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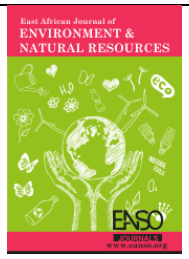

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*Original Article*

# Impact of Anthropogenic Processes on Sustenance of the Itigi-Sumbu Thicket Ecosystem Services in Tanzania

*Fortunatus Bulabo Makonda*[1*] *& Nsajigwa Emmanuel Mbije*[1]

[1] Sokoine University of Agriculture, P. O. Box 3014, Morogoro, Tanzania.
[*] Correspondence Email: makonda@sua.ac.tz

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*Itigi-Sumbu thicket, Settlements, Agriculture, Mining, Bussea massaensis.*

## ABSTRACT

This study aimed to assess the impact of human activities on the role of the Itigi-Sumbu Thicket Ecosystem (ISTE) of the Tanzanian portion, as an ecosystem services provider. Specifically, the study worked to: a) identify the major anthropogenic processes that impact the envisaged delivery of ISTE services; b) determine flora and fauna species composition and distribution; c) evaluate current species and habitats; and d) identify and evaluate the role and current status of ISTE in ecosystem services delivery. The study area was stratified according to the identified main land use categories. The modified Whittaker method was adopted in data collection. The vegetation could be categorised mainly as natural or modified habitat forms of either thicket, scrub or open woodland, the modified habitat leading to either or some combinations of human settlements, agricultural land and mining areas. A total of 406 and 218 flora and fauna species were recorded, respectively. As far as conservation status is concerned, five flora and four fauna species were recorded, calling for concern over genetic erosion in many of their populations. Also, four exotic plant species with invasive, allelopathic and phytotoxic properties were encountered. It could be concluded that ISTE is rich in species diversity; nevertheless, in the general land, the habitats were mostly dominated by a few species. A human population influx was projected in the near future following the stabilisation of gold mining and cashew farming activities, leading to further rapid depletion of the already degraded resources. The natural habitats, therefore, need to be conserved.

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## INTRODUCTION

A thicket is a very dense stand of small trees or tall shrubs which are often dominated by only a few species, to the exclusion of all others. In Tanzania, thicket ecosystems are mainly confined to the flatland semi-arid areas in central parts of the Maasai-Somali eco-regions, between 950 and 1,200 m.s.l. However, the famous and unique ecosystem of this nature is the Itigi Thicket, which is found in an area near Itigi Town in the Singida Region. The Itigi Thicket constitutes part of the Itigi-Sumbu Thicket Ecosystem (ISTE), an eco-region consisting of two small areas of thick shrubland in Tanzania, Zambia and the adjacent Democratic Republic of the Congo (MLNREP, 2015).

The thicket is described to comprise a unique dense floral community having many endemic species and almost no ecotone between it and the surrounding dry miombo woodlands. The community is among the last strongholds for species of African large mammals, including black rhinoceros (*Diceros bicornis* L.) before they were eradicated by poachers, elephant (*Loxodonta africana* Blumenbach), and buffalo (*Syncerus caffer* Sparrman). ISTE could, therefore, be concluded to represent a globally unique biodiversity hotspot resource. Apart from biodiversity conservation, ISTE has been providing livelihoods and ecosystem services such as provisioning, regulating, supporting and cultural services to the adjacent local communities (Makero and Kashaigili, 2016; Newman, 2019). In spite of the great role played by ISTE in biodiversity conservation, the area is suffering much from anthropogenic disturbances, mainly settlements, agriculture and mining (Baena *et al.*, 2016). Recently, cashew (*Anacardium occidentale* L.), which ranks second after tobacco in income-generating crops in Africa (Monteiro *et al*., 2017), was introduced in the area. Gold mining had also been commenced in ISTE.

The subsistence economy of the area also depended much on livestock. Regrettably, this ecosystem thrives only on unique, highly specialised and sensitive soils that, once disturbed, suffer irreversible impairments, averting further thicket regeneration (Kindt *et al.*, 2011). Whereas Baena *et al.* (2016) reported a clearance of 65% of the total ISTE cover in the Tanzanian portion, Makero and Kashaigili (2016) recorded a thicket area decline of 6.23% and a non-thicket area increase of 3.92% in the same area between 1991/2000 and 2000/2011. From the results, Baena *et al*. (2016) supported the assessment of this ecosystem as endangered, but also recommended that the remaining ISTE both in Tanzania and Zambia/DRC be fully surveyed.

This study aimed to assess the impact of human activities on the ISTE of the Tanzanian portion, as an ecosystem services provider. Specifically, the study worked to: a) identify the major anthropogenic processes that impact the envisaged delivery of ISTE services; b) determine flora and fauna species composition and distribution; c) evaluate species and habitats; and d) identify and evaluate the role and current status of ISTE in ecosystem services delivery.

