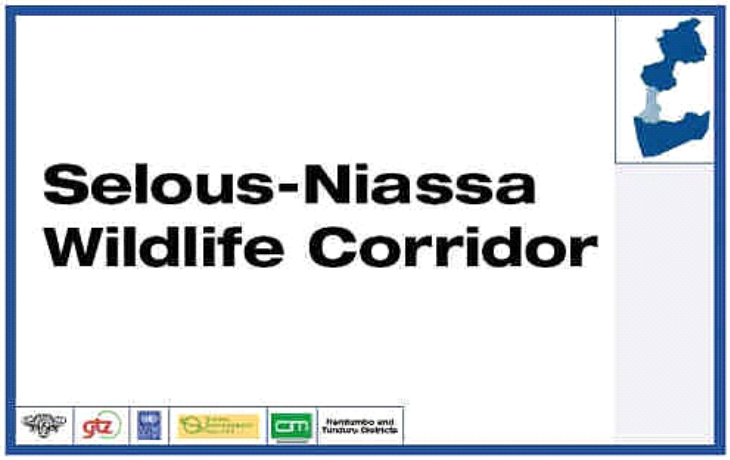
**THE UNITED REPUBLIC OF TANZANIA**

**Ministry of Natural Resources and Tourism**

**WILDLIFE DIVISION**




**IN CO-OPERATION WITH**

**ADAP**

# MUSHROOM STUDY

## The potential of wild edible mushrooms in the miombo woodlands of the Selous - Niassa Wildlife Corridor for the livelihood improvement of the local population

**APRIL 2008**

**Consultants: Dr. Urs Bloesch, *www.adansonia–consulting.ch***

**Frank Mbago, Botany Department, University of Dar es Salaam**

# THE DEVELOPMENT AND MANAGEMENT OF THE SELOUS – NIASSA WILDLIFE CORRIDOR

**UNDP/GEF project no.: 00038545**

**GTZ-IS project no.: 55.3024.1 – 001.00**

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## Acknowledgements

We want to express our sincerest thanks to the Namtumbo District authorities for their confidence and support of this mission. We are grateful to the projects SNWC (UNDP/GEF/GTZ-IS) and Integrated Beekeeping Management Selous-Niassa Corridor (ADAP) for financing this study. Special thanks go to SNWC-Project Manager Kassim Ngomello and the Technical Adviser Rudolf Hahn for the professional preparation of the consultancy and their commitment. Our warm thanks go to Irene Mbonde, ADAP-Community Development Officer, for her commitment and leading role in the socio-economic studies. We are grateful to Ndomondo Issa, Namtumbo District Game Ranger for his kindness and guidance all along the fieldwork. Particular thanks go to Emmanuel Banda who did not only drive us safely through the Corridor but also was an excellent cook.

# 1. Introduction

The Selous-Niassa miombo woodland ecosystem of southern Tanzania and northern Mozambique is one of the largest and for the global biodiversity most significant, trans-boundary natural ecosystems in Africa, covering over 154,000 km$^2$ (see Fig. 1). Through a network of protected areas of various categories of protection, an area of 110,685km$^2$ of this ecosystem is conserved. Two Game Reserves are critical for the protection of this globally important area: the Selous GR, which covers 47,000km$^2$ making it the largest protected area in eastern and central Africa, and the Niassa GR, Mozambique's largest protected area covering 42,400 km$^2$. The Selous-Niassa Wildlife Corridor provides a significant biological link between the two reserves and consequently for the miombo woodland ecosystem. But there are severe threats to its continued existence, which if left unattended, will block this important link.

The Selous-Niassa Wildlife Corridor will be protected with a network of village Wildlife Management Areas. These areas are designated for community natural resource management with a focus on wildlife. The communities of the Corridor are highly dependent on natural resources, but over-utilisation or destructive practices endanger the resource base making law enforcement and the implementation of management and conservation schemes necessary. In order to increase the acceptance of conservation, the project aims at the improvement of the livelihood of the local communities by promoting sustainable use of natural resources from the Corridor.

Mushrooms are fruiting bodies of higher fungi. Fungi are neither plants nor animals and they are nowadays classified as a distinct kingdom of their own, the Fungi. Mushrooms are known to be abundant in the miombo woodlands in Southern Africa and in Tanzania (Härkönen et al. 2003) because almost all of the trees are ectomycorrhizal: Their roots live in symbiosis with mushroom mycelia. Many of the mushrooms are edible and have high nutritional and energy values (Härkönen et al. 2003). Mycorrhiza represents a mutually beneficial (symbiotic) relationship between the fungi and trees. In the case of ectomycorrhiza[1], the fungal hyphae encircle the roots and the spaces in between the cells of the root bark. The mycelium also spreads into the soil around the tree, thereby increasing tremendously the water- and mineral-absorbing area in soil for the benefit of the tree. In return, the fungal partner which cannot photosynthesize and produce food by itself receives carbohydrates from the tree. Mycorrhizal fungi are highly specific to theirs host: usually a certain tree species (or genus) co-occurs with a few mycorrhizal mushroom species only.

Over 60 edible mushroom species have been identified in Tanzania (Buyck et al. 2000; Tibuhwa 2001; Härkönen et al. 2003). Mushrooms are frequently collected in southern Tanzania by the local population, mainly for own consumption. Fresh, but also dried mushrooms are sold at market places and along roadsides. It is reasonable to assume that a considerable commercialisation potential at regional, national and international level exists. Thus, domestic use and better marketing of wild mushrooms could contribute to improve the

[1] In the case of endomycorrhiza, the fungal hyphae penetrate into the cells of the root. Most trees and shrubs in semi-arid *Acacia* savannas have endomycorrhiza but these so-called lower fungi do not produce visible fruit bodies.

livelihoods and to reduce the poverty of the local communities within the SNWC as recommended by Bloesch & Mbago (2006).

The study has been split in two parts to be carried out in two subsequent rainy seasons (see TOR in Annex B). Part two of the study will be financed by ADAP and KfW through the Selous-Niassa Wildlife Protection Corridor project and carried out in a complementary mushroom fructification period during the coming rainy season 2008/09. This approach will also allow assessing a wider range of edible mushrooms since the fructification and collection period of many mushrooms is highly seasonal.

This first part of the study was mandated by the project SNWC-UNDP/GEF/GTZ-IS and the project Integrated Beekeeping Management Selous-Niassa Corridor of ADAP, Switzerland and carried out from 21/1 to 31/1/08 (see itinerary and people met in Annex C). It focussed on:

- Inventory of wild mushrooms which are edible or having medicinal uses; assessment of their fructification period; vegetation description of their habitat.
- Assessment of the current use and commercialisation of mushrooms by the local communities (species, conditioning, existing local markets).

After the joint fieldwork, ADAP conducted a first assessment of the sale of mushrooms at the markets of Songea and Tunduru. The major findings of this preliminary market study are included in this report. In addition, the vegetation description of the mushroom sites together with opportunistic sampling throughout the fieldwork gave us the opportunity to complete the previously established plant checklist of the SNWC (see Bloesch & Mbago 2006).

## 2. Study area

The proposed Selous-Niassa Wildlife Corridor (*Ushoroba*) in Ruvuma Region of Southern Tanzania has an area of about 10,000 km$^2$ (see Fig. 1) extending approximately from 10° S to 11°40' S. The larger part of the Corridor is located in Namtumbo District while a smaller part in the east incorporates Tunduru District. The Corridor borders the Selous GR (North East Undendeule FR) in the north and the Niassa GR in Mozambique along the Ruvuma River in the south.

