Project Update: September 2018

Introduction

Population occurrence of the tree species depends on many factors including climate, elevation, land-use and soil characteristics. Despite the wide occurrence of baobabs in many African countries, the populations have been reported to be restricted to the semi-arid areas only. Several studies have shown that the population structure of the baobab is influenced by land use and human activities through economic and socio-cultural uses of the tree (Wilson, 1988; Schumann *et al*., 2010; Van den Bilcke *et al*., 2013). There have been records of increased reduction in baobab populations across Africa (Leach *et al*., 2011), with some predictions that the species will be threatened in future due to effects of climate change caused by the change in land use and global warming (Sanchez *et al*., 2010). Also, the high demand for baobab products and associated changes in land use (exacerbated by human activities and climate change) are major factors that may threaten the occurrence of baobabs (Dhillion and Gustad, 2004; Venter and Witkowski, 2010; Schumann *et al*., 2011). Despite the importance of the baobab to local communities in the semi-arid regions of Tanzania, data on the distribution of the species is limited and no known study has quantified the distribution hotspots of baobabs in Tanzania. Also the effect of environment factors on baobab populations is not well understood. The aim of this study was therefore to describe the spatial distribution of baobabs populations in the semi-arid regions of Tanzania and assessing how environment factors affect the baobab populations. This study addressed the following questions: What is the current distribution of baobabs in the semi-arid regions of Tanzania? How does the distribution of baobabs vary with land uses and environmental factors? I hypothesized that land use and environmental variables (annual rainfall, temperature, and elevation), and especially rainfall will be stronger drivers of baobab distributions than temperature and elevation.

Data Collection

Research design and sampling strategy within land use types

Prior to field sampling, trees were sampled in the semi-arid regions of Tanzania from February to August 2018. The regions constituted of strictly protected areas; non-strictly protected areas and unprotected areas that were identified. A stratified systematic random sampling design was used. Grids were selected randomly from maps for each of the three land-use types. Each grid was 20 km × 20 km and one strip transect measuring 1km long and 50m wide (i.e. 5 ha) was established in the northwestern corner of the selected grids.

Pre-field work

Before the main field data collection, reconnaissance survey was carried out in the study area. The main aim was to get the actual information about the terrain characteristics, land use systems and baobab distribution as well as to reconcile the reality with the information obtained from topographic map. Several definitions of land use exist but there is one in common denomination in all definitions. They all refer to certain types of management activities conducted by a man on a tract of land. DeBie (2000) defined land use as "a series of operations on land, carried out by humans with the intention to obtain products and/or benefits through using land resources". The focus of this study was on baobab distribution in certain land use types other than government's gazetted towns, urbans, formal settlements and cities. Therefore, land use was restricted to forms of human management of vegetation that turns out to affect baobab species. Land use in this study therefore referred to: (1) strictly protected areas; (2) non-strictly protected areas and (3) unprotected areas.

Coordinates of all sampled points were plotted on maps and imputed in a Global Positioning System (GPS). The nearest land use to a sample point was firstly located by using the combination of digitized land use map of the study area, sampled points map and the topographical map. At each land use type, the sampled point was navigated, following the GPS reading until the GPS direction became perpendicular to the direction that could be used to reach the desired point. The size of each grid was calculated during reconnaissance survey to ensure proportionate distribution of the sample points, which is a requirement of stratified random sampling.

Field work

Using a topographic map of the study area in combination with some level of knowledge of the site about the baobab distribution and density in relation to the major land use types, the study area was marked into grids of 20 x 20 km. For a given sampling error, stratification ensures reduced number of sampling units and improved precision (Kent and Cooker, 1992). Based on the background hypothesis for this study, it is assumed that each grid is uniform in terms of baobab density. Also, each land use type was assumed to be uniform. The climate map was constructed from more than 30 years of rainfall and temperature data to reflect the distinctive patterns/gradients of this across the study area.

A total of 337 grids (40% of total 842 randomly selected grids) were surveyed for the study. The number of surveyed plots in each land-use type was determined by their relative sizes: strictly protected area had 21 plots; non-strictly protected areas 26 plots and unprotected areas had 68 plots. In each of the plot, information on the number of baobab stems and land uses were documented. Formal and informal discussions were conducted to find out historical occurrence of baobabs in the area, different management practices and their impacts on the species**.** All baobab trees in each transect were counted. Transect coordinates were used to estimate. The actual GPS points of the surveyed transects were overlaid on the total annual mean rainfall and annual mean temperature maps covering the last 30 years (TMA, 2014) to reconstruct rainfall and temperature data.