## METHODOLOGY

### Study Area Description

Surveys for this study were conducted in the Tanzanian ISTE portion (the Itigi Thicket) in Manyoni, Itigi and Ikungi districts, Singida. The area covers 410,000 ha and lies between 5°12' - 8°10' S and 33°30 - 35°10' E. The altitude of this area ranges between 1,390 – 1,450 m.a.s.l. The climate is generally tropical with marked seasonal and altitudinal temperature variations and sharply defined dry and rainy seasons. The temperature average ranges between 15°C in July and 30°C during the month of October. The annual average rainfall in the area is low and short, ranging from 500 mm to 800 mm with high seasonal and annual variation. Rains start in October through May,

 

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followed by a dry and cold spell between June and September.

**Sampling and Data Collection**

The study involved stratification of the ecosystem into two main land use categories, namely, general land and conservation land (Table 1). The general land was further sub-stratified into two: human settlements and agricultural land, and gold mining lease area. Likewise, the conservation area, which was under the Tanzania Forest Services Agency (TFS), was sub-stratified into Aghondi National Bee Reserve (ANBR) and Kilinga Forest Reserve (KFR). The Transect belt method was employed using eight transect lines in each stratum, selected and established in such a way that all vegetation types and habitats were covered. These transects were also used in the fauna study, involving walks and traps. Along the transects, Nested Quadrat plots, each with a size of 50 x 20 m, were used as narrated by Stohlgren *et al*. (1995) for recording trees. Examination of the tree for signs of human disturbance, which is an indicator of its utilisation by people in the area and for what purpose, was also made, guided by key informants knowledgeable on the plant resources.

For shrubs, 36 nested plots, each of size 5.0 m x 2.0 m, one in each of the main plots, were used for each stratum. All the shrubs were identified to species level and their numbers recorded. Information on the use of each shrub species was also explored by the local guide and augmented with information from informal group discussions with local people living in adjacent villages. For grasses and herbs, 144 nested plots, each of size 1.0 m x 1.0 m and four of them were established within each of the main plots in each stratum. All grasses and herbs were identified and enumerated. In addition, their percentage cover within the plot was estimated using a scale of 0 – 100% cover. The fauna study technique employed i) a ground survey of large mammals on foot using a line transect (Sutherland, 1996), ii) a drive on a road transect to determine the presence/signs of large mammals, small mammals and nocturnal birds, iii) opportunistic recording of animals, iv) a one transect walk and iv) interview with key informants to determine fauna present in the ISTE.

The key informants involved natural resource managers, local government leaders and persons with indigenous knowledge of the natural resources from the study area. In each sub-stratum, respective forest officers, wildlife officers, village executive officers and ward executive officers represented the informants. Also, in the list for the sub-stratum were two groups comprising of four villagers each, one for responding to flora and the other for fauna issues.

**Data Analysis**

The conservation status of various taxa encountered was established using LEAP (2024), CITES (2024), as well as the IUCN Red List of Threatened Species (2024).

Variations between the two land categories (general and conservation land) and within their sub-categories were assessed using the Shannon-Weiner Species Diversity Index, computed from the formula:

$$H' = -\sum_{i=1}^{s} pi \ln pi$$

where H' is the species diversity index, s is the number of species, and pi is the proportion of individuals of each species belonging to the ith species of the total number of individuals. The assessment of ecosystem services delivery for ISTE was done in accordance with IFC (2019)

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**Table 1: Sampling for the Impact of Anthropogenic Processes on the Itigi-Sumbu Thicket Ecosystem Services Sustenance in Tanzania**

| Stratum | Sub-stratum | General Site Description | | | Population | | | |
|---|---|---|---|---|---|---|---|---|
| | | Location | General habitat type | Size (Ha) | Adjacent communities | Human | Cattle | Goats, sheep and donkeys |
| General land | Human Settlements and Agriculture | - Ikungi and Manyoni districts<br>- Latitude 5°34' - 5°43' S<br>- Longitude 34°40' - 34°54' E<br>- 50 km northwest of Manyoni Town | - Itigi thickets<br>- Wooded scrubland<br>- Mixed herbaceous agricultural<br>- Cashewnut farms<br>- Open woodland | 6,125 (URT, 2020a) | Masigati, Mkwese and Mkiwa villages | 59,314 (URT, 2022a) | 5,224 (IDC, 2015; MDC, 2015) | 6,813 (IDC, 2015) |
| | Mining lease area | - Ikungi District<br>- Latitude 5°12' - 5°15' S<br>- Longitude 34°56' - 35°04' E<br>- 70 km east of Singida Town | - Itigi thickets<br>- Wooded scrubland<br>- Mixed herbaceous agricultural<br>- Open woodland | 28,500 (Ikungi District Council, 2015) | Mang'onyi Ward | 22,665 (URT, 2022a) | 12,668 (IDC, 2015) | 6,066 (IDC, 2015) |
| Conservational land | Bee Aghondi Reserve | - Itigi and Manyoni districts<br>- Latitude 5°50' – 8°10' S<br>- Longitude 33°30 – 35° 10' E<br>- 6 km west of Manyoni Town | - Itigi thickets<br>- Wooded scrubland<br>- Open woodland | - 2,162<br>- Gazetted in 2005 (URT, 2008) | Manyoni, Aghondi and Idodyandole wards | 71,972 (URT, 2022a) | 7,838 (IDC, 2015; MDC, 2015) | 4,962 (IDC, 2015; MDC, 2015) |
| | Kilinga Forest Reserve | - Manyoni District<br>- Latitude 5 23' - 5° 30' S<br>- Longitude 34° 53 - 34 59' E<br>- 75 km north of Manyoni Town | - Itigi thickets<br>- Wooded scrubland<br>- Open woodland | - 11,526.2<br>- Gazetted in 2019 (URT, 2024) | Makuru Ward | 24,008 (URT, 2022a) | 9,753 (MDC, 2015) | 7,079 (MDC, 2015) |

