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THINK NAMIBIA
Sustainable Forest Management

FACT SHEET ON:

Forest Inventory

The purpose of this fact sheet is to share information on forest inventories and their importance in ensuring Sustainable Forest Management and their importance in Community Forest establishment.

INTRODUCTION

One of the key aspects in forestry resources use is to quantify the resources that are available in a forested area; this is usually done through forest inventories. Forest inventories were first developed out of fear of forest resources' running out in Europe. Over a century later, inventories are conducted all over the world.

Although inventories were initially developed to assess the availability of timber, they have become an important tool in the continuous management of forest resources. Forest inventories are also a key tool in the registration process of Community Forests, which are aimed at supporting Sustainable Forest Management in the country. A wide array of inventory techniques is used in Namibia, ranging from basic field surveys to more advanced remote sensing techniques. Local communities within Community Forests are encouraged to carry out inventories as a means of keeping track of available forest resources, and of complying with requirements for their Community Forest registration and harvesting permits.

WHAT IS A FOREST INVENTORY?

Forest inventory is defined as the systematic collection and description of data on forest resources in a certain area. Inventories generally follow a four-step process.

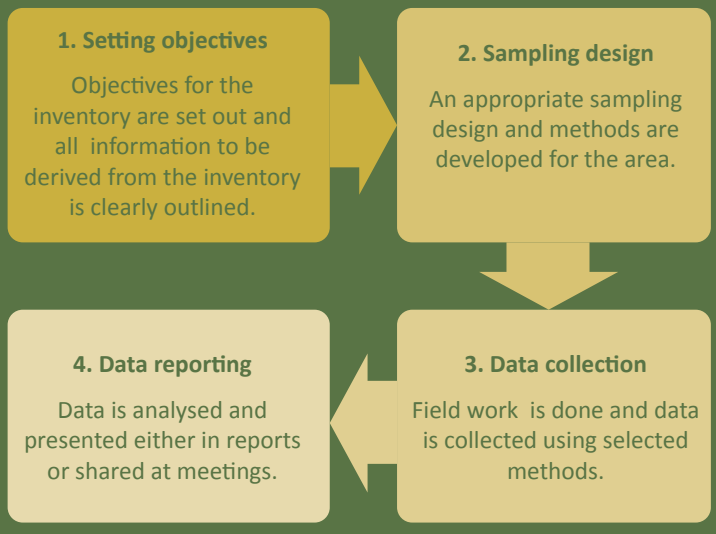

Figure 1: The four-step process to conducting inventories

Inventories provide quantitative or qualitative information on the size, amount, composition, diversity, and state of a forest's resources. They are also important in providing information on the growing stock within a forest ecosystem.

According to the FAO, growing stock is the ***"volume over bark of all living trees more than X cm in diameter at breast height (DBH)". This includes the stem from ground level or stump height up to a top diameter of Y cm, and may also include branches up to a minimum diameter of W cm. Each country defines their X, Y, and W values.***

WHY ARE FOREST INVENTORIES IMPORTANT IN SUSTAINABLE FOREST MANAGEMENT?

Forest inventories serve as a crucial tool in forest management and are carried out to plan and monitor sustainable resource use, especially timber.

- Inventories are important in determining the quantity of forest resources available for use and harvest, especially in the drafting of forest management plans and issuing of harvesting permits.
- Inventories provide data for research on tree growth, which makes it possible to determine yield.
- Certain inventory aspects, such as tree regeneration, growth, and mortality, serve as good indicators or warning systems for climate and other environmental changes.
- Inventories are also important in visually estimating the quality of forest timber and assessing potential fire risks. This is important in developing preventive actions and awareness.

DATA COLLECTION TECHNIQUES OF A FOREST INVENTORY

The data collection will depend on the objective and budget of the inventory, and on the human resources available.

- **The purpose or objective of the inventory**: A survey can be once-off or repeated. National forest resources assessments are normally repeated every 10 years. Most forest inventories aim to quantify timber. Sometimes there are additional objectives, such as describing forest structure.
- **The scale of the inventory:** It may be for a small or a large area.
- **The skills or human resources:** Which skills and human resources are available to carry out the inventory?
- **The availability of supporting information:** For instance, is aerial and satellite imagery available?

