# Forest Fragments Connectivity to Save Two Critically Endangered endemic birds from possible extinction in the Taita Hills.

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by

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## Introduction

This work was conducted in the Taita Hills, Kenya principally to enhance landscape connectivity in three forest fragments (Ngangao, Yale and Vuria). Forest fragmentation is considered among the main causes of species extinction globally. The Taita Hills forests are extremely fragmented and are quickly losing their unique biota as a result. This forest fragments connectivity work is therefore critical and timely as it will promote interaction among isolated subpopulations of the Critically Endangered Taita Apalis, *Apalis fuscigularis* and Taita Thrush *Turdus helleri* to prevent inbreeding. Genetic factors affect extinction risk because threatened species have small and/or declining populations and in such populations inbreeding and loss of genetic diversity are bound to occur.
This work succeeded in raising over 170,000 seedlings representing 68 different native species meant to restore a 16ha belt connecting three vital forest fragments to facilitate species movement. This was done with full involvement of the local community who were also provided with the required skills and awareness.

## Study Area

The Taita Hills are located in south-eastern Kenya (3˚25'S, 38˚20'E) within Taita Taveta County and occupy an area of about 250km². The Hills form the northernmost part of the Eastern Arc Mountains, one of 34 global biodiversity hotspots. The Taita Hills are also ranked as one of Kenya's Important Bird and Biodiversity Areas (IBA) due to their avian richness. Unfortunately, the area has lost 98% of its natural forest cover over the last two centuries (Beentje, 1988). Only small forests that are highly fragmented currently remain on hill tops and steep valleys, surrounded by mosaics of settlements. The remaining natural vegetation cover occupies only about 500ha existing in small fragments some as small as 1ha and far distanced from each other. The massive fragmentation has continuously caused severe biodiversity loss of flora and fauna as well as huge change in the general area landscape. This work targeted three forest fragments of the Taita Hills (Ngangao, Yale and Vuria) which are relatively close to each other and critical for connectivity in efforts to save two Critically Endangered, endemic bird species from possible extinction.