 

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## RESULTS AND DISCUSSION

### Major Anthropogenic Processes That Impact the Ecosystem Services Provision

During the study, ISTE was highly under threat of anthropogenic processes, namely; human settlements and agricultural activities, including arable farming and livestock grazing. Gold mining, which was being haphazardly conducted by petty miners in Londoni (Manyoni District) and Mang'onyi (Ikungi District) wards, was yet another menace to the ecosystem. According to the key informants, the threat had been further exacerbated by the newly inaugurated commercial gold exploration and its mining in Mang'onyi and the introduction of cashew as a commercial crop in Ikungi and Manyoni districts.

The current human population in the study area was 177,960 in an area covering 444,625 ha (40 $km^{-2}$), though lower than the National statistics of 68 $km^{-2}$ (URT, 2022a), which also covered urban areas. This population needed settlements, farming and pasture lands, together with other social services requiring land. The total livestock population, involving cattle, goats, sheep and donkeys, could be estimated at 60,396.

Analysis of the area distribution showed that only 13,688 ha (3.34%) of the total ecosystem area (410,000 ha) was under conservation, and the balance was vulnerable to encroachment and poaching. Encroachment cases and illegal grazing of livestock in the conservation land (ANBR and KFR) were rampant during 2019/20 and 2020/2021, involving about 200 cattle daily (URT, 2024). Also, information from key informants indicated that fire outbreak cases during 2019/20 and 2022/23 were rampant due to juxtaposed land preparation and wildlife poaching. Whereas Jones *et al.* (2009) noted that the whole ISTE area was vulnerable to poaching and rhinos had been eradicated, and as a highly threatened current elephant distribution and corridors in Tanzania, IFC (2019) concluded that such an area was a critical habitat.

Major parts of the agricultural land had been cleared to pave the way for farming activities. Whereas intensive livestock grazing and tree cutting were recorded, fresh wild bushfires were also registered. According to URT (2020a), the growth of cashew started in 2016/2017 with 597 ha planted and in 2017/2018, the planted area increased by 12,269 ha. In 2018/2019, another land of 2,413 ha was added, altogether indicating an annual average of 5,093 ha or a 2.4% increment in the land for cashew. The cultivation of cashew is done through block farming for the enhancement of extension services, inputs and markets at Masigati and Mkwese villages in Manyoni District, as well as at Mkiwa Village in Ikungi District. Apart from competition for land with ecosystem conservation, URT (2007; 2020b) observed intensive use of pesticides for controlling cashew insects, diseases and weeds. As a result, a study by Kachinde *et al.* (2022) found existing physical-chemical contaminations in honey emanating from the increased use of pesticides in the area.

Gold mining had been allocated 28,500 ha (7.0%) out of the total ISTE area of 410,000 ha, for use in excavation, pitting, dumping, general construction and human settlements, therefore causing direct deforestation and degradation to the lease area. As noted by Seki *et al.* (2022), mining is associated with impacts that manifest largely outside operational lease boundaries and therefore, the majority of ISTE was at risk of deforestation and degradation.

### Flora and Fauna Species Composition and Distribution

Whereas the vegetation types in ISTE could be classified into thicket, scrubland, open woodland, agricultural land and residential habitats, the fauna could be classified into mammals, birds, reptiles, amphibians, and insect/non-insect invertebrates.

#### *Thicket*

The thicket habitat comprised a very dense stand of impenetrable stunted shrubs composed of *Baphia* spp., *Grewia burttii, Albizia petersiana, A. adianthifolia, Zanthoxylum chalybeum, Dichrostachys cinerea, Boscia angustifolia* and

 

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*Combretum celastroides*. Others were *Bussea massaiensis, Markhamia obtusifolia, Senna singuena, Commiphora* spp. and *Pseudoprosopsis fischeri*. In the herbaceous layer were *Leucas mollis, Ocimum* spp., *Bidens pilosa, Tegetes minuta, Agrostis* sp. and *Cyperus* sp. Others were *Emilia* sp., *Spermacoce sinensis, Tridax procumbens, Triumfetta rhomboidea* and *Oxygonum* sp. However, they were not dominant and only noted in disturbed habitats.

