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Geo-ICT Technology for Efficient Management of Forests and Sustainable Provision of Biomass Energy in Rwanda

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Arbonaut around the world

- Founded in 1994
- International staff of 45 people and 15 different nationalities
- Headquarters in Joensuu, Finland
- Close cooperation with universities and research organisations
- Variety of in-house experts (e.g. foresters, mathematicians, computer scientists, geographers)

Arbonaut's services

Forest Information Systems

- Collect, analyze, plan, share, report
- Web, desktop and mobile GIS solutions
- Operational forest management
- Water quality monitoring tools

above ground biomass (tons/ha)
.01–100.00
00.01–200.00
00.01–300.00
00.01–400.00
00.01–478.00

Forest Inventory

- Remote sensing based inventories
- LiDAR and satellite image
- For private and public sector
- Methodology development
- Trainings and technology transfer

REDD+ and Sustainable Forestry

- REDD+ Strategy Development
- Definition of Forest Reference Level
- Land use and land cover mapping
- MRV – Measuring, Monitoring, Verification systems
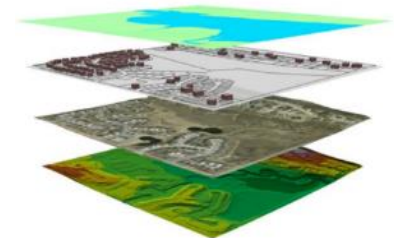
Context – Forests in Rwanda

- Forests and tree resources have strategic position in the Rwandan development agenda as primary energy source to a large portion of population, supporting agriculture and ensuring equilibrium of the ecosystem
  - Estimated 86 % of Rwanda's energy is provided by biomass
  - Growing population, shrinking land availability
  - → Forest resources under high pressure

- Meeting the growing demand of woody biomass with sustainable supply is of key importance for environmental protection (SDG15), adaptation to climate change (SDG13) and securing energy for all (SDG7)

- Target to increase forest cover to 30 % of the total country land area by 2020
  - Natural forest 12 %
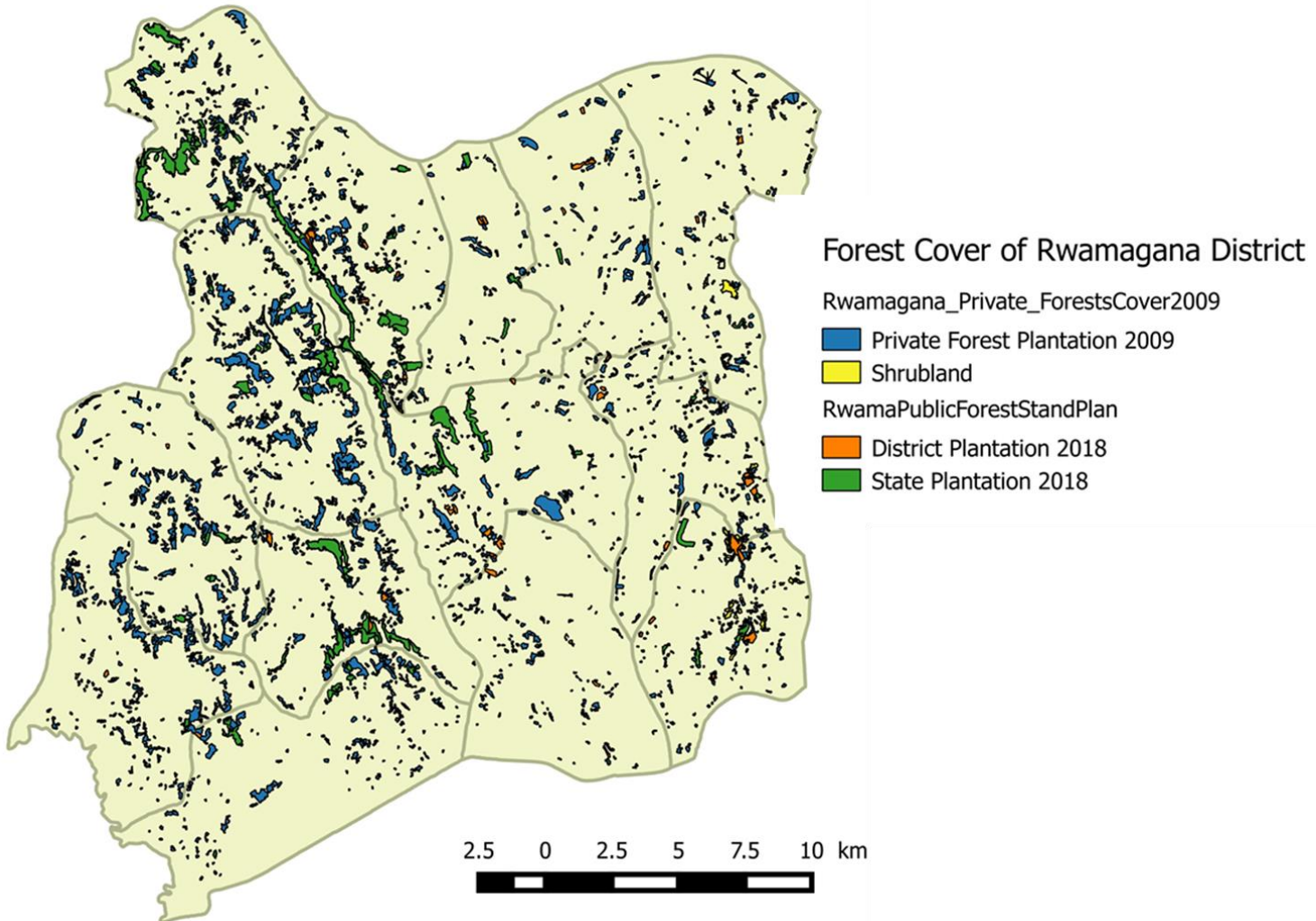 - Areas allocated to plantations 18 %