The following activities have been accomplished:

1. Ecological surveys were conducted in selected protected areas as well as in the communal land in the semi- arid regions of Tanzania.
2. Baobabs were sampled between February and August 2018 using transects of 1km long and 50m wide within established and randomly selected grids of 20km× 20km.
3. Collected baobab fruits, prepared baobab seeds for oil extraction.
4. Identified tree major ethnic tribes (Gogo in Central region, Hehe in Southern region and Pare in Northern region) for the ethno-botanical importance

assessment. This will focus on the use vales and patterns of African baobab and their perceptions on the utilization of the baobab tree in different semi-arid regions.

5. Developed the socio-economic data collection tools.
6. Prepared two draft manuscripts to be submitted to peer reviewed journals: The titles of the manuscripts are: (1) Emerging issues associated with conservation of the African baobab (*Adansonia digitata* L.) in the semi-arid zones of Tanzania and, (2) Pinpointing baobab (*Adansonia digitata)* population hotspots in the semi-arid regions of Tanzania

Preprimary findings

The potential area for baobab population in semi-arid region of Tanzania is shown in (Figure 1) however, out of 842 grids a total of 337 selected grids were surveyed and it was observed that 115 (34.12 %) grids had baobabs in the semi-arid region of the Tanzania. Uninformed distribution of baobabs in semi-arid region was observed. The absent of baobab population to the rest of the grids might due to environmental factors and anthropogenic activities. Most of baobab populations concentrated in the central regions (Dodoma and Singida) running from the southern central parts (Iringa) to the northern central parts (Manyara and Kilimanjaro). The regions with more baobab populations were Dodoma and Singida regions. This was probably due to the economic and social importance of the baobab products to the local communities living on those areas. It might also be due climatic factors that favor the growth of the species.

Baobab abundance varied substantially and significantly across land use types in the semi-arid region ($F_{2, 115} = 6.806$, $p = 0.002$) after controlling for rainfall, temperature and elevation. It appears that baobabs are sensitive to both land use and the environmental factors.

The highest baobab abundance (11.43±7.26 trees) was observed in strict protected areas while lowest abundance (7.58±4.94 trees) was recorded in non-protected areas (Figure 2). Based on *post hoc* LSD multiple comparisons baobab abundance was greater for strict protected areas than in the non-strict and non-protected areas. As expected, significant difference in baobab abundance in strict and non-protected areas ($p = 0.026$) was found. Furthermore, there was a marginal significant difference in baobab abundance in strict and non-strict protected areas ($p = 0.05$). However, no significant difference in baobab abundance was observed in non-strict protected and non-protected areas ($p = 0.42$).

