Bikara*, Musanze District. In Rwanda, most of the traditional healers are grouped into cooperatives under the supervision of the Ministry of Health in close collaboration with the Institute of Scientific and Technological Research. The traditional healers provided the information about traditional healing practices for both humans and animals, while the elders provided information regarding rituals and beliefs surrounding the forest. The information regarding the use of medicinal plants was collected following structured questionnaire through interviews involving eight traditional healers (five men and three women) aged between 41 and 80 years. These traditional healers were recognised by the local government authorities and selected based on their reputation on herbal medicinal uses. Plant species mentioned by traditional healers were visited inside the relict forest and home gardens to verify the reliability of data obtained during interviews (Alexiades 1996; Gerique 2006). The recorded field data include the following: collection number, plant local name, scientific name, habit, plant parts used, mode of preparation, habitat and locality (Martin 1995). The information regarding the traditional practices and utilisation of Buhanga sacred forest were captured through three focus discussion groups. Each discussion group comprised 15 persons (10 men and 5 women) who were natives of the *Nkotsi-Bikara* village aged between 50 and 80 years; inclusion was based on a good knowledge of Buhanga sacred forest history. During the discussion, each member of the group took about 5–8 min to talk about the importance of cultural knowledge and use of Buhanga sacred forest.

Species information provided either during the interview or group discussion were recorded. When a species was physically observed in home garden and not in the forest and vice versa, the information regarding that species was collected. Species recognised only through vernacular names without physical identification either in home garden or in the forest was considered unreliable and rejected. Species botanical identification was carried out in the National Herbarium of Rwanda using voucher specimens, identification keys, field guides and the flora of Rwanda (Troupin 1966, 1978, 1982, 1983, 1985, 1988; and Fischer & Dorothee 2008) (see picture showing different sites of study area in Appendix 1).

## Data analysis

Validation of plant names, family and plant authority were carried out using the Royal Botany Garden and Missouri Botanic Garden plant names database (<http://www.theplantlist.org>).

Collected data were analysed using descriptive statistics. The determination of relative frequency of citation of reported medicinal plant species was done using the following formula:

$$\text{RFC (\%)} = (\text{FC/N}) \times 100$$

[Eqn 1]

where, FC is the number of informants mentioning the use of medicinal plant species and N is the total number of informants participating in the survey.

## Results

### Plant diversity

This study recorded 45 plant species that were used by local communities in the vicinity of Buhanga sacred forest. Of the 45 species, 38 plant species were categorised in 34 genera and 19 families to have medicinal value. In terms of species composition of medicinal plants, the family of Asteraceae, Acanthaceae and Fabaceae had three species each followed by the family of Chenopodiaceae, Rutaceae, Rhamnaceae, Ranunculaceae, Polygonaceae, Solanaceae, Menispermaceae, Verbenaceae, Urticaceae and Cucurbitaceae with two species each. The remaining 14 families were represented by a single species each (see Figure 3). Regarding life form, 21 species (47%) were herbs, 8 species (18%) were trees, 10 species (22%) were climbers, 4 species (8%) were shrubs and 2 species (4%) were grasses (see Figure 4).