Introduction on the DFMPs

- To improve the management of forest resources, an essential step was taken to develop **District Forest Management Plan (DFMP)** for each district

- DFMP is a mandatory tool for each district to guide and monitor forest resources management according to:
  - Forestry Law (2013)
  - National Forest Policy (2018)
  - Forestry Sector Strategic Plan (FSSP 2018-2022)

- From 2014, 27 DFMPs designed (with support of PAREF.Be2, PAREF.NL, PAGREF, UICN and FMBE)

- Each DFMP has to be updated regularly to integrate changes

Example of main data constituting the basis of each DFMP

Forest Cover of Rwamagana District

Rwamagana_Private_ForestsCover2009

▮ Private Forest Plantation 2009
▮ Shrubland

RwamaPublicForestStandPlan

▮ District Plantation 2018
▮ State Plantation 2018

2.5 0 2.5 5 7.5 10 km

Attribute data management and calculations in Excel

Forest ID	Previous Forest Names	Sector	Forest stand area ha	Species for conversion or management	Recommand Treatment Regime	Soil condition	Subgroup in FMU	Year of FMU contracting	Final year of starting of planning	Period of Full Cycle Management years	Tree planting density nbr stem per ha	Rotation CD in years	CC1	CC2
0501010001	GBK1	Fumbwe	13,89	Eucalyptus spp.	CopWtStand	Medium	Rwama_St_FMU1_GR1	2019	2020	32	2500	after CC	7	8
0501010002	GBK2	Fumbwe	2,58	Callitris robusta	High Forest	Bad	Rwama_St_FMU1_GR1	2019	2020	40	2000	8	NA	NA
0501010003	MININTER1	Fumbwe	1,21	Eucalyptus spp.	High Forest	Good	Rwama_St_FMU1_GR1	2019	2020	30	1600	8	NA	NA
0501010004	MININTER2	Fumbwe	2,98	Eucalyptus spp.	High Forest	Medium	Rwama_St_FMU1_GR1	2019	2020	30	1600	8	NA	NA
0501010005	MININTER3	Fumbwe	4,13	Eucalyptus spp.	Coppice	Bad	Rwama_St_FMU1_GR1	2019	2020	32	2500	after CC	7	8
0501010006	GBK3	Fumbwe	37,16	Eucalyptus spp.	Coppice	Bad	Rwama_St_FMU1_GR4	2019	2023	32	2500	after CC	7	8