Field survey

The field survey method allows data to be collected on the ground by forest inventory teams. This can be a cost-effective method for local communities. A sample of the area can be surveyed, as large scale inventories would cost more. Ideally, permanent sampling plots are established; these can be surveyed frequently, depending on data needs.

Photo 1: Assessing tree cover in a field survey (Credit: N. Baptista)

The Namibia Finland Forestry Programme was instrumental in conducting the regional forest inventory in the 1990s. The inventories were conducted in the northern and north-eastern parts of the country, using a field-based method of nested circular plots to collect data. This approach works well for open forests in dry climates.

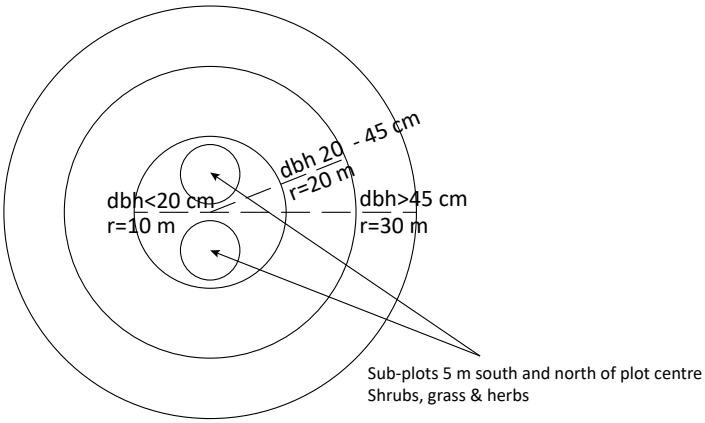

Figure 2: Nested plot design (Burke, Juola & Korhonen, 1996)

Table 1: Basic field measurements and required tools

MEASUREMENTS	TOOLS REQUIRED
Diameter	Diameter tape, tree calipers, or measuring tape
Height	Clinometer or long pole
Vegetation cover	Measuring tape (line transects)
Dendrochronology	Increment borer
Location	Global positioning system (GPS)
Regeneration	Measuring stick
Canopy cover	Bitterlich gauge

Drone imagery

Drone imagery is an innovative approach to performing vegetation inventories. It allows for rapid and efficient assessments of vegetation cover and even tree height over larger continuous areas. For areas of several km², they are cheaper than aerial photography or satellite imagery with similar resolution. The use of drones is an approach that requires technical skills and know-how in implementation, which can be obtained through partnerships with institutions such as universities that carry out ecological research using drones. Some field surveys will still be necessary for measurements, such as tree diameter, which are important in forest inventories.

Photo 2: A drone used for vegetation cover assessments (Credit: V. Amputu)

Remote sensing (GIS)

Remote sensing involves the acquisition of data from planes or satellites. Aerial photos or satellite images can be used to determine the extent of forest coverage and to estimate wood volume, forest density, and biomass over large areas. The use of near-infrared allows assessing the health of trees when they have leaves. Repeated assessments can be used to estimate changes in vegetation cover and other parameters over years. Remote sensing data can also be used to plan a field survey. Specialised training and software licences are required to be able to use remote sensing as a tool in inventories. The use of remote sensing in Namibia is hindered by open canopies in the forest areas, leading to images with mixed pixels: they combine the reflectance of trees, shrubs, soil, and sometimes even fire scars, making it difficult to distinguish forest and shrubland.

Figure 3: QGIS is an open source GIS tool that allows the study of remote sensing data (https://qgis.org)

Estimation of growing stock and biomass

The first step towards estimating growing stock is determining the forested area.

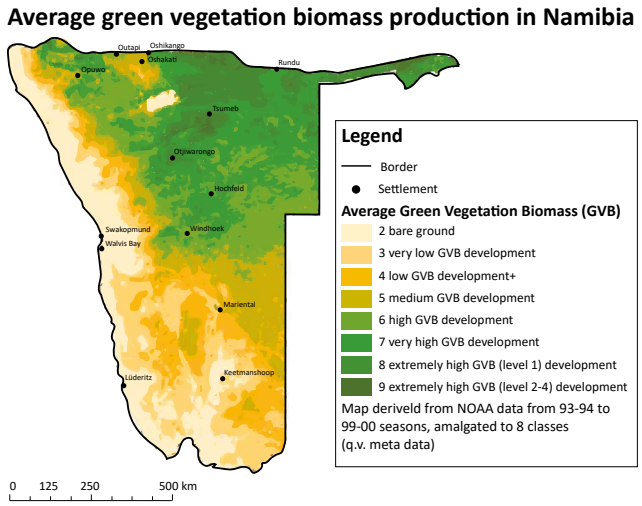

Figure 4: Vegetation biomass can also be estimated using remote sensing, which is relevant to determining carbon sequestration (Credit: University of Cologne)