***Scrubland***

The scrubland habitat was characterised by much sparser stunted vegetation, including grasses, herbs and geophytes that were highly degraded. The most frequent taxa recorded were *Vachelia* and *Senegalia* spp. Notably *V. tortilis, V. nilotica, V. drepanolobium* and *Senegalia Senegal.* Others were *Dalbergia melanoxylon, Euphorbia candelabrum, Zanthoxylum chalybeum, Senna singuena, Combretum* spp. and *Terminalia* spp. In the shrub layer, the species included *Tapiphyllum floribundum, Zanthoxylum chalybeum, Commiphora* spp., *Combretum molle, C. adenogonium, Markhamia obtusifolia, Senna obtusifolia, Strychnos* spp., *Margaritaria discoides, Byrsocarpus orientalis, Strophanthus emiinii* and *Triumfetta rhomboidea. Boscia angustifolia, Balanites aegyptiaca, Cordia sinensis, Burkea africana, Cassia abbreviata, Combretum zeyheri, Commiphora africana, Lannea humilis, Terminalia mollis, Vangueria infausta, Vitex mombassae* and *Ximenia caffra*. Others were *Acalypha chirindica, Albizia petersiana, Baphia burttii, Baphia massaiensis, Afrocanthium burttii, Combretum celastroides* and *Tarenna neurophylla.* The herbaceous layer was dominated by *Ocimum* spp., *Bidens pilosa, Tegetes minuta, Agrostis* sp., *Cyperus* sp., *Emilia* sp., *Spermacoce sinensis, Tridax procumbens, Triumfetta rhomboidea* and *Oxygonum* sp.

***Open Woodlands***

The open woodlands encountered were of Miombo type, mostly either of *Brachystegia/Pterocarpus/Afzelia quanzensis, Pterocarpus/Combretum/Terminalia* or *Vachelia/Senegalia/Dalbergia*. Gashaw *et al.* (2008) attempted to explain that the vegetation in this ecosystem has developed under the influence of fire. Thus, trees have very thick bark to cope with fire, while most of the herbs have perennial bulbs. In the general land stratum, the vegetation was frequently being disjuncted and often denuded by either agricultural, human settlements or mining activities.

***Agricultural and Residential Habitat***

The habitat comprised pockets of cultivated land, either with perennial or mixed herbaceous crops, pastures and residential areas. The remnant natural trees found were those used for shade, fodder and bee keeping, such as *Vachelia tortilis* and *Afzelia quanzensis,* those used for food, e.g., *Vangueria infausta, Strychnos* spp. and *Vitex* spp. and those which were regarded as sacred, e.g., *Ficus syncomorus, Commiphora mossambicensis, Senna singueana* and *Grewia* spp. Species in the shrub layer included regenerants of the species of the tree layer. Others were young trees of *Balanites aegyptiaca, Dombeya* spp, *Markhamia obtusifolia, Vachelia nilotica, Diospyros fischeri* and *Vangueria infausta*. The herbaceous layer was dominated by *Leucas mollis, Hyparrhania rufa, H. filipendula, Heteropogon contortus, Hyparrhenia figariana, Cymbopogon* spp., *Ocimum* spp., *Vernonia* spp., *Tegetes minuta* and *Solanum* spp.

Due to anthropogenic influences in this habitat, a good number of the species were exotic; being either cultivated herbaceous or perennials for food, shade, ornamental, environmental or multipurpose. The herbaceous crops included *Zea mays* (maize), *Helianthus annuus* (sunflower), *Pennisetum glaucum* (millet), *Sorghum bicolor* (sorghum), *Sesamum indicum* (sesame), *Cajanus cajan* (pigeon peas) and *Hibiscus sabdariffa* (rosella). Whereas the perennial food and cash crops were *Anarcadium occidentale* (cashew) and *Mangifera indica* (mango), the timber crops composed of *Melia azedarach* (chinaberry tree), *Trichilia emetica* (mahogany), *Senna siamea* and *S. spectabilis* (Jahor), *Acacia mangium* (silver wattle) and *Azadirachta indica* (neem). Other

 

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exotic cultivated species were *Agave sisalana* (sisal), *Euphorbia tirrucali* (finger tree) and *Jatropha curcas* (purging nut), all of which were planted for demarcation.

**Evaluation of the Species and Habitats**

A total count of 406 and 218 flora and fauna species were recorded in ISTE, presented in 80 and 49 families, respectively. Out of the identified plant species, eight were exotic been introduced in woodlots or residential areas and around the mining campsite. Of these, four were potential environmental weeds with allelopathic and phytotoxic properties to non-ruminants. These are *Acacia mangium* (Koutika *et al.,* 2019), *Azadirachta indica* (Moro *et al.*, 2013), *Senna siamea* and *S. spectabilis* (Orwa *et al.,* 2009). Whereas the herbaceous plants were 180 (44.3%), shrubs, including lianas were 117 (28.9%), and 109 (26.8%) were trees.

For fauna, the study identified 12 species of small, medium and big mammals (Table 2), 169 of local birds and 13 species of Palearctic migratory birds (Table 3). Also, in the list were 10 species of reptiles and amphibians (Table 4) and 14 species of ground insects and non-insect invertebrates (Table 5). Among the birds were those which impact local economic activities, including preying on poultry such as falcons (*Falco* spp.) and globally recognised crop pests such as Red-billed quelea (*Quelea quelea*) and species of such ecological importance as the Red-billed Ox-pecker (*Buphagus erythrorhynchus*) and Cattle Egret (*Bubulcus ibis*). Their habit of feeding on ecto-parasites, particularly ticks found on herbivores, controls the population of the parasite. With regard to habitat use, most birds were recorded in bushland, probably because this habitat type constituted a large portion of all available habitats.