The northern part is generally hilly while the area towards the Ruvuma River is slightly undulated to flat with isolated hills, some of them having prominent rock outcrops (inselbergs). Mtungwe Mountain (1284m a.s.l.) in the centre of the Corridor is the highest elevation. The plateau slightly slopes to the Ruvuma River which reaches its lowest level of about 460m a.s.l. in the south-eastern corner of the Corridor. The soils are generally very sandy and washed-out. Two drainage basins exist in the SNWC. North of the watershed, located roughly along the main Road Namtumbo-Tunduru, the rivers drain into the Rufiji River while the area south of the watershed is part of the Ruvuma drainage basin. Some of the major tributaries like Mbarangandu, Lukimwa, Luchulukuru, Luego or Msanjesi are usually permanent watercourses.

The Corridor has the typical unimodal rainfall system of the miombo woodland ecosystem (Bloesch 2002). The southeast monsoons, bearing moisture from the Indian Ocean, are responsible for the rainy season chiefly occurring from mid-November to mid-May, however inter-annual variations are important. Northeast winds prevail in the dry season and there is usually no measurable rain for at last five months but fog may sporadically occur at higher elevations.

The mean annual rainfall at Soluti Agricultural Sub-research Station (about 8 km west of Namtumbo town) is about 1230 mm (see Annex D). The rainfall in the Corridor generally decreases from the northern part with about 1200-1300 mm rainfall per year towards the south having a mean annual rainfall of about 800 mm along the Ruvuma River. The aridity of the sites towards the Ruvuma River is further enhanced by higher evapotranspiration due to lower altitude and more sandy soils. The variability of mean annual rainfall is quite high with 24 % using the coefficient of variation defined as standard deviation expressed as % of the mean (Norton-Griffiths et al. 1975). The coefficient of variation is an indicator for the predictability of rainfall and therefore an important factor for crop production. Maximum rainfall per rainy season occurred 1997/98 with 1708 mm, followed by 2006/07 with 1691 mm. Mean monthly rainfall is highest in March with 304 mm having also the highest reliability of all months regarding rainfall. The mean annual temperature is about 21°C and the climate type following the Köppen system is Aw (Köppen 1931).

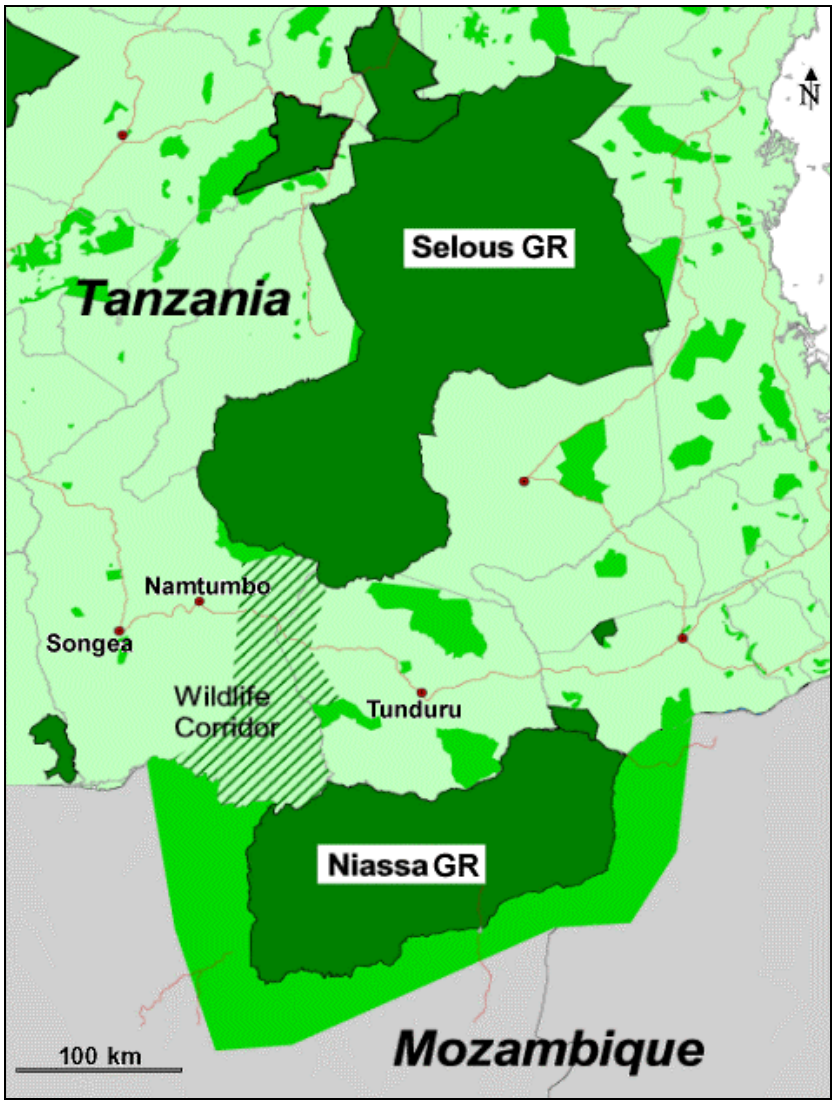


**Fig. 1.** Map of the Selous-Niassa Wildlife Corridor connecting the miombo woodland ecosystems.

Two major ecosystems occur within the Corridor (Bloesch & Mbago 2006):

(1) The miombo woodland covers at least two thirds of the Corridor with a wetter type, usually having more than 1,000 mm of rainfall per year and a drier type, usually having less than 1,000 mm of rainfall per year (White 1983). The vegetation structure and floristic composition of both miombo types is fairly homogeneous over large areas and only slightly influenced by the topographic position. Trees from the *Caesalpiniaceae* family are largely dominating: Several species of *Brachystegia* occurring either alone or together with *Julbernardia globiflora*. These typical miombo species do not occur in other vegetation types like the adjacent savannas or riverine forests. Because the dominants of miombo are extremely gregarious, few other species enter the canopy. The principal canopy associates are *Parinari curatellifolia*, *Pericopsis angolensis* and *Pterocarpus angolensis*.

(2) The savanna landscape occupies the southern part of the Corridor along the Ruvuma River where the rainfall is lowest. More drought tolerant species typical for savanna ecosystems and widely absent in the miombo woodland prevail: *Acacia* spp., *Adansonia digitata*, *Combretum* spp., *Bauhinia tomentosa*, *Dalbergia melanoxylon*, *Dichrostachys*

*cinerea*, *Euphorbia candelabrum*, *Oxytenanthera abyssinica*, *Piliostigma thonningii*, *Sclerorcarya birrea* and *Stereospermum kunthianum*.

Dry evergreen forest patches of various shapes and smaller sizes are scattered within the two major ecosystems including different types of dry evergreen riverine forests, thickets on termite hills and vegetation associated with rock outcrops and grasslands (*Mbuga*). Vast areas are annually burnt and late dry season fires are severe due to the prolonged dry drought.

Namtumbo District is sparsely populated having only 11 people per $km^2$ according to the population census 2002. The dominating ethnic groups within the 29 villages participating in the management of the Corridor are Yao people followed by Ndendeule people who are mostly settled in the northern part. The economy within the two districts depends on agricultural crop production. Maize, beans and paddy are mainly cultivated for subsistence while in some areas cashew-nuts, sesame and tobacco are grown as cash crops. In contrast to other miombo woodlands, livestock keeping is poorly developed and the Corridor area is not used for cattle ranching.