In Namibia the growing stock is calculated with volume equations for all trees of more than 5 cm in DBH and includes all branches. The equations were established as part of the Namibia Finland Forestry Programme and are based on trees felled in four regions, namely Zambezi, Otjozondjupa, Oshikoto, and Omusati.

Estimation of tree growth using dendrochronology

Dendrochronolology is the study of annual growth rings in trees by assigning the ring formations to specific years or seasons. It is used to determine the age of trees and assess plant responses to different climatic conditions or to climate change. Dendrochronology is, however, not often used in Namibia because many tropical trees do not have annual growth rings, and the occurrence of annual growth rings has to be tested for each individual Namibian tree species. Considering the country's vulnerability to climate change, an alternative method has been used in estimating the ages of timber species based on their stem diameter.

Photo 3: Using an increment borer to collect a tree core for dendrochronology

Table 2: Summary of vegetation parameters that can be measured by the different methods

	Field surveys	Drones	Remote sensing
Extent of coverage	No	Yes	Yes
Diameter	Yes	Yes, through a relation between crown diameter and trunk diameter	Yes, through a relation between crown diameter and trunk diameter
Height	Yes	Yes	Yes
Density estimations	Yes	Yes	Yes
Health and vitality of trees	Yes	Yes	Yes
Biomass and volume estimations	Yes	Yes	Yes
Tree growth	Yes	Yes	Yes

Different methods serve different purposes and vary in terms of implementation costs and required skills. The methods can however be used in a complementary manner, which can be achieved through stakeholder partnerships and constant skills development.

CITIZEN SCIENCE AND COMMUNITY INVOLVEMENT IN FOREST INVENTORIES

It is important for communities to get involved in forest inventories as it is an informative tool for their planning and management activities. It also serves as a good opportunity for capacity building and creating a sense of ownership.

- Some of the basic parameters in field surveys can be carried out by the community's appointed forestry rangers, some communities, such as the Likwaterera Community Forest, have been able to do this successfully.
- University students, preferably from the area, could be employed to carry out forest inventories as part of their studies and in cooperation with the community.
- Schools from within or near Community Forests can be encouraged to contribute to forest inventories as part of their environmental club outdoor activity.
- Collaboration and partnerships are highly encouraged, especially with local universities and research institutions, as these are good platforms for skills training in forest inventory methods, analysis and interpretation.

Forest inventories are a crucial component of forestry management and an important source of information for decision making. The inventory methods that a community selects must be in line with their capacity, to ensure that they can continue collecting data on a regular basis. It is however crucial for them to realise the benefit of partnerships with institutions that can help improve their forest inventory programmes.

GLOSSARY

Canopy cover:
Also known as crown cover, is the proportion of ground that is covered by the projection of tree crowns.

Dendrochronology:
A scientific method of determining the age of trees by using tree rings.

DBH:
Diameter at breast height, is the diameter of a tree measured at a height of 1.3 metres from the ground.

Forest biomass:
Includes all parts of trees, such as the trunk, the branches, the leaves, and even the roots.

GIS:
Geographic information system, is a system by which spatial and geographical information is captured, analysed and used to create maps.

Remote sensing:
The process of acquiring information about a project from a distance, by using satellites or aircraft.

Vegetation cover:
The percentage of the ground that is covered by vegetation. This can include various types of vegetation, such as grasses, herbs, and trees.

Yield:
The amount of forest material or resources available for harvesting and use.

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Author: Miya Kabajani

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FOR MORE INFORMATION CONTACT THE NSFM-PROJECT:
Hanns Seidel Foundation (HSF) Namibia, House of Democracy
70-72 Dr Frans Indongo Street, Windhoek West; P.O. Box 90912, Klein Windhoek, Windhoek, Namibia

Tel: +264 (0) 61 237 373 Email: sustainability@hsf.org.na www.thinknamibia.org.na

facebook.com/thinknam twitter.com/thinknamibia instagram.com/thinknamibia/

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