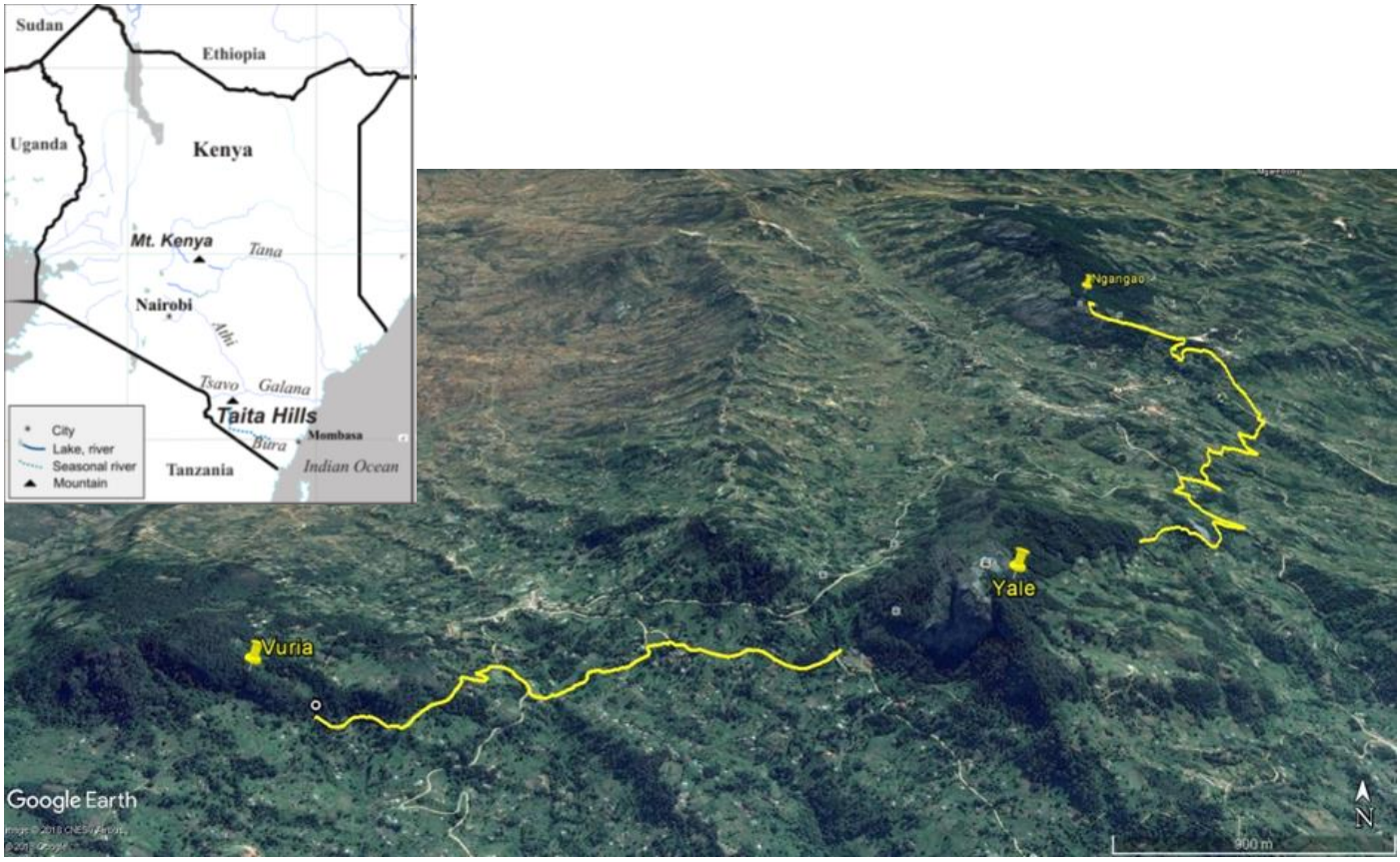


Fig 1. Location map of the Taita Hills and Google image showing the restoration belt connecting three forest fragments (Vuria, Yale and Ngangao)

## Aim of the project work

The main aim of this project work was to conduct landscape connectivity through restoration of a continuous belt (8km by 0.02km) that would connect three forest fragments (Ngangao Yale and Vuria).
The work aimed at facilitating the interaction of different sub-populations of Taita Apalis, *Apalis fuscigularis* and Taita Thrush, *Turdus helleri* both of which are Critically Endangered birds endemic to the Taita Hills. This would significantly reduce inbreeding among isolated small populations to save the two species from becoming extinct. Restoration along the proposed belt committed to returning the system to a close approximation of the original ecosystem that would be self-sustaining.

320,000 seedlings of a variety of native species were targeted to be raised and to be later planted on the identified 16 hectare belt. This would see an increase in Taita Hills natural vegetation cover by about 3.2% that would provide critical habitats and corridors for the target species and with expected spill-over benefits

to many other species. The project involved the local community members at all levels during which they were provided with environmental education. The requested amount was meant to support the initial part of this project which involved raising the required seedlings.

## Methods

### Restoration belt survey

The target areas among the three forest fragments (Ngangao, Yale and Vuria) were surveyed in order to identify the most appropriate sites for the restoration belt. Several aspects were put into consideration during the survey which included land ownership and willingness of the land owners to embrace the idea both of which were critical in determining the success and the future of the restored belt. Therefore, the restoration belt was set to mostly run through communal and government owned land located within the intend range since they were perceived as safe from future encroachment. Due to the small size of land in the areas, the belt was set to mostly pass in-between two differently owned plots where applicable so that each owner can allow 10metres width of his/her land. The owners of the land along the identified area were then approached and successfully convinced. The selected belt continuously stretches 8km long by 20 metres width connecting three forest fragments.

### Plant species survey

A quick but detailed vegetation survey was carried out in the existing forest fragments in order to understand the composition and structure of the original natural vegetation cover. Existing literature on the flora of the Taita Hills was also sought to avoid the bias emanating from the forest disturbance over time. The vegetation survey focused on trees and shrubs. This was crucial in determining the right species to plant, where to plant various species and the planting ratio of each species hence ensuring that the area was restored to almost its original state.

### Seed acquirement and propagation

78 kilogrammes of seeds of 44 different native species were acquired from local people and the Kenya Forest Service (a parastatal that is the forests' custodian). An additional 22 native tree/shrub species were cautiously collected as wildings from the existing forest fragments. These wildings were from the species that are hard to propagate and those that take a long time to germinate. Two species that readily grow from cuttings were also acquired from the existing forests. (See Table 1 for a summary of all species acquired and the mode of propagation).

Two community conservation groups (Yale Angamiza and Dabico) were fully involved in the preparation and seed propagation in the nursery beds under the supervision of the principal investigator. The two identified groups had some past experience in similar work.

## Results

The survey carried out on species variety and density provided guidance on the kind of species and the number of seedlings to be raised as well as areas to be planted depending on the landscape. A total of 178,141 native seedlings of 68 different species were successfully raised (44 species in propagation beds, and 24 wildings collected that included cuttings). The propagation beds were placed in two operation sites (Yale and Ngangao) both near the forests. The plant species included endemic, globally threatened and rare species. The number of seedlings raised was above half the targeted number (320,000). The work was entirely done by two local groups from the two different sites under supervision. The two groups received training prior to the beginning of the work and as work progressed. Eight local schools were also invited to visit the sites for environmental awareness.