## 3. Methods

This study was conducted along a decreasing rainfall gradient from north to south (considering the accessibility of an area) including 6 villages of Namtumbo District (Nambecha, Likuyu Seka, Milonji, Matapwende, Amani, and Magazini) and Marumba village of Tunduru District. The assessment of a site was done in two steps: interviews in the village and subsequent field visit together with the mushroom hunters. First we introduced ourselves to the village authorities as far as possible on the previous day what allowed them to mobilise the key informants. 33 key informants where interviewed, whereof twenty four women and 9 men aged between 25 and 65 and 35 and 65 years, respectively (4-6 key informants per village, see Fig. 2). The questionnaire focussed on the recognition and use of wild mushrooms, including vernacular name, fructification period, edibility, medicinal uses, habitat of mushroom sites, mushroom picking, consumption, reserving techniques, marketing, and villagers suggestions (see questionnaire in Swahili in Annex E). The interviews were led by Irene Mbonde and Issa Ndomondo (Frank Mbago). At the same time an open group discussion with key informants not busy with the interview and other interested villagers were animated by the teamleader. We used the colour photographs in the book from Härkönen et al. (2003) to obtain more vernacular names and people's opinions about a particular species. These group discussions allowed us to check and complete some of the information received from the questionnaires. After the interviews/group discussions the key informants brought us to some of their usual mushroom picking sites (see Fig. 3).

**Fig. 2.** Interview with key informants at Amani (interviewer Irene Mbonde).

All mushrooms mentioned and/or found in the miombo woodlands are listed in Table 1 including vernacular (Ndendeule and/or Yao) and scientific names, edibility and location. The book from Härkönen et al. (2003) was very helpful in the identification of the mushrooms since it gives also the vernacular names of the mushrooms. Representative fruit bodies of all found mushrooms were systematically photographed what allowed the subsequent verification/identification at least at genus level by Dr. Mshandete from the Department of Molecular Biology and Biotechnology, University of Dar es Salaam and by Mrs Silvia Feusi and Mr. André Gindrat, both mushroom specialists from Switzerland. The edibility of each eatable mushroom was evaluated by the locals in comparison with other mushrooms. For the edibility rating we followed Härkönen et al. (2003):

* = edible species
** = good edible species
*** = edible, delicious

The habitat of each mushroom picking site has been described (Annex G). We focussed on the tree (shrub) species due to their intimate relationship with mushrooms (Härkönen et al. 2003). At each site the tree and shrub layer was studied in an area of 25x25m. Cover value and height of the tree/shrub layer and other habitat notes including the coordinates of the site were taken. Cover-abundance values of all species having at least a value of 1 were recorded, using the scale from Braun-Blanquet (1932):

5: Any number, with cover more than ¾ of the reference area (> 75 %)
4: Any number, with cover ½ - ¾ cover (50-75 %)
3: Any number, with cover ¼ - ½ cover (25-50 %)
2: Any number, with cover 1/20 - ¼ cover (5-25 %)
1: Numerous, but less than 1/20 cover, or scattered, with cover up to 1/20 (5 %)

**Fig. 3.** Mushroom picking site at Naheno area, Likuyu Seka.

A first assessment of the sale of mushrooms was carried out at the central market of Songea and in local markets (*Soko Mjinga*) in Songea and Tunduru (there were no mushroom sold at the central market of Tunduru at the time of the survey). The questionnaire has been jointly prepared with ADAP, which carried out the market study after the socio-economic study at the village level (see questionnaire in Swahili in Annex F). In total 17 sellers were interviewed.

Opportunistic collection and observations of tree, shrub and ground floras throughout the fieldwork completed the previously established plant checklist (Bloesch & Mbago 2006). In addition we surveyed the inselberg of Chuma mbili (near Amani) since this kind of rock outcrop was not sampled in the vegetation survey of the Corridor in 2006. Uncertain plants were identified/confirmed at the herbarium of the Department of Botany, University of Dar es Salaam.

# 4. Results

## 4.1 Species inventory and fructification period

The best mushroom specialists in villages are usually elderly women who frequently pick the mushrooms together with their children. During our field studies we recorded in total 57 mushroom species from 22 genera belonging to 15 families (see Table 1). Out of the recorded 57 species 30 could be identified at species level, and 23 at genus level only. 4 species could not yet been identified. Several species were only mentioned by the locals during the interviews and were not seen in the field. Those which could be identified with the book from Härkönen et al. (2003) are written in *italic* and included in Table 1. Those which could not be identified are the following: *Katogwa*, *Mangaukau* (synonym: *Mangunguli*), *Mgovala*, *Nakahuko*, *Kancheke*, *Upelepete*, (all Ndendeule names); *Chimwagansanga*, *Kalungeja*, *Maholoko*, *Makulukutu*, *Nakabibi*, *Nakateleza*, *Ndeuyalamu*, *Ukwalo*, *Uyonjwe* (all Yao names).

The interviewees in one village recognised 15-20 (Ndendeule) and 25-30 (Yao) wild edible mushrooms, respectively. People pay no attention to those mushrooms which are not eaten, and hence they have no local name and are systematically considered as poisonous (*ukavo* or *ikoko* in Ndendeule and Yao, respectively). All recorded species belong to the Basidiomycota, which produce spores from a so-called basidium. The most common families in the Corridor are as follows:

*Amanitaceae*: The genus *Amanita* is typical for miombo woodlands and quite easy to identify. A striking characteristic is the sac-like volva at the stipe base which surrounds the developing fruit body. Another character of Amanita is the ring (annulus) on the stipe, but it is not always present. Eight species have been distinguished whereof five of them have still to be named scientifically. The cup-like remnant of universal veil surrounding the stipe (the volva) is characteristic for this genus. The fungus emerges like a white egg, before splitting at the apex to reveal the cap (see front page with *Amanita loosii*).

*Boletaceae*: Typical of *Boletaceae* is that instead of gills they have tubes. Many species are bright-coloured, and often bruised pore surface and exposed flesh show rapid and bright colour changes. The genus *Afroboletus* is purely tropical African. The genus *Boletus* includes stout, robust species with regularly convex cap, which is not slimy, but glabrous to tomentose. Contrary to Boletus, *Suillus*[2] can be identified by the cap, which is slimy or viscid, at least in moist weather and yellow or brownish tubes and pores.

*Cantharellaceae*: Chanterelles are the prominent species of the miombo woodlands of the Corridor and very abundant. All chanterelles are easily recognised by their fleshy and firm fruit bodies, which are often trumpet- or funnel-shaped (see Fig. 4). Most tropical species are brightly coloured: yellow, orange, pink or red, but some are grey or even black. Smell is usually fruity and very pleasant.

[2] Recently *Suillus* has been moved into *Suillaceae*.