### Plant species role in ecological, social and cultural welfare

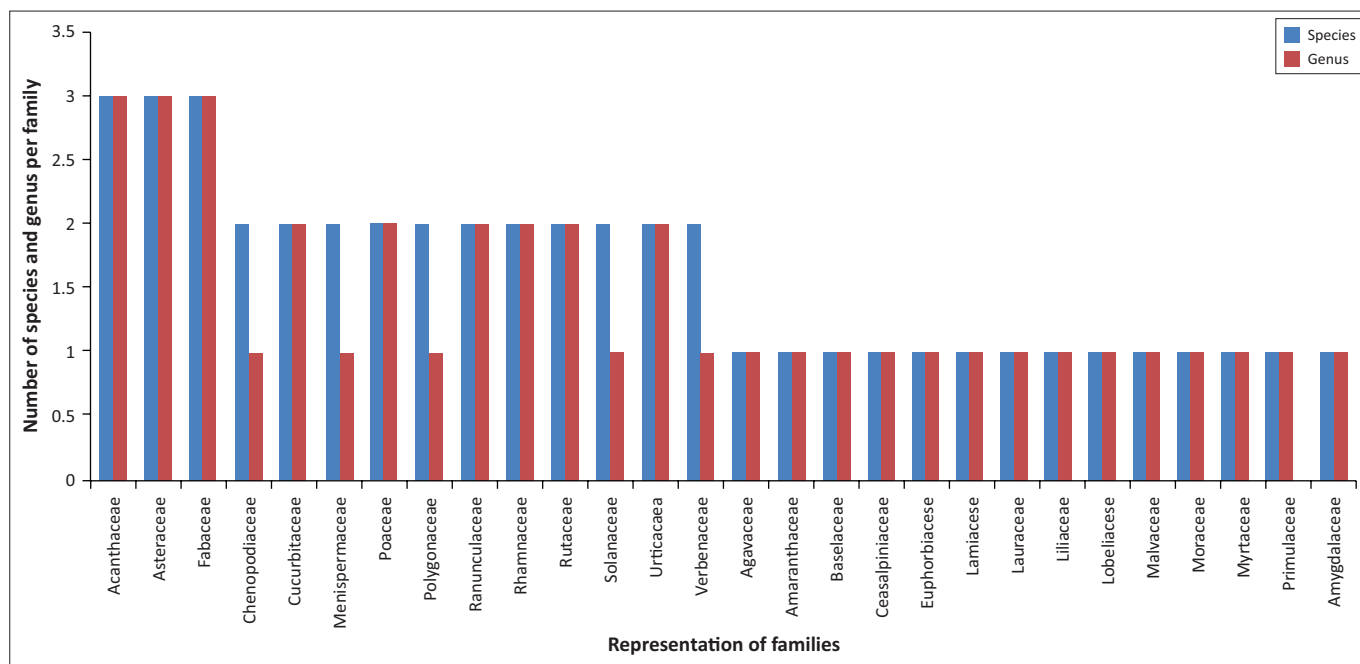
Results of medicinal plants collected from different habitats show that most of the plant species, about 29 species (62.22%) were harvested from natural vegetation followed by 9 species (20.00%) under cultivation in home gardens, 6 species (13.33%) collected in farming plots and 2 species (4.44%) found near the roadsides. The goods and uses of the vegetation in our study area showed that most of the plant species are used for medicinal purposes (38 plant species [74.51%]) followed by raw materials (8 species [15.69%]), social symbol (3 species [5.88%]) and 2 species (3.92%) for spiritual purpose (see Figure 5 and Table 1).

Interviewees from the three group discussions recounted stories of transgressors who had taken resources from a sacred forest and misfortunes fell on them (see Table 2). For example it was said that villagers would not dare to enter the Buhanga sacred forest for fear of angering some spirits in control of the forest. They believe that these spirits were able to curse them by sending a resident giant snake protective of the surrounding marshland called *igishanga cya gihanga*. Moreover, Buhanga sacred forest is a habitat for many rare species of snakes which upon sight a curse follows. Calamities such as drought were also associated by such omens.

### Medicinal flora

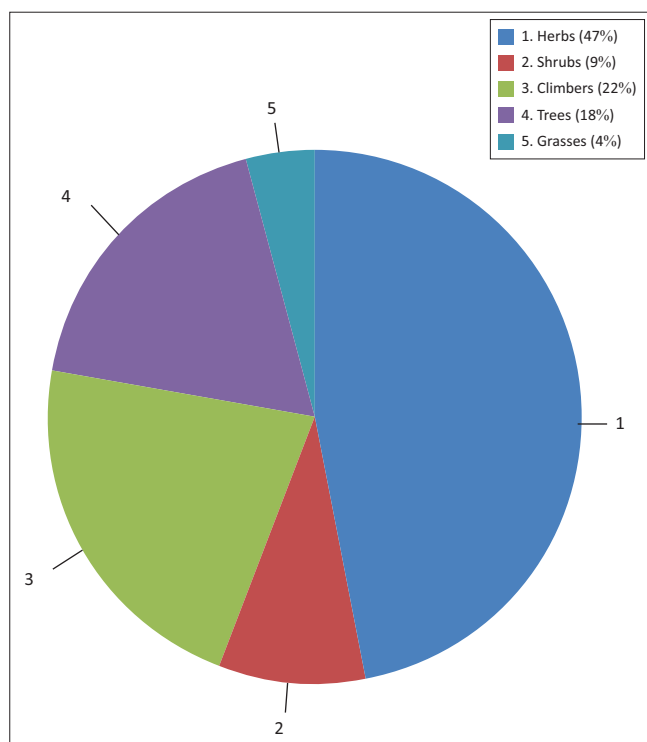
Of the 38 plant species reported to have medicinal uses, 29 species distributed in 19 families were reported to be used against human health problems, six species belonging to six families were used against cattle diseases and three species belonging to three families were used against both human and cattle diseases. The most striking diseases recorded in 17 human health problems were the poison vomiting treated by





