Use of DNA Technology in Combating Illegal Trade and Promoting Conservation and Sustainable Use in Kenya and Tanzania

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• Plants play important roles in local economic growth and poverty alleviation.

• They enhance food security, environmental protection and climate change mitigation.

• Their benefits are transboundary and loss of forests and forest cover affects all sectors of the economy at all levels.

• The management of plant resources in Africa need to be based on scientific data to inform policies, legislation, institutional development, supportive linkages, sustainable management, research, technology transfer and market knowledge management.

• The resource manager now needs a mix of scientific, social science and business expertise
Introduction

• Most plants, are valued as herbal remedies, beauty products, ornamentals etc.
• Commercial trade is the largest threat to wild plant populations
• Wildlife traffickers poach and ship them as roots, barks, powder etc., a form not easily identifiable.
• DNA barcodes can be used in identification and verification of such samples
Introduction

• About a year ago, here in South Africa, the 17\textsuperscript{th} CITES Conference of the Parties included more than 900 tree species under the CITES Appendices \textit{(enforcement and regulation challenge)}

• Concern that long-term survival, of commercially valuable tree species may be threatened by over-exploitation,

• Financial assistance be provided to Parties in conservation and management measures to ensure that trade in timber, bark, extracts and other products from CITES-listed tree species is sustainable, \textit{legal and traceable}.

The expected outcomes:

• Sustainable management of rare tree species and their products

• Contribute to legal, traceable, and fair trade in products from CITES tree species

• Improve and strengthen forest governance, policies for forest management, and enforcement capacity and ensure benefit from long-term
EU contributes 8 million Euro to support the CITES tree species programme and the protection of African elephants

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Introduction

The Barcode of Wildlife Project Kenya (BWPK)- a Google Global Impact Award funded project, through CBOL

- It aims to demonstrate use of DNA barcode evidence in investigations, prosecution and convictions of wildlife crime
- Construction of reference BARCODE library to support Partner Country priorities
- All CITES-listed or nationally protected species selected by Partners and closely related/look-alike species
- Formal adoption and implementation by Partner Countries
Introduction

USAID PEER funded Project:

*Use of DNA Technology in Combating Illegal Trade and Promoting Conservation and Sustainable Use of Plants in Kenya and Tanzania*

• Create a database for plants in illegal trade

• To promote sustainable use of plants for ecosystem security and economic development

• Generate DNA Barcodes and create reference library

• Enable natural resources and CITES management authorities in Kenya and Tanzania to use barcode reference library for investigations and prosecution of wildlife crime
Market survey

- Questionnaires and PIC forms were developed and pre-tested before the market surveys.
- Visits were made to various markets in Kenya and Tanzania, questionnaires administered.
- Plant products on sale purchased (herbal products, seedlings, wood/products, carvings, seeds and lotions).
- Market samples were sub-sampled and used for lab protocol test.
- All interviewees signed PIC forms-in compliance with Nagoya Protocol.
# Results: Interviewee profiles and plants/products

<table>
<thead>
<tr>
<th>Kenya</th>
<th>Tanzania</th>
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<tbody>
<tr>
<td>• Number of Interviewees: 78 (51 males, 27 Females)</td>
<td>• Number of Interviewees: 40 (30 males, 10 Females)</td>
</tr>
<tr>
<td>• Religious affiliation: 5/78-muslim 73/78-Christian</td>
<td>• Religious affiliation: 15-non religious, 10/40-muslim, 15/40-Christian</td>
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<tr>
<td>• 675 market samples collected</td>
<td>• 522 market samples were collected</td>
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<tr>
<td>• 405 successfully identified</td>
<td>• 400 samples were successfully identified</td>
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<td>• Corresponding to 94 plant spp.</td>
<td>• Corresponding to 172 plant species.</td>
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<td>• 270 specimens referred by 139 local names/condition they treat yet to be identified</td>
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</table>
Market trends in plant products-Kenya

- Plants/plant products: Mostly Medicinal products-85%, Others-15%-Furniture, carvings, Ornamental, domestic,
- Herbal medicine contributes the highest diversity of wild-sourced plants in trade.
- Only Furniture (3% ) is part of the regulated market.
Herbal products
Herbal extracts

Roots and bark

Unsustainable harvest with conservation and sustainability challenges.
Other Market Products
Ornamental Plants
Domestic use products
Market trends in medicinal plants – Tanzania

Vendors of medicinal products harvest roots (49%), barks 18% or both 12% and leaves (16%) in commercial trade.