According to the key informants, the diversity of fauna was relatively high in the area, being associated with proximity to the wildlife corridor linking Rungwa Game Reserve and several wildlife-controlled areas in the north of ISTE.

**Table 2: Identified Mammals in the Itigi-Sumbu Thicket Ecosystem in Tanzania**

| Common English name | Scientific name | Habitat type |
|---|---|---|
| Kirk's dik-dik | *Madoqua kirkii* | Thicket, scrubland |
| Bush-buck | *Tragelaphus scriptus* | Scrubland |
| Greater galago (Bush baby) | *Otolemur crassicaudatus* | Thicket, scrubland |
| Yellow baboon | *Papio cynocephalus* | Woodland |
| Vervet monkey | *Cercopithecus aethiops* | Woodland |
| Cape/South African porcupine | *Hystrix africaeaustralis* | Woodland |
| Hedgehog | *Atelerix albiventris* | Scrubland |
| Rock hyrax | *Procavia capensis* | Woodland |
| Side-striped jackal | *Cinus adustus* | Scrubland |
| White-tailed mongoose | *Ichneumia albicauda* | Scrubland |
| Impala | *Aepyceros melampus* | Woodland |

**Table 3: Identified Palaearctic Migratory Birds in the Itigi-Sumbu Thicket Ecosystem in Tanzania**

| Common English name | Scientific name | Habitat type |
|---|---|---|
| Black Kite | *Milvus migrans* | Scrubland, Settlements |
| Montagu's Harrier | *Circus pygargus* | Scrubland |
| Common Buzard | *Buteo buteo* | Scrubland |
| Tawny Eagle | *Aquila rapax* | Scrubland |
| Common Sandpiper | *Actitis hypoleucos* | Marshy woodland |
| Wood Sandpiper | *Tringa glareola* | Woodland |
| Marsh Sandpiper | *Tringa stagnatilis* | Woodland |
| Blue-cheeked Bee-eater | *Merops persicus* | Scrubland |

 

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| Common English name | Scientific name | Habitat type |
|---|---|---|
| African Hoopoe | *Upupa epops* | Scrubland |
| Common House Martin | *Delichon urbica* | Scrubland |
| Common Rock-Thrush | *Monticola saxatilis* | Scrubland |
| Icterine Warbler | *Hippolais icterina* | Scrubland |
| Spotted Flycatcher | *Muscicapa striata* | Scrubland |

**Table 4: Identified Reptiles and Amphibians in Itigi-Sumbu Thicket Ecosystem in Tanzania**

| Common English name | Scientific name | Habitat type |
|---|---|---|
| Green mamba | *Dendroaspis angusticeps* | Woodland |
| Black-necked spitting cobra | *Naja nigricollis* | Woodland |
| Vine snake | *Thelotornis capensis* | Woodland |
| Striped skink | *Mabuya striata* | Woodland |
| Puff adder | *Bitis arietans* | Woodland |
| Nile monitor lizard | *Varanus niloticus* | Scrubland, woodland |
| Flat-headed rock agama | *Agama agama mwanzae* | Woodland, scrubland |
| Leopard tortoise | *Geochelone pardalis* | Woodland |
| African helmeted turtle | *Pelomedusa subrufa* | Marshy woodland |

**Table 5: Identified Insect and Non-Insect Invertebrates in Itigi-Sumbu Thicket Ecosystem in Tanzania**

| Common English name | Scientific name | Habitat type |
|---|---|---|
| Long-legged darkling beetle | *Stenocara longipes* | Woodland, scrub |
| Yellow-spotted ground beetle | *Craspedephorus bonvouloiri* | Woodland, scrub |
| African brown cricket | *Platygryllus primiformis* | Woodland, csrub |
| Black field cricket | *Teleogryllus wernerianus* | Woodland |
| Leaf-rolling cricket | *Eremus glomerinus* | Scrubland, thicket |
| Con cricket | *Enyaliopsis* sp | Woodland, scrubland |
| Elegant grasshopper | *Zenocerus elegans* | Woodland, scrubland |
| African giant black millipede | *Archispirostreptus gigas* | Woodland |
| Giant African land snail | *Achatina fulica* | Woodland |
| Pyrgomorphid grasshopper - | *Taphronota stali* | Woodland |
| Red-headed Cockroach | *Deropeltis erythrocephala* | Woodland |
| Harvester ant | *Streblognathus aethiopicus* | Scrubland, thicket |
| E. African lowland honey bee | *Apis mellifera* | Woodland |
| Stingless honeybees | *Meliponula* sp. | Woodland, scrubland |

Species diversity analysis results had the conservation land having higher overall diversity (3.6 and 3.7) than the general land (2.8 and 2.1) for flora and fauna, respectively (Table 6). The observed anthropogenic processes were, nevertheless, likely to have contributed to the local extinction of various large mammal species, such as the black rhino, which were previously reported to be significant to the area. Kasisi *et al.* (2024) had similar observations for butterfly species diversity and abundance between a conservation area and farmlands in southern Tanzania.