Source: Association for the Conservation of Nature in Rwanda, 2008

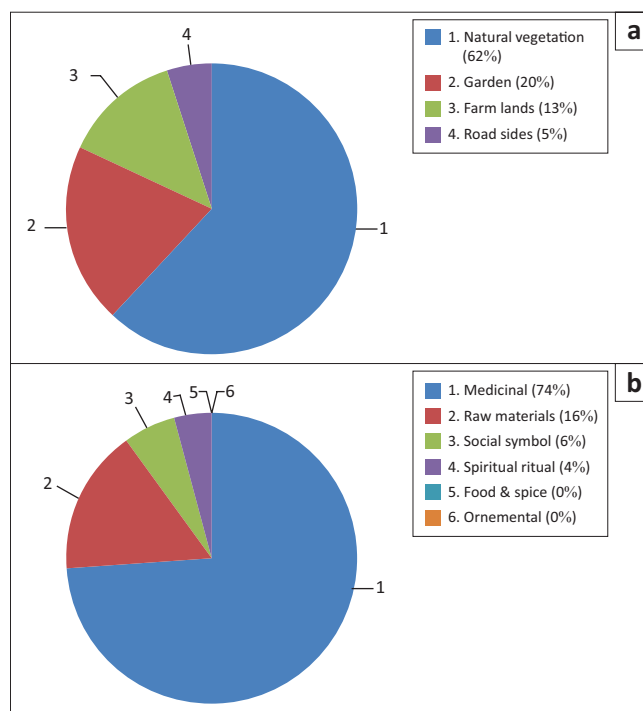
**FIGURE 3:** Distribution of 45 identified plant species among botanical families.



Source: Association for the Conservation of Nature in Rwanda, 2008

**FIGURE 4:** Life form proportion of plant species.

six plant species followed by mental diseases and *Kilondatumbo* (Symptoms of *Kilondatumbo*: painful sensation in the digestive system with presence of ulcers in the ileum and rectum) treated with five specific plant species (Table 3). Stomach ache was treated by three plant species while other plant species were used to treat one or two diseases (see Table 3). In regard to ethnoveterinary medicine, the most remarkable diseases were tick-borne diseases (East coast fever, Babesiosis and Anaplasmosis) treated by four species followed by sexual



Source: Association for the Conservation of Nature in Rwanda, 2008

**FIGURE 5:** (a) Origin of medicinal plants and (b) social welfare of plant species.

dysfunction treated by two species. All other diseases were treated by one species each (see Table 4).

Regarding of some medicinal plants popular than others, *Brillantaisia cicatricosa* was the most popular plant cited by 5 traditional healers for its medicinal value (Relative frequency of citation [RFC] = 62.5%) followed by three plant species *Senna septemtrionalis*, *Thalictrum rhynchocarpum* and *Solanum terminale* mentioned by 4 traditional healers (RFC = 50%). The species *Zanthoxylum* sp., *Rumex abyssinicus*, *Prunus africana*,