## Table 1. Recorded mushroom species

| Mushroom species | Ndendeule | Yao | Edibility | Locality |
|---|---|---|---|---|
| Agaricaceae | | | | |
| *Macrolepiota dolichaula* | | | (**) | Amani, termitaria |
| Amanitaceae | | | | |
| Amanita loosii | Ulelema | Utenga | *** | Iringa/Amani |
| | | | | Marumba, Kaunde |
| Amanita masasiensis | Kagongoro | Nakajongoro | */** | Iringa/Amani |
| Amanita tanzanica | Kagongoro | Nakajongoro | (*/**) | Kitonye H./Marumba |
| Amanita sp. 1 | | Nakajete[2] | * | Ubueti/Milonji |
| | | | | Iringa/Amani |
| Amanita sp. 2 | | | | Magemani/Magazini |
| Amanita sp. 3 | | Nandotindoti | * | Magemani/Magazini |
| Amanita sp. 4 | | | | Nambecha |
| Amanita sp. 5 | | | | Amani |
| Boletaceae | | | | |
| Afroboletus luteolus | | Nakatunu/ | */** | Kitonye H./Marumba |
| | | Nakakong'o | | Iringa/Amani |
| *Boletus pallidissimus* | | *Maoloko* | | Marumba |
| *Boletus spectabilissimus* | | *Magoma ya karunga* | (*) | Marumba |
| Boletus sp. 1 | | Magoma ya karunga | * | Kitonye H./Marumba |
| Boletus sp. 2 | | Magoma ya karunga | * | Kitonye H./Marumba |
| Suillus sp. 1 | Ngoma ya nyani | Magoma ya majani[3] | | Nambecha fallow |
| | | | | Mabanzini/Matapw. |
| Suillus sp. 2 | dito | dito | * | Ubueti/Milonji |
| Suillus sp. 3 | | | | Kitonye H./Marumba |
| Cantharellaceae | | | | |
| Cantharellus congolensis | | Chipatwe che piliu | ** | Kitonye H./Marumba |
| Cantharellus cf. floridula | Unguyugu mdogo | Nakachejwa | *** | Kaunde Camp |
| | | | | Chuma mbili |
| | | | | Kitonye H./Marumba |
| Cantharellus isabellinus | Unguyugu | Upatwe/ | *** | Nambecha |
| | | Chipatwe cha njano | | Ubueti/Milonji |
| | | | | Mabanzini/Matapw. |
| | | | | Kitonye H./Marumba |
| *Cantharellus platyphyllus* | | *Kunguru kwetiti* | (***) | Marumba |
| Cantharellus symoensii | Unguyugu | Kunguru kwetiti | ** | Kitonye H./Marumba |
| | | Chipatwe cha njano | | Naheno/Likuyu S. |
| | | | | Ubueti/Milonji |
| Coriolaceae | | | | |
| Gloeophyllum sp. | | | | Sasawala R.; wooden board |
| Pycnoporus sanguineus | | | | Sasawala R.; wooden board |
| Pycnoporus sp. | | | | Naheno/Likuyu Seka; on dead wood |
| Clavariaceae | | | | |
| Clavaria sp. | | | | Kitonye H./Marumba |

| | | | | |
|---|---|---|---|---|
| Clavulinaceae | | | | |
| Clavulina wisoli | | Ndenzya lamu | | Ubueti/Milonji<br>Mabanzini/Matapw.<br>Marumba |
| Ganodermataceae | | | | |
| Ganoderma sp.[5] | | | | Katoto/Magazini, on Pericopsis a. |
| Humphreya eminii | | | | Amani; on roots |
| Lycoperdaceae | | | | |
| Bovista sp. 1 | | | | Katoto/Magazini |
| Bovista sp. 2 | | | | Kitonye H./Marumba |
| Polyporaceae | | | | |
| *Pleurotus sajor-caju* | | *Utanda zima* | * young | Marumba |
| Pleurotus sp. | Ulundi | Nakazohuu | * | Amani; on roots |
| Russulaceae | | | | |
| *Lactarius edulis* | | *Uboa* | (**) | Marumba |
| Lactarius gymnocarpoides | | Nakasuku | ** | Iringa/Amani<br>Marumba |
| *Lactarius kabansus* | Kambalakata | Nakambalakata | (*) | Marumba |
| Lactarius cf. volemoides | | | | Magemani/Magazini |
| Lactarius volemoides | Chaundila | Nakandanga | * b&d | Kaunde<br>Magemani/Magazini |
| Russula cellulata | Uhinda | Usinda | ** (d) | Nambecha fallow<br>Likuyu Seka |
| *Russula ciliata* | | *Nakatelezya* | (* b&d) | Marumba |
| *Russula compressa* | | *Lipalapi* | (* b&d) | Marumba |
| Russula congoana | Unguwala | Chikoko | */not eaten | Kaunde<br>Chuma mbili |
| Russula sp.? | Upoa or Masikio ya jeuri | | *** | Naheno/Likuyu S. |
| Russula sp.? | Likanganchunela | | * only dry | Naheno/Likuyu S. |
| Russula sp. | | Nakatandi | | Marumba Guest H. |
| Sclerodermataceae | | | | |
| Scleroderma verrucosum? | | | | Marumba Guest H. |
| Rhizopogonaceae | | | | |
| Rhizopogon sp. | Litongo la huruku[4] | | *[1] | Naheno/Likuyu S.<br>Ubueti/Milonji<br>Mabanzini/Matapw. |
| Thelephoraceae | | | | |
| Cymatoderma sp. | | Unguyugu mkubwa | | Ubueti/Milonji |
| Tricholomataceae | | | | |
| Clitocybe sp. | | | | Amani |
| *Termitomyces eurrhizus* | | *Nakazowu* | ** | Amani, Marumba; agric. fields |
| *Termitomyces letestui* | | *Utembo, Uzawi wachimatila* | ** | Amani, Marumba; agric. fields |
| *Termitomyces microcarpus* | | *Urundi* | ** | Marumba |
| *Termitomyces singidensis* | | *Namajete* | ** | Marumba; agric. f. |
| Family not known | | Chikoko | * b&d | Iringa/Amani |
| | | Nakambarakata (verify name) | | Iringa/Amani; on dead wood |
| | | Hairy fungus | | Katoto/Magazini<br>Kitonye H./Marumba |
| | | Livangwe | *** | Kitonye H./Marumba |

| **N all species 57** | **N edible species 35** |
|---|---|

Locality: miombo woodlands when not specified; mushrooms written in *italic*: not seen in the field; (*) edibility rating according to Härkönen et al. 2003; b = boiling; c = drying.
1) Grilled without skin and eaten by children
2) Swahili: *Chumir*
3) also Swahili
4) Swahili: *Mpumbu za ngorombwe*
5) Powder used against cough and asthma

**Fig. 4.** *Cantharellus isabellinus* the most common chanterelle within the Corridor (Kitonye Hill, Marumba).

*Russulaceae*: This family comprising the two genera *Lactarius* and *Russula*, is extremely common among the miombo woodlands of the Corridor. Both genera have brittle flesh. *Lactarius* species (milk caps) exude milky or clear latex when broken open. *Russula* species have usually brightly coloured smooth caps and do not exude milky latex when bruised (see Fig. 5).

**Fig. 5.** *Russula congoana* at Chuma mbili.

*Tricholomataceae*: We found only one specimen of the genus *Clitocybe* but no specimen of the conspicuous termite mushrooms *Termitomyces*. This tropical genus is typified by symbiotic life together with termites. *Termitomyces* cultivate the mycelium in their nests and fruit bodies can be seen arising on or near the mounds. Due to this special way of growth, the central stipe of *Termitomyces* is prolonged into an underground pseudorrhiza, a root-like extension of the stipe, connected to the fungus comb in an underground termite nest.

## 4.2 Edibility

35 species out of 57 recorded species are eaten by people (see Table 1). All interviewed people valued mushrooms as food very highly. *Amanita loosii*, three chanterelles (*C. isabellinus*, *C.* cf. *floridula* and *C. platyphyllos*) and one unknown *Russula* species are preferred to any other kind of food, even meat. The fleshy *Cantharellus isabellinus* is very common throughout the miombo woodlands of the Corridor. *Boletaceae* and *Russulaceae* are not eaten anywhere and mostly only taken when more priced mushrooms are not abundant. All *Termitomyces* would be edible and most are considered superior to all other mushrooms but none was recorded (see 5.1).

## 4.3 Medicinal uses

The interviewed people mentioned only one mushroom species having medicinal uses. The polypores *Ganoderma* sp. (see Fig. 6) grows exclusively on *Pericopsis angolensis*. In the Magazini area its powder is used to treat cough and asthma. The powder is received by first burning the mushroom what facilitate the subsequent grinding. The powder mixed with salt is then directly swallowed by the patient.