 

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**Table 6: Flora and Fauna Species Count and Diversity Index (H') in Itigi-Sumbu Thicket Ecosystem of Tanzania**

| Land use category | | Species count | | H' | |
|---|---|---|---|---|---|
| | | Flora | Fauna | Flora | Fauna |
| General | Human settle. and agriculture | 182 | 42 | 1.7 | 1.9 |
| | Mining lease area | 393 | 173 | 3.1 | 0.1 |
| Conservational | Aghondi Bee Reserve | 391 | 191 | 3.6 | 2.5 |
| | Kilinga Forest Reserve | 395 | 185 | 3.5 | 3.4 |

In the general land, the key informants had a general concern that much of the species' diversity had been lost, particularly in the human settlements and agriculture, whose habitats had been totally transformed from their original state. However, in the mining campsite, the natural state of the habitats had been greatly maintained.

As far as conservation status is concerned, the study recorded five species of flora (1.3%) of conservation importance, namely; *Dalbergia melanoxylon* (mpingo), *Bussea massaiensis* (mfetu), *Pterocarpus angolensis* (mninga), *Securidaca longipedunculata* and *Zanthoxylum chalybeum*. IUCN (2024) described *Pterocarpus angolensis* and *Dalbergia melanoxylon* as near threatened species. Whereas mpingo is widely used in the wood carving industry and in musical instrument manufacture, mninga is heavily exploited for fine furniture. The levels of exploitation of the two species are very high, rendering the suitably exploitable individuals becoming increasingly scarce. Also, their regeneration is poor in many places, since parent trees are scarce and serious genetic erosion is believed to have occurred. There is therefore cause for concern over genetic erosion in many of their populations (WCMC, 1998). *Bussea massaiensis* is endemic to Tanzania and Zambia in the ISTE ecoregion (Ruffo *et al*., 2002). In Tanzania, it is found only in Singida, Dodoma and Tabora, being restricted to small localities within its area of distribution, where it may be abundant. The wood is harvested for building poles, pestles, tool handles and carvings. The seeds are roasted and eaten like groundnuts and are also sold in local markets.

**Table 7: Plant Species of Conservation Importance in the Itigi-Sumbu Thicket Ecosystem, Singida, Tanzania**

| Scientific name | Conservation status | Habitat type |
|---|---|---|
| *Dalbergia melanoxylon* Guill. & Perr. | Near Threatened (IUCN, 2024) | Thicket, Scrubland, Woodland |
| *Bussea massaiensis* (Taub.) Harms | Vulnerable (Brummitt *et al.*, 2007; Groom, 2012) | Thicket, Scrubland, Woodland |
| *Pterocarpus angolensis* DC. | Near Threatened (IUCN, 2024) | Miombo Woodland |
| *Securidaca longipedunculata* Fresen | Near Threatened (Wyk *et al*., 2000; Wyk and Gericke, 2000) | Woodland |
| *Zanthoxylum chalybeum* Engl. | Vulnerable (Wyk *et al*., 2000; Wyk and Gericke, 2000) | Thicket, Scrubland, Woodland |

*Bussea massaiensis*, therefore, was present within the protected areas network, and there were a number of threats posed to the species' habitat. This species was rated by Brummitt *et al.* (2007) as vulnerable. The species can be propagated easily, using seeds, nevertheless, according to Ruffo *et al.* (2002), the establishment of this tree outside its habitat requires mycorrhizal inoculation, using soil from a natural stand. *Zanthoxylum chalybeum* was also reported by Wyk *et al*. (2000) and Wyk and Gericke (2000) as vulnerable, and *Securidaca longipedunculata* as near threatened. The two species were mainly used medicinally, and there was no control over the rate of harvesting.

 

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According to the IUCN (2024), as presented in Table 7, one species of fauna, namely *Gyps ruepellii* (Ruppell's Griffon vulture), was considered critically endangered. Whereas *Terathopius ecaudatus* (the Bateleur eagle) and *Agapornis fischeri* (Fischer's Lovebird) were considered under the near threatened category, *Bucorvus leadbeateri* (Southern ground-hornbill) was considered vulnerable.

**Table 8: Fauna Species of Conservation Importance in the Itigi-Sumbu Thicket Ecosystem, Singida, Tanzania**

| Scientific name | Conservation status (IUCN, 2024) | Habitat type |
|---|---|---|
| *Gyps ruepellii* Brehm, AE | Critically endangered | Woodland, Scrubland, thicket |
| *Agapornis fischeri* Reichenow | Near Threatened | Woodland |
| *Terathopius ecaudatus* | Near Threatened | Thicket, Scrubland, Woodland |
| *Bucorvus leadbeateri* Vigors | Vulnerable | Thicket, Scrubland, Woodland |

Elsewhere, Thiollay (2006) documented *Gyps ruepellii* populations to be on a steady decline throughout their entire range. The declines could be attributed to the loss of habitat related to anthropogenic activities. Though a wide-ranging species, *Agapornis fischeri* population is rather considered by IUCN (2024) as near threatened because it has experienced a moderately rapid population decline arising from trapping for export trade. From 2012 to 2014, IUCN (2024) had the species listed as endangered, and after its reassessment in 2015, it was re-categorised as critically endangered.