**TABLE 1:** Plant species uses by local communities as raw material.

Scientific name	Family	Vernacular name (Kinyarwanda)	Life form	Part used	Utilisation (Kinyarwanda)
<i>Stephania abyssinica</i> (Dill. & Rich.) Walp	Menispermaceae	Umuhandu	Liana	Stem	Traditional plate ( <i>inkoko</i> )
<i>Triumfetta rhomboidea</i> Jacq.	Malvaceae	Umusarenda	Shrub	Stem	Ceiling ( <i>Idari</i> )
<i>Pennisetum purpureum</i> S. humach.	Poaceae	Urubingo	Grass	Stem	Ceiling ( <i>Idari</i> )
<i>Stephania cyanantha</i> Welw. ex Hiern	Menispermaceae	Umwifuzo	Liana	Stem	Vans ( <i>ibigega</i> )
<i>Gouania longispicata</i> Engl	Rhamnaceae	Umusando	Liana	Stem or leaves	Basket ( <i>Ibitebo</i> )
<i>Urera hypselodendron</i> (A. Rich.) Wedd.	Urticaceae	Umuse	Liana	Stem	Traditional mats ( <i>Ibirago</i> )
<i>Clerodendrum rotundifolium</i> Oliv.	Verbenaceae	Umuziranyenzi	Liana	Stem	Straw for drinking the traditional beer ( <i>Umuheha</i> , <i>Imikenke</i> )
<i>Ficus thonningii</i> Blume	Moraceae	Umuvumu	Tree	Stem	Vat for fermentation of banana wine

**TABLE 2:** Name of sites and species of spiritual importance among local people.

Sites and species	Importance	Brief history
Caves	Place for spiritual rituals	Caves of Buhanga sacred forest are spiritual ritual places for local people. Before the colonisation, it is said that Rwandan kings always spend one night in caves before the first investiture the following day
Mysterious water-spring	Water-spring for the villager	In 1983, the government authorities tried to improve the water-spring of Buhanga sacred forest into modern catchment for local communities uses, it is said that the water-spring dried immediately. Later after renouncing the project, the water started flowing again. It is also said that the water from the same spring was given as bath for Rwanda former kings before coronation. Currently, people come from everywhere in the country to visit and collect the water for cultural purpose
Igishanga cya gihanga (marshland)	Place for spiritual rituals outside the sacred forest	Place for spiritual rituals for local communities. They believe that the marshland is protected by a giant snake avoiding the forest from drought. The rare appearance of the snake is a prediction of a bad event
<i>Dracaena steudneri</i> Engl.	Social symbol	A piece of bark of the species is burned and charcoals are used to burry single people (unmarried people/single) at the funeral
<i>Ficus thonningii</i> Blume	Social and spiritual symbol (respectful tree)	The species is planted at the entry of the main gate <ul style="list-style-type: none"> <li>• as a symbol of keeping something valuable (heritage) to remain in the family</li> <li>• as a symbol for showing the personality (respect) of the family</li> </ul>
<i>Erythrina abyssinica</i> Lam. ex Dc.	Social and spiritual protection	The species is planted as spiritual protection against evil spirits in the compound of the house

*Ranunculus multifidus*, *Tragia brevipes*, *Urtica massaica* and *Ajuga alba* were mentioned by 3 informants (RFC = 37.5%) while *Chenopodium opulifolium*, *Cyathula cylindrica*, *Solanum aculeastrum* and *Solanecio mannii* were mentioned by only 2 traditional healers (RFC = 25%) (see Tables 3 & 4).

Concerning plant parts used frequently for medicinal preparation, the leaves were the most used parts followed by both leaves and tree barks in human health problem representing 81% and 6% respectively. Regarding the ethnoveterinary medicine the leaves were also the most plant part used followed by both roots and tree barks and flowers representing 78% and 11% each. The majority of remedies were prepared in the form of juice from freshly collected plant parts. The juice was prepared by pounding or crushing a plant part in a wooden or stone mortar and pestles. Water was the most liquid substance used to dilute the prepared juice. The remedies were taken orally, accounting 84% of medicinal plants use, followed by external application applied typically on skin representing 8% and 5% on ear application except remedies from the species *Eucalyptus maidenii* giving anally as smoke to treat haemorrhoids and fresh leaves from *T. brevipes* rubbing on painful joint to treat rheumatism accounting both 3% (see Figure 6).