0501010007	KUBABIKIRA	Fumbwe	0,40	Eucalyptus spp.	Coppice	Good	Rwama_Di_FMU1_GR1	2021	2022	32	2500	after CC	7	8
0501010008	MININTER4	Fumbwe	8,47	Pinus spp.	High Forest	Bad	Rwama_St_FMU1_GR4	2019	2023	25	2000	8	NA	NA
0501010009	NYARUSANGE	Fumbwe	1,92	Eucalyptus spp.	Coppice	Medium	Rwama_Di_FMU1_GR1	2021	2019	32	2500	after CC	7	8
0501010010	GBK4	Fumbwe	39,21	Eucalyptus spp.	High Forest	Bad	Rwama_St_FMU1_GR2	2019	2021	30	1600	8	NA	NA
0501010011	MININTER4	Fumbwe	1,56	Eucalyptus spp.	Coppice	Bad	Rwama_St_FMU1_GR1	2019	2020	32	2500	after CC	7	8
0501010012	SHENGA 1	Fumbwe	1,35	Eucalyptus spp.	Coppice	Good	Rwama_Di_FMU1_GR1	2021	2022	32	2500	after CC	7	8
0501010013	GBK6	Fumbwe	3,97	Eucalyptus spp.	High Forest	Medium	Rwama_St_FMU1_GR3	2019	2022	30	1600	8	NA	NA
0501010014	GBK7	Fumbwe	1,53	Eucalyptus spp.	High Forest	Medium	Rwama_St_FMU1_GR3	2019	2022	30	1600	8	NA	NA
0501010015	MININTER1	Fumbwe	3,96	Eucalyptus spp.	High Forest	Good	Rwama_St_FMU1_GR4	2019	2023	30	1600	8	NA	NA
0501010016	NTUNGAMO 1	Fumbwe	0,09	Eucalyptus spp.	Coppice	Medium	Rwama_St_Conflict to be s	2019	2020	32	2500	after CC	7	8

Standing stock (m3) projection for all public forests in the District
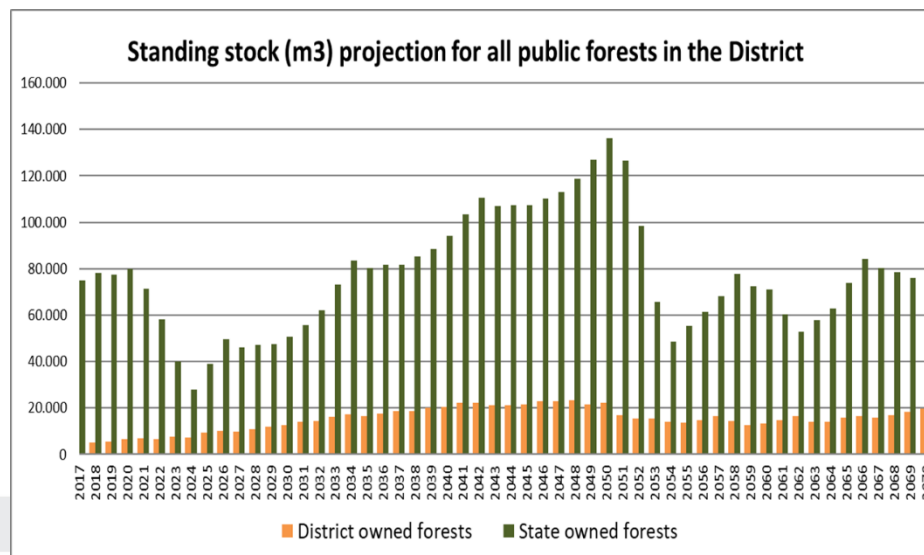
Challenges in the Excel based system

- Complex and not user-friendly heavy Excel files

    => Very difficult for officers to master it and to easily update/change when necessary

    => No validation rules for data entry, easy to make mistakes

- Shapefiles for spatial data not automatically linked to the Excel files

- Districts might have different Excel file format/structure => Need of harmonization to allow consolidation and centralisation in one unique database

- No connection to GPS/tablet system => Not efficient for using at field level

- No integration to other existing databases like LAIS (Land Administration Information System)