The predominant use of Root and bark (79% combined) for medicine poses major conservation and sustainability challenges.
• Most traders collect plant/products from the Wild (46%), or buy from collectors-middlemen (23%), or collect and buy (21%)
• Total of 3% import or buy from farm outlets, or stalls
Sources
Chain of commercial trade in plants and their products

Sources → Intermediaries → Destinations

- **Sources** - Open communal or private forests, woodlands, coastland, valleys/wetlands, farmlands, plant nurseries

- **Intermediaries** - Harvesters/collectors, processors/middlemen, vendors*, traditional healers

- **Destinations** - local markets, community, urban consumers, international customers

- Stall vendors* are common for Tanzania market
- Most Kenya collectors are the traditional healers-herbalists
- Hawking of herbal products common in the Kenyan market, renders it impossible to regulate the trade.
Challenges:

- Traders indicated the main challenges associated with collecting plants/products from wild as: Distance, and Availability (combined 60%).
- No challenges 21% (N/A)
- Others 11% - Theft, wild animals etc.
- Challenges associated with legislation - 8%
- Challenges of buying from middlemen: rare but they include: costs (15), delayed/unreliable delivery (13), unknown source/adulteration (5), N/A (21).
Ports of entry/exit points
Ports of entry/exit points
Field work

Field collection

- Field trips were undertaken to collect voucher specimens for Library creation.

- DNA specimens, plants for living collection and herbarium voucher specimens were collected.

- Vouchers specimens were sent to the NMK Herbarium, MUHAS and Botanic Garden for curation and management.

- Field information Management systems (FIMS) for the collected samples is being developed.
Fieldwork

Shimba Hills

Loita Hills

Lake Magadi

Kakamega Forest
Fieldwork
Fieldwork - Plants
DNA barcoding and Reference Library creation

DNA Extraction

- Field information Management systems (FIMS) for the collected samples developed, validated and uploaded
- Tissues sub-sampled to DNA barcoded tubes, Tissue barcodes generated and scanned into FIMS

Extraction process

- DNA - extracted from the tissue samples according to SOPs
- Uploaded in the Laboratory Information Management System
- DNA - aliquoted to DNA barcoded tubes for archival, Extraction barcodes scanned
- Extraction plates created & uploaded
Polymerase Chain Reaction (PCR)

• PCR with Barcoding primers- standardized across countries- *rbcl*, *MatK*, *nrITS*

• PCR plates created and uploaded

• Purified products (> 25ng) sequenced

• Created cycle sequencing plates upload

• Geneious version 10 used- connects FIMS & LIMS
DNA barcoding and Reference Library creation

Sequence Analysis standards

- Sequencing primers used for trimming
- Maximum of 2 mismatches & minimum match length of 10 bases
- Quality sequences passed in LIMs
- Generated barcode sequences submitted to NCBI GenBank with tag “Barcode”
Capacity development

- Legal standards workshops
- DNA barcoding chain analysis and informatics training for Tanzania.
- PhD studentship for Kenya.
- MSc. Studentship for Tanzania
Conclusion

• The global demand for plant products has increased at an alarming rate.

• DNA barcoding has become an accepted and commonly used method for species identification by taxonomists, ecologists and other academic researchers.

• DNA barcoding technology identifies plant materials to species level regardless of life stage, level of processing and gender, thus complementing existing methods.
Acknowledgements