**Fig. 6.** Powder of *Ganoderma* sp. is used for treating cough and asthma (Katoto area, Magazini).

## 4.4 Habitat of mushroom sites

The average walking distance from the village to mushroom picking sites is about two to three hours (about 4 to 8 km) since most of the mushrooms found grow in the miombo woodland or in older fallow lands which are not in the vicinity of the villages. The walking distance to *Termitomyces* sites is certainly shorter since they are abundant in the ruderal areas (pasturelands and cropland) around the villages.

The common trees and shrubs (having cover-abundance values of at least 1) are given in Annex G. The data are too limited for identifying the specific host tree of a given mycorrhizal mushroom species.

## 4.5 Mushroom picking

The tradition of collecting edible mushrooms is still very alive in the Corridor area. Almost exclusively women and children go on a mushroom foray. All interviewed people got their mushroom knowledge from their family, i.e. one generation passes the knowledge to the next only verbally. The children are taken at young age by their mothers to the field to learn and pick mushrooms, as well as other natural products. The transport of large quantities of mushroom close-packed in a large bag is not appropriate since the mushrooms risk to be spoiled rapidly (see Fig.7).

**Fig. 7.** Close-packed mushrooms risk to be spoiled rapidly (Likuyu Seka).

## 4.6 Consumption and preserving techniques

Most households are eating three to four times a week mushroom when they are available during the rainy season (usually two meals per day). The surplus is preserved by drying. This is the only method of preservation applied by the locals within the Corridor. Mushrooms are cut into pieces and spread on a mat or iron sheet in the sunshine. Usually, mushrooms are boiled before drying (only *Mangaukau*/*Mangunguli* is directly dried).

## 4.7 Marketing

In the surveyed villages almost all mushrooms are collected for own consumption. Only at Likuyu Seka, Lusewa, Magazini and Marumba mushrooms are sold at the village markets. The prices varying between 50 and 100 TSh for 150-200 g.

According to the preliminary market studies in Songea and Tunduru all mushrooms are sold fresh. Customers prefer fresh mushrooms because they do not trust the preservation techniques. The most widely preferred and sold mushrooms are *Cantharellus isabellinus* followed by *C. symoensii* (see Fig. 8). Sometimes several chanterelles species are mixed together. The prices varying between 200-500 TSh per 150-200 g for Songea and 200-600 TSh per 200-400 g for Tunduru. The mushrooms come from different places of Ruvuma Region in the case of Songea, and from several villages of Tunduru District in the case of Tunduru market. Some dealers buy themselves the mushrooms in the rural areas paying about 15,000 TSh for a bag of about 30-40 kg in Songea while they pay about 10,000-12,000 TSh for a bag of about 20-25 kg in Tunduru. Other dealers buy them from brokers. The market dealers obtain a benefit of 5,000-7,000 TSh and 10,000-15,000 TSh in Songea and Tunduru market, respectively.

Other mushrooms sold at lower quantities are Usinda, Nakachejwa, Uyonjwe, Nakambalakata, and Kurungu kwetiti. All mushrooms are consumed in the district of Songea and Tunduru, respectively. There are no wholesale dealers buying mushrooms at large quantities for reselling them in large cities like Dar es Salaam. In Tunduru the demand for mushrooms is higher than the offer. In Namtumbo there is no market for mushrooms. However, some households are selling mushrooms at their home place.

We checked also at the central market of Morogoro on 2/3 February 2008, if mushrooms are sold. According to the sellers mushrooms are only sold in this market during the peak of the rainy season in March/April.

**Fig. 8.** *Cantharellus symoensii* (left) and *Cantharellus isabellinus* (right) sold at Songea market.

## 4.8 Villagers suggestions

Many of the interviewees said there was no market nearby and transport facilities are missing. They asked for preservation techniques and market facilities.

# 5. Discussion

## 5.1 Species inventory and fructification period

Mushroom picking in Tanzania is quite different from Central Europe where you have to look for picking sites of edible mushrooms. In the Corridor even highly priced mushrooms are plentiful. This was also indirectly confirmed by the fact that there was currently no competition between mushroom hunters. All interviewed persons were very willing to show us their picking sites since there were enough mushrooms for everybody. The study showed that there is a large quantity of highly priced edible mushrooms in the Corridor which are not picked by the villagers especially in remote areas. Chanterelles grow slowly relative to many other mushrooms and they have the advantage to persist for several weeks.

Miombo woodlands are rich in fungal diversity owing to the ectomycorrhizal association between species of the common miombo genera *Amanita*, *Boletus*, *Cantharellus*, *Lactarius* and *Russula* with trees (shrubs) of the subfamily *Caesalpinoideae* (*Brachystegia*, *Julbernardia*) and of the family *Euphorbiaceae* (*Uapaca* spp.). African mycorrhizal fungi are specialised to co-occur with indigenous tree species only, and are thus endemic to tropical Africa (Härkönen et al. 2003; Smith &Allan 2004). Little is known about the species involved in the mycorrhizal symbiosis between trees and mushrooms.

According to the survey of Härkönen et al. (2003) including 34 tribes of Tanzania, the largest diversity of wild edible mushrooms exists in the southern and western part of Tanzania what has been confirmed for the south by this study with 22 and 47 edible species recognised by the Ndendeule and Yao, respectively. The genera recorded in the SNWC are globally widespread and occur also in Europe except for *Afroboletus*, but at the species level all mushrooms are different. Very many tropical mushroom species are still scientifically unnamed, even if they are well-known to local people (Härkönen et al. 2003). Mushroom species usually cannot be identified from photographs only. For facilitating the identification of unknown species during the second part of the study we will take systematically good dry specimens (exicates) with notes about important taxonomic characteristics including substrate, consistency, smell and taste, colour changes, latex (colour and possible colour changes) and spore print.

The mushroom fructification period is strongly seasonal. Certain species are found in early season only, while others are late-comers. Termite mushrooms (*Termitomyces*) were not found during this survey since they mostly occur at the end of the peak of the rainy season in February-March according to the information received from the locals. However, Härkönen et al. (2003) reported that the good, edible termite mushrooms emerge early in the rainy season, in places where termite colonies are about to swarm.

No survey has been carried out in savannas. Even the site of Mabanzini area south of Matapwende is still dominated by *Caesalpinoideae* trees typical for Miombo woodland! Since the drier savannas have mainly endomycorrhiza with lower fungi, and hence fruit bodies are more seldomly seen. The only mushrooms are small ones on dung, and *Termitomyces* on or near termite mounds.

## 5.2 Edibility and nutritional and energy values

Mushrooms make a remarkable addition to the daily diet of the locals: they are plentiful and available for free and appear at the beginning of the rainy season when food stores from the

last harvest become scarce. Being rich in proteins and vitamins, mushrooms are a potentially valuable source of proteins, particularly for the poor section of the population (Kivaisi 2007).

There are big differences in the chemical composition of different species of mushrooms. There are differences also within one species depending on the substratum and the stage of development (Härkönen et al. 2003). As in most living organisms, the biggest share of the content is water varying between an 85 and 95% of the fresh weight. About 50-70% of the dry weight are different carbohydrates including glucose. About 15-50% of the dry weight is composed of proteins and other nitrogen-containing substances, such as chitin. The amino acid contents of the protein differ in different species of mushrooms but in general they are close to those of animal proteins. Mushrooms contain only small amounts of fats, about 1-15% of their dry weight, but the fat quality is good, being rich in unsaturated fatty acids. The wide variety and abundance of minerals is the most valuable part of mushrooms as food. However, some mushrooms tend to collect all kind of minerals from their surroundings, even the toxic heavy metals such as lead, cadmium and mercury that are present in polluted areas. Furthermore, fungi have a good ability to synthesize many kinds of chemical substances such as aromatic compounds. The energy values of common edible wild mushrooms in Tanzania vary between 1,450 and 1,840 kJ per 100 g dry weight, what is significantly higher than the cultivated field mushroom *Agaricus bisporus* (for more information see Härkönen et al. (2003).