## Discussion

Taking consideration the size of Buhanga sacred forest, there is a high percentage of plants being naturally harvested in the forest by local communities. The fact that more than a half of remedies were prepared from herbs in natural habitat than cultivated or home gardens indicates that the natural area of Buhanga sacred forest is very important for local

communities to satisfy their home-based healthcare. Our finding is similar to the finding of Edwards (2004) reporting that 2/3 of medicinal plants used worldwide are harvested from the natural environment. During interview, traditional healers reported that more medicinal plants were harvested previously than now in Buhanga sacred forest and some species formerly forest-habiting species are now rarely encountered in the area. This is the case of the species *P. africana* that became extinct in the natural forest while *C. cylindrica* still existed occasionally due to overharvesting in the past. Studies involving Rwanda on medicinal plants reveal decline of these resources (Stewart 2003).

Our research findings revealed that the poison vomiting, mental diseases and *Kilondatumbo* in human health problems were the most cited diseases in our study area because remedies against these three predominant health problems were mostly prepared. In a situation where several drugs in one area are required, this indicates a prepotency of a particular disease (Dawit & Ahadu 1993). The potential of medicinal plants recorded in this study were also confirmed by other research conducted elsewhere in Rwanda (Dessouter 1991; Kamagaju *et al.* 2013; Kayonga & Habiaryemye 1987; Mbarubukeye & Niang 1996; Rwangabo 1993). As per the ethnoveterinary medicine represented mostly by tick-borne diseases, suggests that these diseases were very important in the area. According to Byavu *et al.* (2000), Mbarubukeye (1991) and Van Puyvelde *et al.* (1985), the East Coast fever (theileriosis) played a vital role in cattle mortality in Rwanda, particularly in exotic pure breed crossing with the Ankole breed while anaplasmosis and babesiosis represented an enormous cost in term of time and money. Also study conducted by Nshimiyimana and Mutandwa (2010) indicates that damages attributable to ticks borne diseases in Rwanda