Although the project managed to raise a good number of many varieties of seedlings, most of the seedlings later died as a result of the extreme drought that occurred in 2016 and 2017. This extended drought that was witnessed throughout the country was unexpected and beyond our control. The project's next move of planting the raised seedlings was therefore not achieved. The few remaining saplings were shared among the group members to plant in their respective lands. Given the huge investment in terms of resources and time dedicated, this was considered such a huge loss that the team explored ways to recovery through a volunteer basis. We are currently taking advantage of the 2018 heavy rains to raise seedlings that will be used to accomplish the initial intended purpose.

Table 1 below shows the varieties of species propagated, the number of each species and the mode of propagation.

| Species | Type | No. of seedlings | Mode. of germination |
|---|---|---|---|
| ***Afrocarpus usambarensis*** | Tree | 608 | Wildings |
| ***Albizia gummifera*** | Tree | 7000 | seeds |
| ***Aphloia theiformis*** | Tree | 4100 | Seeds |
| ***Apodytes dimidiata*** | Tree | 2000 | Seeds |
| ***Bridelia micrantha*** | Tree | 4000 | Seeds |
| ***Brucea antidysenterica*** | Shrub | 6040 | Seeds |
| ***Canthium oligocarpum*** | Shrub | 5000 | Seeds |
| ***Celtis africana*** | Small tree | 2000 | Seeds |
| ***Celtis gomphophylla*** | Tree | 850 | Seeds |
| ***Chassalia discolor*** | Shrub | 6000 | Seeds |
| ***Chassalia parvifolia*** | Shrub | 4000 | Seeds |
| ***Chrysophyllum gorungosanum*** | Tree | 670 | Seeds |
| ***Clausena anisata*** | Shrub | 7000 | Seeds |
| ***Coffea fadenii*** | Shrub | 100 | Wilding |
| ***Cola greenwayi*** | Tree | 2050 | Wilding |
| ***Craibia brownii*** | Tree | 700 | Wilding |
| ***Croton macrostachyus*** | Tree | 4070 | Seeds |
| ***Croton megalocarpus*** | Tree | 2000 | Seeds |
| ***Cussonia spicata*** | Tree | 400 | Wildings |
| ***Dasylepis integra*** | Small tree | 1200 | Seeds |
| ***Dacranolepis usambarica*** | Shrub | 800 | Wildings |
| ***Dovyalis abyssinicas*** | Shrub | 3670 | Seeds |
| ***Dracaena afromontana*** | Shrub | 2900 | Cuttings |
| ***Dracaena laxissima*** | Shrub | 2700 | Seeds |
| ***Dracaena steudneri*** | Shrub | 3100 | Cuttings |
| ***Drypetes gerrardii*** | Small tree | 1800 | Seeds |
| ***Ekebergia capensis*** | Tree | 1400 | Seeds |
| ***Ensete vetricosum*** | Herb | 60 | Wilding |
| ***Garcinia volkensii*** | Small tree | 430 | Seeds |
| ***Lepidotrichilia volkensii*** | Shrub | 2500 | Seeds |
| ***Leptonychia usambarensis*** | Tree | 4000 | Seeds |
| ***Macaranga capensis*** | Tree | 4900 | Seeds |
| ***Macaranga conglomerata*** | Tree | 1176 | Seeds |
| ***Margaritaria discoidea*** | Tree | 250 | Wildings |
| ***Maytenus acuminata*** | Shrub | 400 | Seeds |
| ***Meineckia ovata*** | Shrub | 1580 | Wilding |
| ***Memecylon teitense*** | Shrub | 1347 | Wildings |
| ***Millettia oblata* subsp. *teitensis*** | Tree | 6400 | Seeds |
| ***Neoboutonia macrocalyx*** | Tree | 1067 | Seeds |
| ***Newtonia buchananii*** | Tree | 5700 | Seeds |
| ***Nuxia congesta*** | Tree | 2360 | Wilding |
| ***Nuxia floribunda*** | Tree | 930 | Wilding |
| ***Obetia radula*** | Small tree | 15 | Wilding |
| ***Ochna holstii*** | Small tree | 3400 | Seeds |