*Terathopius ecaudatus* is a long-lived, slow-maturing and slow-breeding species tending not to breed every year (Brown and Amadon, 1986; Simmons and Brown, 1997), and Watson (1990) noted that the probability for its annual replacement in East Africa was about 50%. Coupled with anthropogenic activities, *T. ecaudatus* was considered near threatened. Taylor and Kemp (2015) noted the population of *Bucorvus leadbeateri* to be on a decline, mainly due in part to its slow reproductive rates, persecution and habitat destruction, rendering them listed globally as vulnerable to threatened and as endangered in southern Africa.

**Services Provided by the Itigi-Sumbu Thicket Ecosystem**

Both timber and non-timber forest products (NTFPs) from ISTE were reported by the key informants to be directly obtained through extractivism. According to IFC (2019), the identified ecosystem services were four, namely; provisioning, regulating, supporting and cultural.

***Provisioning Services***

***Livestock Fodder***

Livestock grazing in the area could be considered a moderate priority environmental service, from the fact that livestock are an economic asset to the local community, however, their grazing was taking place within the forest area and was particularly heavy during the dry season, when there is not much left in the designated pasturelands. On a long-term basis, this service would not be sustainable. Improved grazing management principles therefore, would be beneficial. The important fodder materials for the livestock include *Cymbopogon* spp., *Heteropogon contortus, Hyparrhenia figariana, Flacourtia indica* and *Vachelia* spp.

***Medicinal Products***

Debarking of plants for medicinal purposes was relatively high, particularly with *Senna singuena, S. occidentalis, Desmodium intortum, D. repandum, Dombeya* spp., *Turraea floribunda, Lonchocarpus* spp. and *Zanthophylum chalybeum. Dombeya* spp. were also used for fibre and fuelwood. The indigenous knowledge of plant use as an aphrodisiac was noted on *Bussea massaiensis* seeds. Debarking of trees is obviously not sustainable if widespread and happening on a regular basis. There might be

 

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considerable dependence, but there were alternative medicaments available from the local pharmacies.

***Human Food Products***

ISTE was an important source of wild food of both floral and faunal origin. The harvesting of fruits, seeds and vegetable matter in the area could be conducted in a sustainable manner since there was no involvement in killing the resources and the presence of crops grown in the area and the improved crop production techniques enhanced the reduction of the demand. The important wild vegetables included *Launaea cornuta, Cleome gynandra, Amaranthus* sp., *Sesamum angunotifolium* and *S. angolense*. Table 9 presents the fruit and seed plant species, in which the key informants provided the vernacular names.

**Table 9: Wild Food Plant Species Recorded in the Itigi-Sumbu Thicket Ecosystem, Singida, Tanzania**

| Name | | | |
|---|---|---|---|
| **Scientific** | **Vernacular (Nyaturu)** | **Family** | **Product used** |
| *Afrocanthium burttii* (Bullock) Lantz | Njauma | Rubiaceae | Fruit |
| *Azanza garckeana* (F. Hoffm.) Exell & Hillc. | Mutrogho | Malvaceae | Fruit |
| *Balanites aegyptiaca* (L.) Delile | Mfughuyu | Zygophyllaceae | Fruit |
| *Boscia madagascariensis* (DC.) Hadj Moust. | Mutumba | Capparaceae | Fruit |
| *Bussea massaiensis* (Taub.) Harms | Mfetru/Mpetu | Fabaceae | Seed |
| *Cordia* sp. | Muhenwa | Boraginaceae | Fruit |
| *Grewia bicolor* Juss. | Musuna-nu-kuu | Malvaceae | Fruit |
| *Grewia conocarpoides* Burret | Musuna-wa-ufamba | Malvaceae | Fruit |
| *Grewia similis* K. Schum. | Mukhantokhanto | Malvaceae | Fruit |
| *Grewia* sp. | Musuna wa muwanga | Malvaceae | Fruit |
| *Grewia villosa* Willd. | Mumpembe | Malvaceae | Fruit |
| *Lannea schweinfurthii* (Engl.) Engl. | Musaghaa | Anacardiaceae | Fruit |
| *Searsia pyroides* (Burch.) | Msakasaka | Anacardiaceae | Fruit |
| *Strychnos cocculoides* Baker | Mudikhi | Loganiaceae | Fruit |
| *Vangueria infausta* Burch. | Mlade | Rubiaceae | Fruit |
| *Vangueria madagascariensis* J.F. Gmel. | Mlade | Rubiaceae | Fruit |
| *Vitex doniana* Sweet | Mufuu | Lamiaceae | Fruit |
| *Vitex ferruginea* Schumach. & Thonn. | Mufuu | Lamiaceae | Fruit |
| *Vitex mombassae* Vatke | Irwana | Lamiaceae | Fruit |
| *Vitex payos* (Lour.) Merr. | Mufuu | Lamiaceae | Fruit |
| *Ximenia caffra* Sond. | Munhundwe | Olacaceae | Fruit |

The area is also famous for the production of wild edible mushrooms collectively referred to as *madale* by the local Nyaturu people, particularly in the open woodland habitat. Table 10 presents a summary of the important edible mushroom species found in ISTE, as appreciated by the key informants in vernacular names.