**TABLE 3:** Medicinal plants used against human health problems.

Family	Scientific name	Vernacular name	Life form	Substance	Medicinal indication	Plant part used	Route of administration	Mode of preparation	RFC
Acanthaceae	<i>Barleria grandicalyx</i> Lindau.	<i>Bugangabukari</i>	Herb	Juice	Child bellybutton	Leaves	Oral	Dcmw	12.5
	<i>Asystasia</i> sp.	<i>Akanyamafundo</i>	Herb	Juice	Mental trouble	Leaves	Oral	Cmw	12.5
	<i>Brillantaisia cicatricosa</i> Lindau.	<i>Kirogora, Ikinyamugere</i>	Herb	Juice	Mental trouble	Leaves	Oral	Cmw	62.5
Agavaceae	<i>Dracena steudneri</i> Engl.	<i>Igihondohondo</i>	Tree	Powder	Mental trouble	Tree bark	Oral	Cmw	12.5
Amygdalaceae	<i>Prinus africana</i> (Hook. f.) Kalkm.	<i>Umwumba</i>	Tree	Juice	Dysentery	Leaves	Oral	Cm Aloe vera 4cswbj	37.5
				Powder	Stomach aches	Tree bark	Oral	Dcmw	12.5
Asteraceae	<i>Bidens pilosa</i> L.	<i>Inyabarasanya</i>	Herb	Juice	Mental trouble	Leaves	Oral	Cmw	12.5
	<i>Gynura scandens</i> O. Hoffm.	<i>Kizimyamuro</i>	Liana	Juice	<i>Kilondatumbu</i> †	Leaves	Oral	Cmw	12.5
	<i>Solanecio manii</i> (Hook.f.) C. Jeffrey	<i>Umutagara</i>	Herb	Juice	Poison vomiting	Leaves	Oral	Cmw	25
Cesalpiniaceae	<i>Senna septemtrionalis</i> (Viv.) Irwin-& Barneby (Syn: <i>Cassia floribunda</i> Cav.)	<i>Umukubanzoka</i>	Shrub	Juice	Intestinal worm	Leaves	Oral	Cmw	50
Chenopodiaceae	<i>Chenopodium opulifolium</i> Auct. Non-schrad.	<i>Umugombe</i>	Herb	Juice	Muscle disease, <i>Kilondatumbu</i> †	Leaves	Oral	Cmw	25
	<i>Chenopodium procerum</i> Hochst. ex Moq.	<i>Umwisheke</i>	Herb	Juice	Muscle disease	Leaves	Oral	Cmw	12.5
Cucurbitaceae	<i>Zehneria scabra</i> (L.F.) Sonder	<i>Umushishiro</i>	Liana	Juice	Mumps	Leaves	Ear	Cmw	12.5
	<i>Momordica foetida</i> Schum.	<i>Umwishwa</i>	Liana	Juice	Poison vomiting	Leaves	Oral	Cmw	12.5
Euphorbiaceae	<i>Tragia brevipes</i> Pax.	<i>Isusa</i>	Herb	Juice	Gonorrhoea, Diarrhoea	Leaves	Oral	Cmw	37.5
				Fresh leaves	Rheumatism	Leaves	Joint pain	Rlpj	12.5
Fabaceae	<i>Desmodium repandum</i> (Vahl) Dc.	<i>Ituza</i>	Herb	Juice	Heart trouble, Poison vomiting	Leaves	Oral	Cmw	12.5
	<i>Erythrina abyssinica</i> Lam.	<i>Umuko</i>	Tree	Powder	Mental disease <i>Kilondatumbu</i> †	Tree bark	Oral	Dcmw	12.5
	<i>Cajanus cajan</i> (L.) Millsp.	<i>Umukunde</i>	Herb	Juice	Mumps	Leaves	Ear	Cmw	12.5
Lamiaceae	<i>Ajuga alba</i> (Guerke) Robyns	<i>Igitingwa</i>	Herb	Juice	Poison vomiting	Leaves	Oral	Cmw	37.5
Lauraceae	<i>Persea americana</i> Millier.	<i>Ivoca</i>	Tree	Juice	Stomach trouble	Fruit	Oral	Cmw	12.5
Liliaceae	<i>Aloes</i> sp.	<i>Igikakarubamba</i>	Herb	Juice	Diarrhoea	Leaves	Oral	Cmw	12.5
Myrtaceae	<i>Eucalyptus maidenii</i> F.Muell	<i>Inturusu</i>	Tree	Smoke	Haemorrhoids	Bark	Anal	Bbwlspp	12.5
Polygonaceae	<i>Rumex abyssinicus</i> Jacq.	<i>Umufumbageshi</i>	Herb	Juice	<i>Kilondatumbu</i> †	Leaves	Oral	Dcmw	12.5
Primulaceae	<i>Lysimachia ruhmeriana</i> Vatke.	<i>Umuyobora</i>	Herb	Juice	Stomach trouble	Leaves	Oral	Dcmw	12.5
Ranunculaceae	<i>Ranunculus multifidus</i> Forsk.	<i>Kazingashya</i>	Herb	Juice	Fracture,	Leaves	Broken part	Cmwai	37.5
				Powder	Poison vomiting	Leaves	Oral	Dcmw	12.5
	<i>Thalictrum rhynchocarpum</i> Dillon ex. A. Rich	<i>Ubugomboro</i>	Herb	Juice	Snakebites	Leaves	Oral	Cmw	50
Rhamnaceae	<i>Gouania longispicata</i> Engl.	<i>Umusando</i>	Liana	Juice	Foetal trouble	Leaves	Oral	Cmw	12.5
	<i>Rhamnus prinoides</i> Lihert.	<i>Umunanira, umusasa</i>	Tree	Juice	Poison vomiting	Leaves	Oral	Cmw	12.5
Rutaceae	<i>Clausena anisata</i> (Willd) Hook. F ex. Benth	<i>Umuzo</i>	Shrub	Juice	Varicela, scabies	Leaves	Skin lesions	Cmw	12.5
	<i>Zanthoxylum</i> sp. (Engl.)	<i>Intare y'irungu</i>	Tree	Powder, Juice	Gonorrhoea	Tree bark	Oral	Cmw	37.5
Solanaceae	<i>Solanum terminale</i> Forsskal.	<i>Umuhanurankuba</i>	Herb	Juice	Placenta retention	Leaves	Oral	Cmw	37.5
Urticaceae	<i>Urtica massaica</i> Mild Br.	<i>Igisura</i>	Herb	Juice	Gonorrhoea	Roots	Oral	Cmw	37.5
Verbenaceae	<i>Clerodendrum fuscum</i> Guerke	<i>Umumara</i>	Liana	Juice	Poison vomiting	Leaves	Oral	Cmw	12.5

RFC, Relative frequency of citation; Cmw, Crushed and mixed with water; Cm Aloe vera 4cswbj, Crushed and mixed with Aloe vera (4 coffee spoons) then swallow with banana juice; Dcmw, Dried, crushed and mixed with water; Rlpj, Rubbing the leaves on the painful joints; Bbwlspp, Boil the bark with water and lead the smoke with a small plastic pipe; Cmwai, Crushed and mixed with water then applied immediately.