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|---|---|---|---|
| ***Olea europaea* subsp. *cuspidata*** | Small tree | 58 | Wilding |
| ***Oxyanthus speciosus*** | Shrub | 2610 | Wilding |
| ***Pauridiantha paucinervis*** | Shrubs | 4140 | Seeds |
| ***Phoenix reclinate*** | Palm tree | 3582 | Wilding |
| ***Podocarpus latifolia*** | Tree | 359 | Wildings |
| ***Polyscias fulva*** | Tree | 1180 | Wilding |
| ***Polyscias stuhlmannii*** | Tree | 97 | Wilding |
| ***Pouteria adolfi-friedericii*** | Tree | 1510 | Seeds |
| ***Prunus africana*** | Tree | 6000 | Seeds |
| ***Psychotria petitii*** | Shrub | 5040 | Seeds |
| ***Psychotria pseudoplatyphylla*** | Shrub | 3600 | Seeds |
| ***Rapanea melanopphloeos*** | Tree | 3948 | Seeds |
| ***Rauvofia mannii*** | Shrub | 2300 | Seeds |
| ***Ritchiea albersii*** | Small tree | 1900 | Seeds |
| ***Rytigynia eickii*** | Shrub | 1150 | Seeds |
| ***Strombosia scheffleri*** | Tree | 3100 | Wilding |
| ***Syzygium guineense*** | Tree | 3300 | Seeds |
| ***Syzygium sclerophyllum*** | Tree | 1028 | Seeds |
| ***Tabernaemontana stapfiana*** | Tree | 5080 | Seeds |
| ***Turraea holstii*** | Shrub | 3211 | Seeds |
| ***Vangueria volkensii*** | Shrub | 2735 | Seeds |
| ***Vepris simplicifolia*** | Small tree | 5060 | Wilding |
| ***Vitex keniensis*** | Tree | 2421 | Seeds |
| ***Xymalos monospora*** | Small tree | 2059 | Wilding |

## Discussion

Habitat fragmentation is considered among the main causes of species extinction globally. (Laurance & Bierregaard 1997). The Taita Hills forests that host many endemic species of flora and fauna are severely fragmented. Two bird species, Taita Apalis *Apalis fuscigularis* and Taita Thrush *Turdus helleri* are endemic to the Taita Hills. The two species are listed as Critically Endangered (IUCN Red List, 2018). Their population continues to show drastic decrease due to several overarching factors that include genetic factors due to inbreeding.

A recent demographic study revealed a population crash for *A. fuscigularis* with a global population of only 650 individuals and only 1,200 for *T. helleri* (Borghesio *et al*, 2014). A more recent population study carried out in 2017 shows that less than 200 individuals of *A. fuscigularis* now remain (Borghesio *et al* Unpublished data). *A. fuscigularis* has completely disappeared in three forest fragments (Mbololo, Chawia and Fururu) within a period of four years. One of the major causes for the quick disappearance of these species is thought to be loss of genetic diversity. Genetic factors affect extinction risk because threatened species have small and/or declining populations and in such populations inbreeding and loss of genetic diversity are unavoidable (Frankham *et al*, 2002).

Increasing landscape connectivity is considered vital to enhance the long-term survival of small, isolated populations in fragmented landscapes (Brooker et al. 1999). Both *A. fuscigularis* and *T. helleri* are natural habitat specialists and exist in isolated sub-population in only four Taita Hills forest fragments. The inability of the two species to migrate between fragments is leading to inbreeding among isolated small populations. Inbreeding depression and loss of genetic diversity is known to contribute to extinction risk in most wild populations of naturally outbreeding species (Frankham, 2005). Inbreeding is reduced following crossing of unrelated populations, even if those populations are themselves inbred. Connectivity achievements would ensure free movement and interaction of different populations of the target species allowing breeding of unrelated populations from different forest fragments to occur.

This forest connectivity work is therefore a vital and timely undertaking to safeguard these species and other species that may be experiencing the same threat in Taita Hills forest fragments. This work prioritizes connecting forest fragments that are known to host high numbers of the target species (Vuria, Yale and Ngangao) which are also in close proximity making it the area with highest potential. The local communities in the Taita Hills generally show a very positive attitude towards indigenous trees and many are willing to plant trees that complement their farming and supply some of their needs (Githiru *et al,* 2011). This restoration work will not only benefit the target species but will also deliver many other benefits to the community members that will include the sale of carbon credits, increased rainfall, protection from soil erosion, woodlots and sites for apiary, landscape beatification and nature-based-tourism.

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Figure 2: Training on tree-planting at Yale site

Figure 3: Tree nursery at Yale site. Most seedlings died due to drought.

Figure 4: Tree nursery at Ngangao site 1

Figure 5: Tree nursery at Ngangao site 2