The hunting of fauna in the general land had been reduced to the lesser creatures due to the removal of the larger species, suggesting that it was no longer sustainable. The important food fauna included *Madoqua* spp. (dik-dik), *Sus scrofa* (wild pig), *Phacochoerus africanus* (warthog) and a number of such birds as *Numida meleagris* (helmeted Guineafowl) and *Galloperdix lunulata* (panted spurfowl).

 

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**Table 10: Summary of Important Edible Mushroom Species in the Itigi-Sumbu Thicket Ecosystem, Singida, Tanzania**

| Name | | |
|---|---|---|
| **Scientific** | **Vernacular (Nyaturu** | **Family** |
| *Afroboletus luteolus* (Heinem.) Pegler & Young | Mahumbuka | Boletaceae |
| *Auricularia delicata* (Mont. ex Fr.) Henn. | Mareremа | Auriculariaceae |
| *Boletus spectabilissimus* Watling | Masonju ya nghuku | Boletaceae |
| *Cantharellus cyanoxanthus* R. Heim ex Heinem. | Makhalumbi | Cantharellaceae |
| *Cantharellus pseudocibarius* Henn. | Mampotra | Cantharellaceae |
| *Cantharellus rhodophyllus* Adans. ex Fr. | Masonju ya gidindi | Cantharellaceae |
| *Lactarius xerampelinus* (Karhula & Verb.) Verb. | Makanka nyama | Russulaceae |
| *Termitomyces microcarpus* (Berk. & Broome) R. Heim | Masisa | Lyophyllaceae |
| *Termitomyces singidensis* Saarim. & Härk. | Maghojoa | Lyophyllaceae |

**Other Non-Timber Forest Products**

Harvesting of NTFPs was at a moderately low level and supported the communities. Whereas *Bussea massaiensis, Terminalia sericea, Combretum collinum* and *Grewia* spp. were preferred for making hand tools, *Combretum* spp. and *Dalbergia melanoxylon* were priority species for woodfuel. *Bussea massaiensis* was also preferred for building poles and withies for local houses, which were grass thatched using *Hyparrhenia rufa*.

***Regulating Services***

The most important regulating service perceived by the local people was shade. Big and suitable shade trees in the modified habitats were retained for this purpose. The important species include *Vachelia* spp., *Afzelia quanzensis* and *Brachystegia* spp.

***Supporting Services***

Provision of bee forage and pollination services, soil formation, conservation and protection were among the important supporting services from the ecosystem. ISTE harbours ANBR, KFR and Manyoni and Kipondoda village forest and bee reserves with honeybees (*Apis* spp.) and a significant number of stingless honeybees (*Meliponula* sp). So far, in the general land area, this potential has partially been tapped using traditional beehives. URT (2022b) Placed this area in the highest honey production potential area in Tanzania, with 8,000 tons against the actual figure of 600 tons. Production of bee products provides a strong incentive to local communities to conserve the forest resources (URT, 2022b). Plants are responsible for the physical and chemical weathering of soil parent material. They also contribute to soil organic materials, protection from erosion and rejuvenation. The identified plants in the family *Fabaceae*, which harbour nitrogen fixing bacteria, enhancing enrichment of soils with nitrogen were 67 (17%). On the other end, the ISTE is a corridor that links the northern wildlife circuit to the southern regions. Large mammals such as elephants, buffaloes and elands utilise the area as a foraging ground and transitory route (Kideghesho and Maganga, 2000).

***Cultural Services***

Cultural services included spiritual and aesthetic values. Some of the identified species which had spiritual value are *Ficus sycomorus, F. thonningii* and *Jatropha curcas*, planted particularly on graveyards. Other species with spiritual value in the area included *Kigelia aethiopica* and *Commiphora* spp. Acquaviva (2019) appreciated the East African context of the cultural values of plants.

**Limitations of the Study**

Despite its valuable findings, the study encountered limitations in accessing data, particularly from the newly established Kilinga

 

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Forest Reserve, whose offices had not much to rely on.

## CONCLUSIONS AND RECOMMENDATIONS

ISTE is rich in species diversity however, human settlements, agriculture and gold mining and the need for forest products by the ever-growing human and livestock populations around, have modified the habitats in the general land category to be dominated by only a few species. The vegetation is being reduced and degraded rampantly. Moreover, some invasive plant species had been introduced in the area, particularly *Acacia mangium* spreading in the disturbed habitats. If current trends continue unchecked, the natural vegetation and its associated wildlife are not expected to persist for the long term.

The recorded species of flora and fauna of conservation importance call for concern over genetic erosion in many of their populations. Despite the fact that the conservation status of most of the identified species has not yet been evaluated, the whole ecosystem needs to be protected in order to safeguard the habitats. From the study, it could also be concluded that ISTE continued to provide ecosystem services, particularly in the conservation areas. In the general land, however, the role had been reduced to mostly the provision of NWFPs.

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