Kilondatumbu †, painful sensation in the digestive system with presence of ulcers in the ileum and rectum.

were considered as the first economic damage of bovine production transmitting sucking blood parasites diseases such as theileriosis, anaplasmosis and babesiosis.

With more than 70% of leaves use as ingredient in making of medicinal concoction indicates that leaves are more required to solve the health problem in our study area. In reference to Dawit and Ahadu (1993) and Poffenberger *et al.* (1992), the normal harvesting leaves estimated of up to 50% does not significantly affect the growth of plant species or does not cause a great danger to existence of individual plant when compared to the collection of underground part, stem or whole plant from both ecological points of view and survival of species. The

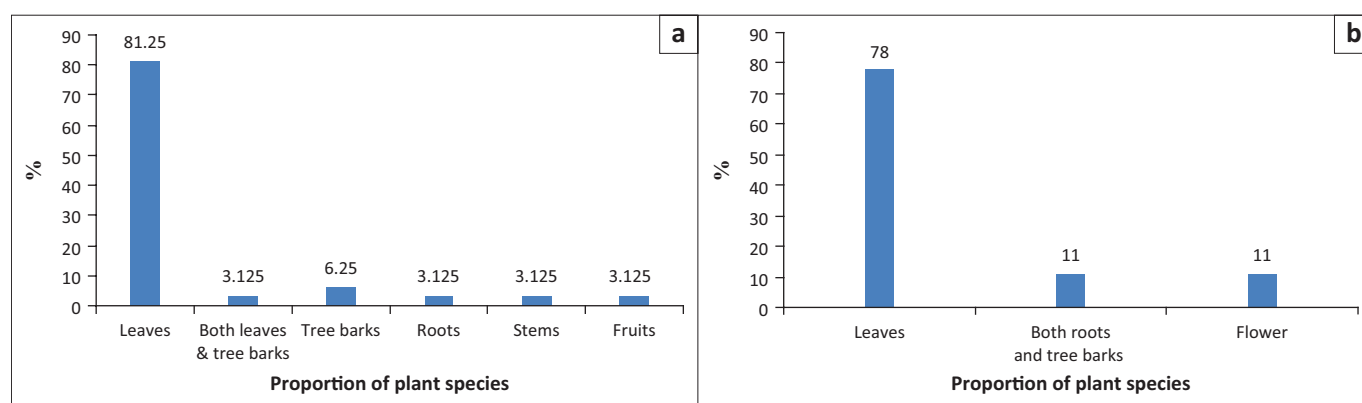
extinction of *P. africana* as reported by the healers is due to overutilisation of both its leaves and barks as ingredients and was replaced by agricultural activities. The same were reported by Sayer, Harcourt and Collins (1992) Stewart (2003) and MINITERE (2003). In general there was no really threat of overharvesting of plant in Buhanga sacred forest as it used to be in the past because the remedies are prepared and used locally, and therefore harvested in small quantities. Traditional healers reported that they do not store remedies for a prolonged period of time because when the need comes, they go out to collect plants, prepare the remedies and use it for treatment. However the importance of Buhanga were known a long time ago, this sacred forest has acquired since 2005 a status of