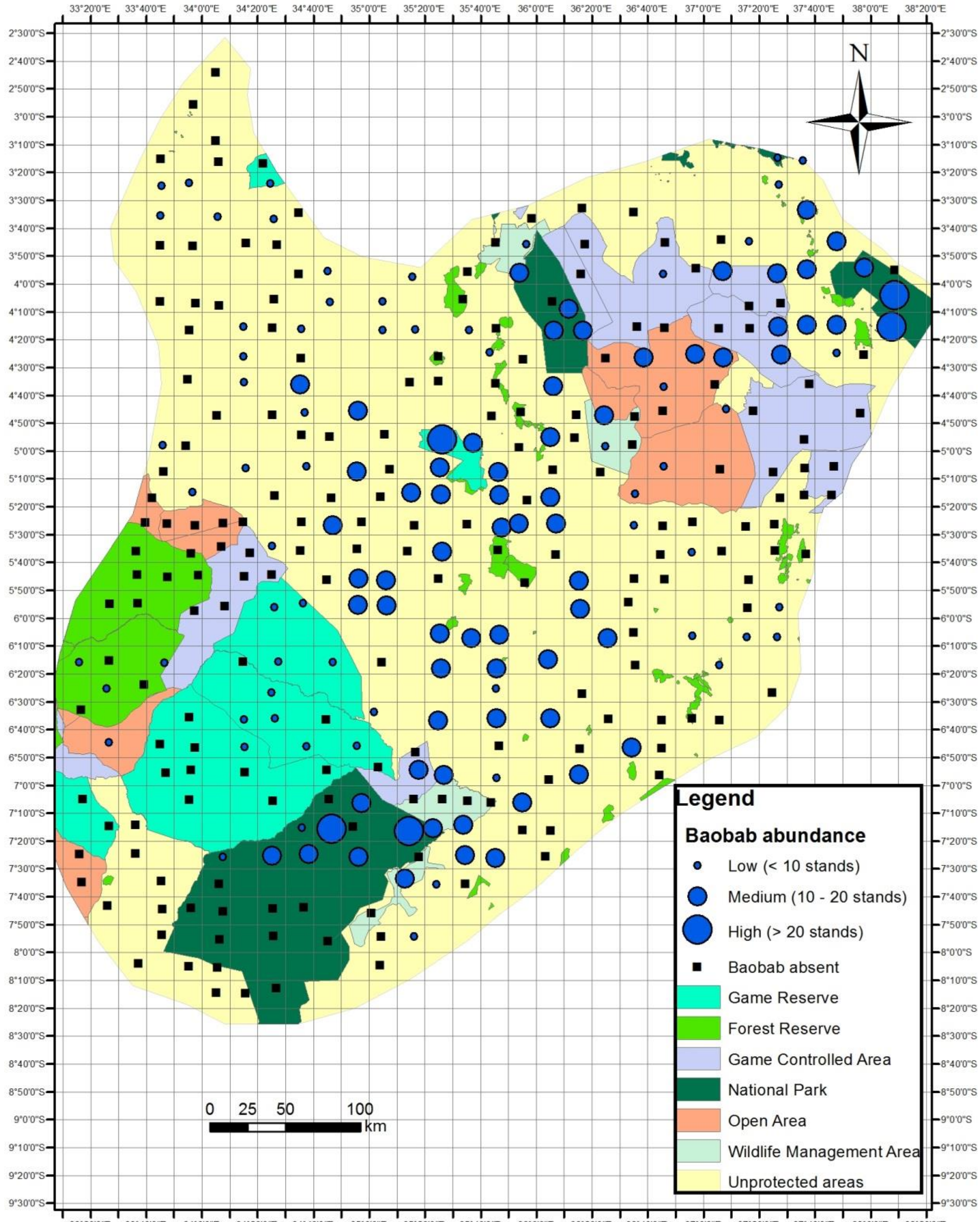


Figure 1: Map showing baobab abundance in the semi- arid regions of Tanzania

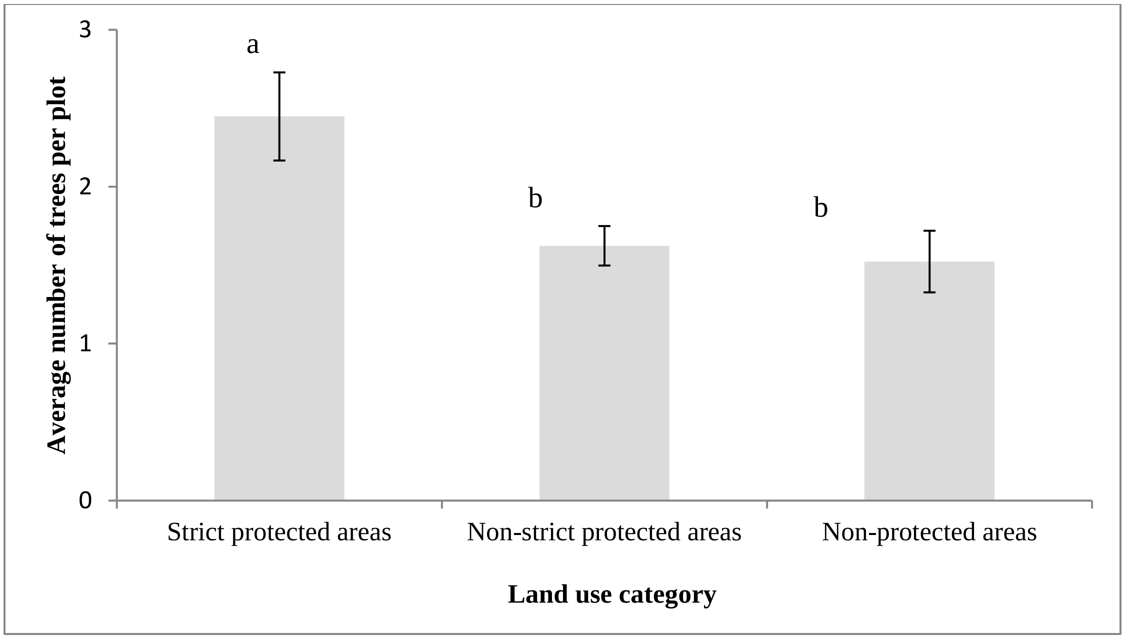
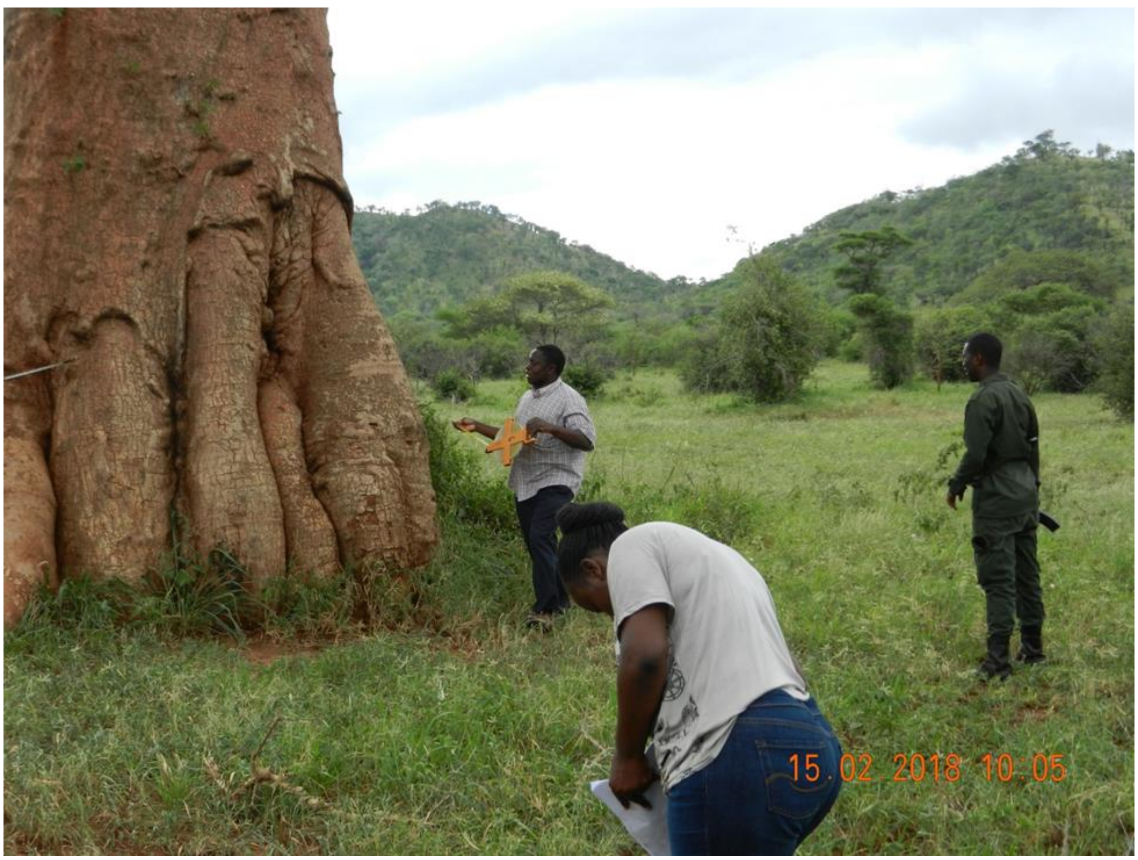


Figure 2: Mean density (number of individuals/ha, ±S.E.) of *A. digitata* in different land-use types, bars marked with different letters (a and b) are significantly different (p = 0.05).



Upendo, field assistant and the Park guard during field data collection in Mkomazi National Park

Upendo measuring the circumference of the baobab tree in Dodoma region

Next activities

The following activities will be done before the end of the project:

1. Continue with the analysis of the field collected data on baobab population structure
2. Preparation of the manuscript on baobab population structure.
3. Ethno-botanical importance assessment. This will involve collection of the socio-economic data from the three major ethnic tribes (Gogo in Central region, Hehe in Southern region and Pare in Northern region).
4. Determination of the physical and chemical properties of the baobab seed oil.