Tanzanians just pick the traditional edible mushrooms and reject all the others. They pay no attention to the identification of inedible fungi. All of the termite mushrooms are edible and most highly priced and their nutritive value is very good. The large early-season *Termitomyces* got the highest ranking by Tanzanians in the study from Härkönen et al. (2003). *Russulaceae* species are collected for food in miombo woodland areas all over Tanzania (Härkönen et al. 2003). Mild species can be used straight away. Many people use also acrid species, but boil them and throw the water away before using them for food.

When people move to new areas, they find a different set of mushrooms; misidentifications become commoner, and can even lead to mushroom poisonings. It is no wonder that many people do not dare to pick mushrooms in a new district (Härkönen et al. 2003). A particular danger of poisoning, however, is caused by introduced ectomycorrical mushrooms, which may resemble indigenous mushrooms. They are growing exclusively under exotic trees, mostly in plantations but sometimes even under a single exotic tree standing on a roadside. When exotic trees are planted, the seedlings may bear spores and hyphae of exotic poisonous mushrooms. The Red fly agaric (*Amanita muscaria*), common in Eurasia and North America, is widespread in pine tree plantations in Tanzania. The Red fly agaric was several times misleadingly taken as *Amanita tanzanica* causing even lethal poisonings of the mushroom hunters. Another introduced species is *Amanita phalloides* (death cap), the moist poisonous fungus known resembling the indigenous delicious *Amanita loosii*. In Tanzania there are a few records from *Acacia mearnsii* and Eucalyptus plantations (see Härkönen et al. 2003). However, these mushrooms do not occur in miombo woodlands since they are strictly host-specific and incapable of living in symbiosis with indigenous trees.

## 5.3 Medicinal uses

It seems that mushrooms are seldom used by the locals for medicinal uses. Härkönen et al. (2003) gives a few uses for mushrooms which grow in the Corridor:

- *Amanita loosii* is considered to god for stomach problems.

- *Termitomyces letestui* was used in pre-colonial times to cure bilharziosis by the Zaramo tribe.
- *Termitomyces eurrhizus* is used in a mixture with some herbs as a lotion for skin diseases.
- *Bovista* spp. as well as other puffballs are used to sedate bees. A puffball is attached to a stick and set on fire. It will produce lots of smoke and can be pushed with the stick into a beehive. While the bees are dizzy, the hive can be emptied of the honeycombs.
- Pieces of puffballs mixed with milk cure stomach ache.

Recently *Schizophyllum commune* is increasingly used against cancer and *Ganoderma* sp. for the treatment of HIV (Mshandete, personal communication).

## 5.4 Habitat of mushroom sites

The most common and edible mushrooms are mycorrhizal. In order to estimate their abundance in the Corridor we need to know their specific host trees. A way forward could be the assessment of the nearest tree(s) of mycorrhizal mushrooms what may allow to identify the specific host tree of a specific fungus. Once the tree-mushroom species dependency and the range of distribution of the common miombo trees are known we could approximately assess the abundance of a specific mycorrhizal mushroom within the Corridor (the elaboration of a vegetation map would be very helpful in this context).

## 5.5 Mushroom picking

Careful picking is very important to meet high quality and hygiene standards for a successful marketing of mushrooms. When you go on a mushroom foray, always have a weave basket and a knife with you. Cut off the mushroom near the ground (instead of plucking) and then cut off remaining soil from the base of the stipe. If you put mushrooms with soil into your basket, the soil will drop between the gills of the other mushrooms in your basket, and you will have a lot of washing to do at home. Also split every mushroom into two halves to see that there are no maggots inside. If there are mushrooms that you do not know yourself but would like to ask somebody about later, keep them away from edible ones you know. Avoid putting many layers of mushrooms on each other in your bag since mushrooms are very delicate and risk to be spoiled during the transport.

## 5.6 Consumption and preserving techniques

Mushrooms are a rapidly deteriorating foodstuff. In that respect they are comparable to meat and should be used soon after picking, or preserved with care (Härkönen et al. 2003). The drying does not kill the microorganisms on mushrooms, but it makes the substratum so dry that they do not find enough water for their needs and they enter a dormant phase. The cooking of mushrooms before drying, however, kills the microorganisms and makes the product more hygienic. In this way, however, the dried specimens become very hard and are not pleasant to use. They will need a long soaking and cooking when prepared for food. Also part of the valuable food and mineral contents are thrown away with the cooking water. Dried mushrooms should be preserved in a container with a cover to be protected from moisture. They may absorb moisture from moist air and then the dormant microorganisms recover and begin to spoil the mushrooms.

## 5.7 Marketing

Chanterelles are sold at Songea and Tunduru markets at a multiple prices compared to the local markets adjacent to the Corridor. Chanterelles are highly appreciated by the dealers since they can be preserved in good quality for quite a long time. Sellers from Songea and Tunduru markets told us that the chanterelles (*Cantharellus isabellinus* and *C. symoensii*) can be preserved fresh for about one week after picking. The exact knowledge of the storage life of chanterelles is crucial in view of selling fresh chanterelles at Dar es Salaam (possibly also Morogoro and other major towns) and possibly also for exportation.

Chanterelles are highly priced as edible mushrooms and can also be dried for consumption throughout the year. For the past few years dried chanterelles have been exported to Europe from several countries of the miombo region (Smith & Allen 2003).

# 6. Conclusions

There is no policy guideline regarding sustainable harvest of wild mushrooms. Clearing of forests and woodlands for various land-uses is the major threat to mushrooms. Traditional slash-and-burn method (shifting cultivation) in the miombo areas does not harm the mycorrhizal mushroom. Thick branches and tree-tops are cut from living trees, left to dry, collected together and then burned. The ash fertilizes the soil, and makes it good for cultivation for a few years. Miombo trees are persistent and sprout vigorously. When the trees stay alive, also their numerous mycorrhizal mushrooms flourish. However, when trees are girdled, they die, and also their mycorrhizal fungi. Fire do not harm mushrooms directly since they occur in the dry season when mushroom are absent (except those growing on wood) and the burning may not affect the mycelia protected in the soil. However, hot late dry season burning may cause the killing of trees and thereby also their mycorrizahl fungi. Disturbances to termite mound should be minimised in view of protecting the growth of *Termitomyces*.

Mushroom harvesting is environmentally friendly and domestic use and commercialisation may contribute to livelihood improvements in general and poverty reduction in particular in rural areas:

- Does not damage forest resources in general and mushroom production in the long run.
- Women and children are mainly involved in picking mushrooms (and they should also benefit from an increased marketing).
- No inputs required for harvesting.
- Land ownership or rental not required (might change when they could be marketed).
- Very high-value crop with a good margin for the collector.
- Mushrooms have a high nutritional and energy values and are plentiful and free when agricultural crops are scarce.

This first part of the study clearly showed that there is a high potential of mushrooms in the Corridor which should play a more important role in the sustainable management of the natural resources in the area. Large quantities of highly priced mushrooms are available and only hardly commercialised. A support in the marketing of wild edible mushrooms would not only create an additional income for the local communities (in particular for women as disadvantaged group) but would also contribute their economic perception of the Corridor and thereby to a better protection of this unique area.

In view of promoting the marketing, picking and preservation techniques (considering hygienic standards) have to be improved and the local communities have to be organised for playing a major role in the marketing chain considering gender equity. Appropriate solutions for packaging and transport have to be assessed. These preliminary activities could be supported by a training programme under ADAP.