- Forest inventory campaigns use different database structure, without automatic linkages with DFMP forest stand Excel files => Need of harmonisation, need of keeping raw data from each inventory to make further comparative analysis

- Several components & functionalities missing in Excel files: Actor register, monitoring of DFMP implementation, managing cut permits, agroforestry planting activities

From Excel files to a modern GIS system

→ A project was started on developing a **User-Friendly and Customized District Forest Managements Plans (DFMP) system**

- Key actors in the project
  - Rwanda Water and Forest Authority (RWFA)
  - Belgian Development Agency (Enabel)
  - Arbonaut Ltd, Finland
  - kartECO, Greece

- On-going project, started in Sept 2018

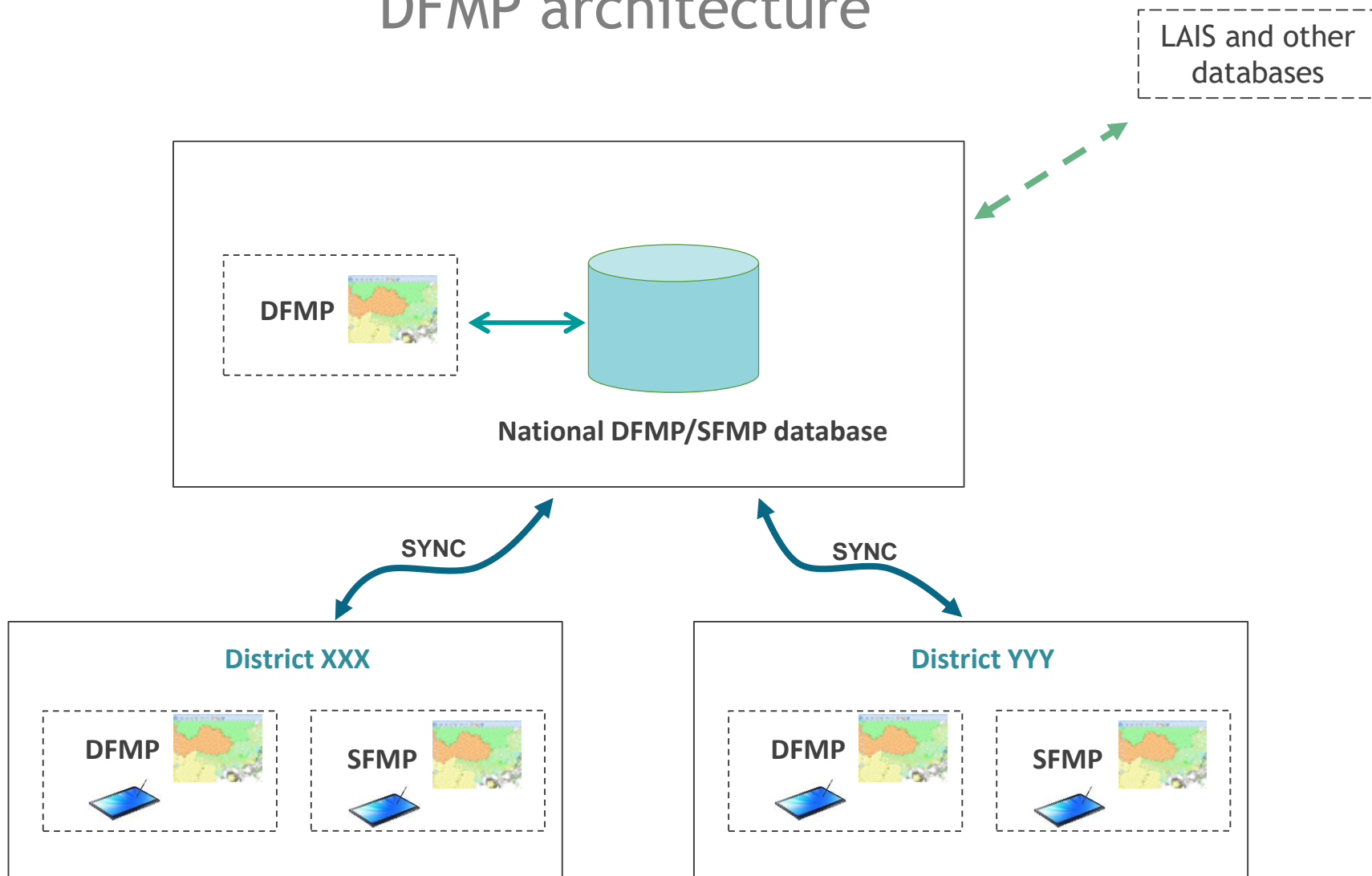- Concentrates in 3 pilot districts in Rwanda: Rwamagana, Gasabo, Gakenke