**TABLE 4:** Plants used in veterinary medicine.

Scientific name	Vernacular name	Family	Life form	Substance	Medicinal indication	Plant part used	Route of administration	Mode of preparation	RFC (%)
<i>Zanthoxylum</i> sp.(Engl.)	Intarey'irungu	Rutaceae	Tree	Juice, powder	Babesiosis (Umushitwe)	Roots, Tree bark	Oral	Dcmw	37.5
<i>Basela alba</i> L.	Urunyaŋja, Ururarama	Baselaceae	Liana	Juice	Anaplasmosis (gasheshe)	Leaves	Oral	Cmw	12.5
<i>Cyathula cylindrica</i> Moq.	Igifashi	Amaranthaceae	Herb	Leaves	Cow cannot feed the calf	Inflorescent	Udder	Rucl	25
<i>Agrostis</i> sp.	Urwiri	Poaceae	Herb	Leaves	Injury	Leaves	Skin	Acl	12.5
<i>Senna septemtrionalis</i> (Viv.) Irwin & Barneby	Umukubanzoka	Cesalpiniaceae	Shrub	Juice	Diarrhoea	Leaves	Oral	Cmw	50
<i>Rumex abyssinicus</i> Jacq.	Umufumbageshi	Polygonaceae	Herb	Juice	Sexual arousal	Leaves	Genital part	Acl	12.5
<i>Rumex usambarensis</i> (Eng) Dammer	Umufumba	Polygonaceae	Herb	Juice	Sexual dysfunction	Leaves	Genital part	Acl	12.5
<i>Solanum aculeastrum</i> Dunal.	Intobokarema	Solanaceae	Herb	Juice	East Coast Fever (ikibagarira)	Leaves	Oral	Cmw	25
<i>Lobelia gibberoa</i> Hersley	Intomvu	Lobeliaceae	Herb	Juice	East Coast Fever (ikibagarira)	Leaves	Oral	Cmw	12.5

Dcmw, Dried, crushed and mixed with water; Cmw, Crushed and mixed with water; Rucl, Rubbing the udder of cow with leaves; Acl, Apply crushed leaves; RFC, Relative frequency of citation.



Source: Association for the Conservation of Nature in Rwanda, 2008

**FIGURE 6:** Proportion of plant parts used for human and cattle health problems: (a) Proportion of plant parts used for human health problems; (b) proportion of plant parts used for cattle health problems.

protected area as a part of the Volcanoes National Park from the former Rwanda Office of Tourism and National Parks (ORTPN), now Rwanda Development Board (RDB) (REMA 2009). In the same context, culture and spiritual beliefs plays an important aspect in the conservation of Buhanga sacred forest. Recently, water springs from Buhanga are still used as source of clean water for local people in the area and caves and some tree species (*Dracaena steudneri*, *Erythrina abyssinica* and *Ficus thonningii*) are important for their ritual and ceremonies.

## Conclusion

This study has revealed the importance of traditional ecological knowledge in Buhanga sacred forest plays a vital role in our heritage. The high plant diversity used in traditional medicine to treat different ailments was localised mostly in the natural habitat and does not really present threat of overharvesting because remedies are prepared on a need-to-need basis. Also this study has shown how cultural values and beliefs are crucial tools for conservation and should therefore be incorporated in all management plans of Buhanga sacred forest.

In light of this research finding, we recommended that traditional healers should be trained on how to domesticate natural plant species as some of them has becoming rare or

extinct in the surrounding area due to past anthropogenic activities. Among others 15 species were documented and reported in our study area as priority species for preservation of stored grains for their medicinal importance uses. These include: *B. cicatricose*, *S. septemtrionalis*, *T. rhynchocarpum*, *S. terminale*, *Zanthoxylum* sp., *R. abyssinicus*, *P. africana*, *R. multifidus*, *T. brevipes*, *U. massaica*, *A. alba*, *C. opulifolium*, *C. cylindrica*, *S. aculeastrum* and *S. mannii*.

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## Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

## Authors' contributions

N.J.S. was the project leader, M.V., B.E. and B.N. made conceptual contribution, N.M. was involved in data collection and R.I. was responsible for data collection and analysis, writing up the article and project design.

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## Appendix 1



Source: Association for the Conservation of Nature in Rwanda, 2008

**FIGURE 1-A1:** (a) Photo showing the village surrounding the study area, (b) one of the group discussion with local indigenous, (c) and some important sites and species of Buhanga sacred forest including the mysterious water-spring, (d) cave (e) and *Dracaena steudneri* (Igihondohondo).



# REMARKABLE EXPERIENCES REMARKABLE PLACES



Source: Remarkable Rwanda, <http://www.rwandatourism.com>

**FIGURE 2-A1:** Remarkable places in Rwanda.