First activities promoting the marketing of mushrooms have to be implemented in future in a flexible way and step by step. Primarily we will focus to improve the marketing of mushrooms at regional and national level, before starting with a possible exportation of mushrooms. Further investigations are necessary in view of defining the future role of the authorities and the private sector in the marketing of mushrooms in the profit of the local communities.

## 7. Vegetation addendum

Opportunistic sampling throughout the fieldwork allowed us to collect additional plants not recorded during our vegetation study in 2006. In total 62 new plants have been added to the plant checklist of the Corridor including now 433 plant taxa whereof three new orchids (included in the CITES list in appendix II) and *Cissus throthae* (*Vitaceae*) as endemic species (possibly also *Wailesia mackenzii* is endemic). The survey of the inselberg Chuma mbili alone added more than 30 new plants and more will be included once the identification of unknown plants will be completed. The Missouri Botanical Garden is currently carrying out the IUCN Red List assessments of Eastern Arc Mountains and Coastal Forests species in Tanzania. Once this assessment will be completed, the IUCN category of threatened species within the Corridor can be defined.

**Fig. 9.** *Chlorophyllum* cf. *macrophyllum* at Magemani area, Magazini (Issa Ndomondo).

During this field study we looked in vain for the new tree species (*Xylopia* sp. nov.) we discovered in a riverine forest along the Ruvuma River during the vegetation survey in 2006. For the botanical description of the new species we need full botanical samples (in particular flowers are missing in the samples from Ruvuma). Issa Ndomondo informed us that the new tree species seems to grow also in a riverine forest north of Nambecha. Due to time constraints, however, we did not manage to survey this area.

The field study also clearly revealed the abundance of wild edible fruits in the Corridor. We believe that wild fruits like *Flacourtia indica* (*Ndawa tawa*), *Syzygium cuminii*, *Uapaca kirkiana* (*Mhuko mkurunga)* and *Ximenia americana* (*Mbingipingi*, see Fig.10) have an important marketing potential as well and a specific investigations is needed.

**Fig. 10.** *Ximenia americana* at Ubueti area, Milonji.

## 8. Recommendations

1) ADAP should define the storage life of freshly picked chanterelles (all four species) and taste the quality of dried chanterelles, if possible still in this rainy season.

2) ADAP should elaborate a training programme for the local mushroom hunters including appropriate picking and preservation techniques, organisation of the hunters, assessment of packaging and transport solutions.

3) SNWC should confirm still during this rainy season the occurrence of *Termitomyces* which should grow mainly towards the end of the rainfall peak in February to March according to the information received from the locals.

4) Elaboration of a brochure with coloured photographs of the most important edible mushrooms within the Corridor.

5) Observe the changes of *Xylopia* sp. nov. in order to collect full botanical samples (in particular flowers) for the botanical description of the new species (Issa Ndomondo got the specific instruction for this task).

6) Adansonia-Consulting will conduct an additional literature research focussing on the marketing of edible mushroom species from the Corridor in view of preparing the second part of the study.

7) Assess the marketing potential of wild edible fruits.

8) The second part of the study during the next rainy season will focus on a regional marketing strategy and on possibilities for selling mushrooms from the Corridor to Dar es Salaam based on a more detailed assessment of the spatial abundance of the most highly priced mushrooms in the Corridor. In order to assess also the potential of the highly priced *Termitomyces* growing towards the end of the peak of the rainy season, we propose to carry out the second part of the study in February/March 2008 extending the survey to the savanna landscape along the Ruvuma River.

9) For facilitating the identification of unknown species during the second part of the study we will take systematically good dry specimens with notes about important taxonomic characteristics including substrate, consistency, smell and taste, colour changes, latex (colour and possible colour changes) and spore print.

## 9. References

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## Annex A: Acronyms & Abbreviations

| | |
|---|---|
| ADAP | Association pour le Développement des Aires Protégées |
| DNRO | District Natural Resources Officer |
| GEF | Global Environment Facility |
| GR | Game Reserve |
| GTZ-IS | Deutsche Gesellschaft für Technische Zusammenarbeit, International Services |
| IUCN | International Union for Conservation of Nature |
| KfW | Kreditanstalt für Wiederaufbau |
| SNWC | Selous-Niassa Wildlife Corridor |
| SNWPC | Selous-Niassa Wildlife Protection Corridor |
| TOR | Terms of Reference |
| UNDP | United Nations Development Programme |

# Annex B: Itinerary and people met

| Date | Itinerary and people met |
|---|---|
| 18/1/08 | Morogoro: Discussion with Dr. Anthony Mshandete, Department of Molecular Biology and Biotechnology, University of Dar es Salaam; discussion with Dr. John Stephen, former ADAP- Co-ordinator |
| 20/1/08 | Travelling Morogoro-Songea |
| 21/1/08 | Travelling Songea-Namtumbo; joint briefing in Namtumbo with SNWC: Ngomello Kassim (Project Manager), Rudi Hahn (Technical Adviser), Madata, (District Game Officer), Issa Ndomondo, District Game Ranger), ADAP: Irene Mbonde (Community Development Officer) and local authorities: Samuel Mgella (acting DNRO); planning and preparation of field trip |
| 22/1/08 | Travelling Namtumbo-Nambecha-Kaunde Camp; interviews and mushroom picking sites at Nambecha |
| 23/1/08 | Travelling Kaunde Camp-Likuyu Seka-Kaunde Camp; interviews and mushroom picking sites at Likuyu Seka (Naheno; between village 2&3) |
| 24/1/08 | Travelling Kaunde Camp-Lusewa |
| 25/1/08 | Travelling Lusewa-Milonji-Matapwende-Lusewa; interviews and mushroom picking sites at Milonji (Ubueti) and Matapwende (Mabanzini) |
| 26/1/08 | Travelling Lusewa-Chuma mbili-Amani-Magazini; vegetation survey at Chuma mbili; interviews and mushroom picking sites at Amani (Iringa) |
| 27/1/08 | Travelling Magazini-Marumba; interviews and mushroom picking sites at Magazini (Magemani and Katoto) |
| 28/1/08 | Marumba; interviews and mushroom picking sites at Marumba (Kitonye Hill) |
| 29/1/08 | Travelling Marumba-Namtumbo |
| 30/1/08 | Debriefing in Namtumbo (participants see briefing 21/1/08); travelling Namtumbo-Songea |
| 31/1/08 | Debriefing SNWPC: Shakim Mhagama (Project Manager), Wayne Lotter (International Team Leader); initiation of mushroom market study at Songea |
| 1/2/08 | Travelling Songea-Morogoro |
| 3/2/08 | Morogoro: Discussion with Dr. John Stephen |
| 4/2/08 | Travelling Morogoro-Dar es Salaam; discussion with Anthony Mshandete |
| 14/2/08 | Debriefing ADAP in Geneva with Yves Hausser (Co-ordinator) and Ezra Ricci (Programme Officer |