DFMP system

- Purpose of the new DFMP system is to provide a user-friendly **web and mobile application for managing** (creating, updating, monitoring) **District Forest Management Plans**

- Modern GIS system managing spatial and attribute data

- Nationwide database

- System developed entirely using **Free and Open Source Software (FOSS)**

- Users:

  - RWFA officers (state level)

  - District officers

  - Private contractors implementing DFMP silvicultural activities

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DFMP architecture

LAIS and other databases

DFMP

National DFMP/SFMP database

SYNC

SYNC

District XXX

DFMP

SFMP

District YYY

DFMP

SFMP

DFMP: District Forest Management Plans tool for state and district users
SFMP: Simplified Forest Management Plans tool for contractors (private operators)
LAIS: Land Administration Information System

DFMP Web application

- Key functionalities
  - Viewing, creating and editing forest stand data (boundaries + attribute data)
  - Producing silvicultural activity chains for forest stands incl. financial calculations
  - Allocation of silvicultural activities implementation to private operators
  - Monitoring of implemented activities
  - DFMP reports

- Technology

  - PostgreSQL + PostGIS
  - Geoserver
  - React
  - OpenLayers
  - Java
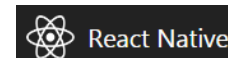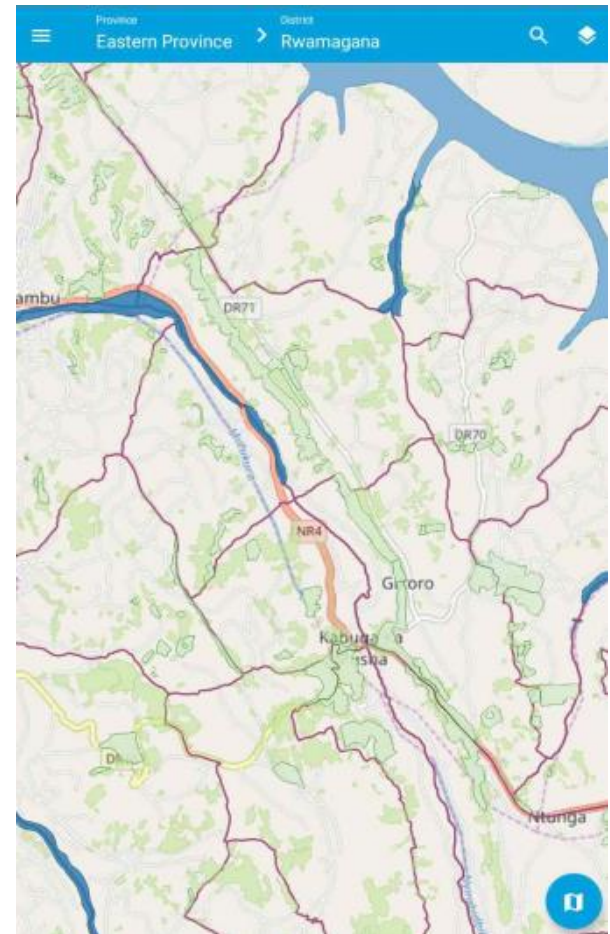 - Knowage (reporting tool)

DFMP Mobile application

- Key functionalities
  - Viewing and editing existing data on forest stands
  - Stand demarcation & collecting data for new forest stands (e.g. newly planted areas), recording boundaries by GPS
  - Collecting sample plot level data
  - Offline functionality

- Technology:
  - React Native
  - Mapbox
  - Offline-First

Thank you!

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N 62°36'50" E 29°44'25"