# Annex C: Rainfall at Suluti

| Soluti | Monthly rainfall (mm) | | | | | | | | | | | | Annual total (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
| 1993 | 146.6 | 286.9 | 294.4 | 298.4 | 71.8 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 51.2 | 108.2 | 1258.7 |
| 1994 | 285.9 | 177.4 | 402.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.5 | 159.8 | 1030.1 |
| 1995 | 338.7 | 215.0 | 414.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 45.0 | 158.9 | 1171.8 |
| 1996 | 193.7 | 258.8 | 251.2 | 50.1 | 46.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 133.3 | 933.8 |
| 1997 | 314.1 | 846.7 | 153.7 | 13.5 | 6.2 | 14.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 320.6 | 1669.7 |
| 1998 | 332.0 | 494.0 | 336.0 | 111.9 | 113.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1386.9 |
| 1999 | 280.0 | 181.0 | 494.0 | 299.0 | 9.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 32.5 | 1295.5 |
| 2000 | 301.8 | 148.5 | 398.5 | 184.0 | 13.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 185.6 | 237.2 | 1469.5 |
| 2001 | 445.1 | 237.5 | 267.8 | 33.0 | 27.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 34.3 | 1044.7 |
| 2002 | 433.3 | 333.8 | 397.6 | 262.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.6 | 153.7 | 189.8 | 1791.6 |
| 2003 | 263.8 | 196.8 | 165.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 257.0 | 883.3 |
| 2004 | 209.8 | 99.8 | 276.6 | 171.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 15.6 | 11.2 | 212.7 | 997.5 |
| 2005 | 196.8 | 217.8 | 305.7 | 127.5 | 15.4 | 2.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 46.3 | 911.8 |
| 2006 | 113.4 | 240.3 | 198.4 | 214.1 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 30.8 | 44.3 | 569.9 | 1412 |
| 2007 | 384.3 | 229.2 | 199.8 | 216.1 | 16.5 | 0.0 | 0.0 | 0.0 | 12.4 | 8.7 | 0.0 | 177 | 1244 |
| Mean | 282.6 | 277.6 | 303.7 | 132.1 | 21.3 | 1.4 | 0.0 | 0.0 | 0.0 | 5.1 | 33.0 | 175.8 | 1233.4 |
| Minimum | 113.4 | 99.8 | 153.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 883.3 |
| Maximum | 445.1 | 846.7 | 494.0 | 299.0 | 113.0 | 14.9 | 0.0 | 0.0 | 12.4 | 30.8 | 185.6 | 569.9 | 1669.7 |
| Standard dev. | 98.0 | 181.5 | 101.9 | 111.5 | 32.5 | 3.8 | 0.0 | 0.0 | 3.2 | 9.7 | 58.8 | 142.3 | 293.7 |
| Variability (%) | 34.7 | 65.4 | 33.5 | 84.4 | 152.4 | 271.1 | – | – | – | 190.4 | 178.1 | 80.9 | 23.8 |

# Annex D: Habitat description of mushroom pickings sites

| Tree species | Mushroom picking sites | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Annona senegalensis | | | | | | | | | | 1 | |
| Baphia massaiensis | | | | | | | | 1 | 1 | 1 | |
| Bobgunnia madagascarienis | | | | | | | 1 | | 1 | | |
| Brachystegia boehmii | 2 | | | | | | 2 | 2 | 2 | 2 | 2 |
| Brachystegia bussei | 2 | 2(3) | | 2 | 3 | 3 | | | | | |
| Brachystegia floribunda | | | | 1 | | | 2 | 2 | 2 | 2 | 1 |
| Brachystegia cf. longifolia | 1 | | | 1 | | 1 | | 2 | | | |
| Brachystegia mitis | | | | | | 2 | | | | | |
| Bridelia cathartica | | | | | | | | | | | 1 |
| Burkea africana | | 1(2) | | 1 | 1 | | | | | | |
| Catunaregam spinosa | | | | | | | 1 | | | | 1 |
| Combretum apiculatum | | | | | | | | | | 1 | |
| Combretum molle | | | | | | | 1 | | 1 | | 1 |
| Combretum psidioides | | | | | | | | | | 1 | |
| Combretum sp. | | | | | | | 2 | | | | |
| Crossopterix febrifugum | | | | | | | 1 | | | | |
| Cryptosepalum maraviense | | | | | | 2 | | | | | |
| Cussonia arborea | | | 1 | | | | | | | | 1 |
| Diplorhynchus condylocarpon | | | | 1 | | | 1(2) | 2 | 2 | 1 | |
| Erythrophleum africanum | | | | | | | | 2 | | | |
| Flacourtia indica | | | | | | | | | | | 1 |
| Hymenocardia acida | | | | | | | | | 1 | | |
| Julbernardia globiflora | | | | | | | 2 | | 1 | 1 | 2 |
| Lannea schweinfurthii | | | | | | | | | | | 2 |
| Maprounea africana | | | | | | | | | 1 | | |
| Monanthotaxis discolor | | | | | | | | | | 1(2) | |
| Multidentia crassa | | | | | | | 1 | | | | |
| Olax dissitiflora | | | | | | | | | | | 1 |
| Parinari curatellifolia | | 1(2) | | | | | | | 1 | | |
| Pericopsis angolensis | | | | | | 1 | | | | | 1(2) |
| Protea angolensis | | | 2 | | | | | | | | |
| Pseudolachnostylis maprouneifolia | | | | | | | 1 | 1 | 1 | | 1 |
| Psorospermum febrifugum | | | | | | | | | | 1 | |
| Pterocarpus angolensis | | | | | 1 | | 1 | 1 | | | 1 |
| Rothmannia urcelliformis | | | | | | | 1 | 1 | | | |
| Strychnos spinosa | | | | | | | 1 | | | | 1 |
| Syzygium guineense | | | 1 | | | | | | | | |
| Swartzia madagascariensis | 2 | | | | | | | | | | |
| Terminalia kaiseriana | | | | | | | | | | 1(2) | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Uapaca kirkiana | | 2 | 2 | 1 | | | | | | | |
| Uapaca nitida | | 1(2) | 2 | 1 | | | | | | | |
| Uapaca sansibarica | | | 1 | | | | | | | | |
| Ximenia americana | | | | | | | 1 | | | | |
| Zanha golungensi | | | | | | | | | | | 1 |

**1:** North Namtumbo; Slope angle: 10%; dominant tree height: 10(12) m; tree/shrub cover:35%

**2:** Nambecha; Slope angle: 10%; dominant tree height: 10(12) m; tree/shrub cover: 35%; S10°13'09.9''/E36°06'41.8''.

**3:** Nambecha fallow: Slope angle: 0-2%; dominant tree height: 7(12) m; tree/shrub cover: 35%; S10°12'53.4''/E36°05'54.5''.

**4:** Naheno (Likuyu Seka): Slope angle: 0-2%; dominant tree height: 10(12) m; tree/shrub cover: 35%; S10°20'25.5''/E36°17'22.4''.

**5:** Likuyu Seka, between village 2&3: Slope angle: 0-2%; dominant tree height: 12(14) m; tree/shrub cover: 45%; S10°16'46.8''/E36°17'51.9''.

**6:** Likuyu Seka, village 2: Slope angle: 0-2%; dominant tree height: 12(14) m; tree/shrub cover: 40%; S10°15'55.5''/E36°16'28.1''.

**7:** Ubueti (Milonji): Slope angle: 0-2%; dominant tree height: 12 m; tree/shrub cover: 50%; S11°08'44.7''/E36°12'22.5''.

**8:** Mabanzini (Matapwende): Slope angle: 0-2%; dominant tree height: 10(12) m; tree/shrub cover: 50%; S11°21'27.4''/E36°07'54.3''.

**9:** Iringa (Amani): Slope angle: 0-2%; dominant tree height: 10(12) m; tree/shrub cover: 45%; S11°28'06.9''/E36°27'37.7''.

**10:** Magemani (Magazini): Slope angle: 2-5%; dominant tree height: 12(15) m; tree/shrub cover: 40%; S11°31'17.4''/E36°27'28.6''.

**11:** Magemani (Magazini): Slope angle: 20-40%; dominant tree height: 8 m; tree/shrub cover: 35%; S11°18'08.5''/E36°51'56.6''.