Towards monitoring of forest degradation – development of biomass models for Tanzania

Rogers Malimbwi[1], Eliakimu Zahabu[1], Tron Eid[2]

[1] Sokoine University of Agriculture, Tanzania
[2] Norwegian University of Life Sciences, Norway

Outline

- Why biomass models?
- Data and methods for developing models
- Main challenges:
  - tree selection
  - aboveground sampling
  - belowground sampling
- Concluding remarks

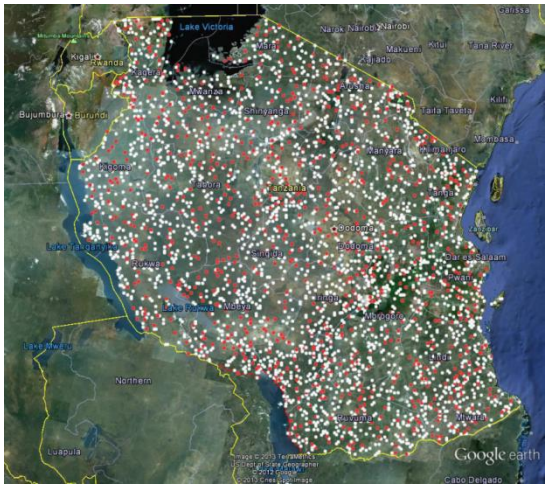
Why biomass models?

- Reduced Emissions from Deforestation and **forest Degradation** (REDD)
- Forest degradation (or enhancement):
  - Change in biomass over time = Biomass at time 2 – Biomass at time 1
  - Carbon change quantified from biomass change
- Inventory methods: field sample plots, remote sensing (or combination of the two)
- Basic requirement irrespective of inventory method:
  - **Models predicting biomass for individual trees**
  - **Based on easily available tree variables**

Why biomass models in Tanzania?

- Carbon stock mapping for implementation of climate change mitigation policies in Tanzania
  - Involved in several (REDD) pilot projects
  - National forest inventory (NAFORMA) with permanent sample plots established from 2010
- Conventional management planning
  - Describe productivity and forest structure
  - Assess fuel wood and fodder potential

NFI sample plots in Tanzania



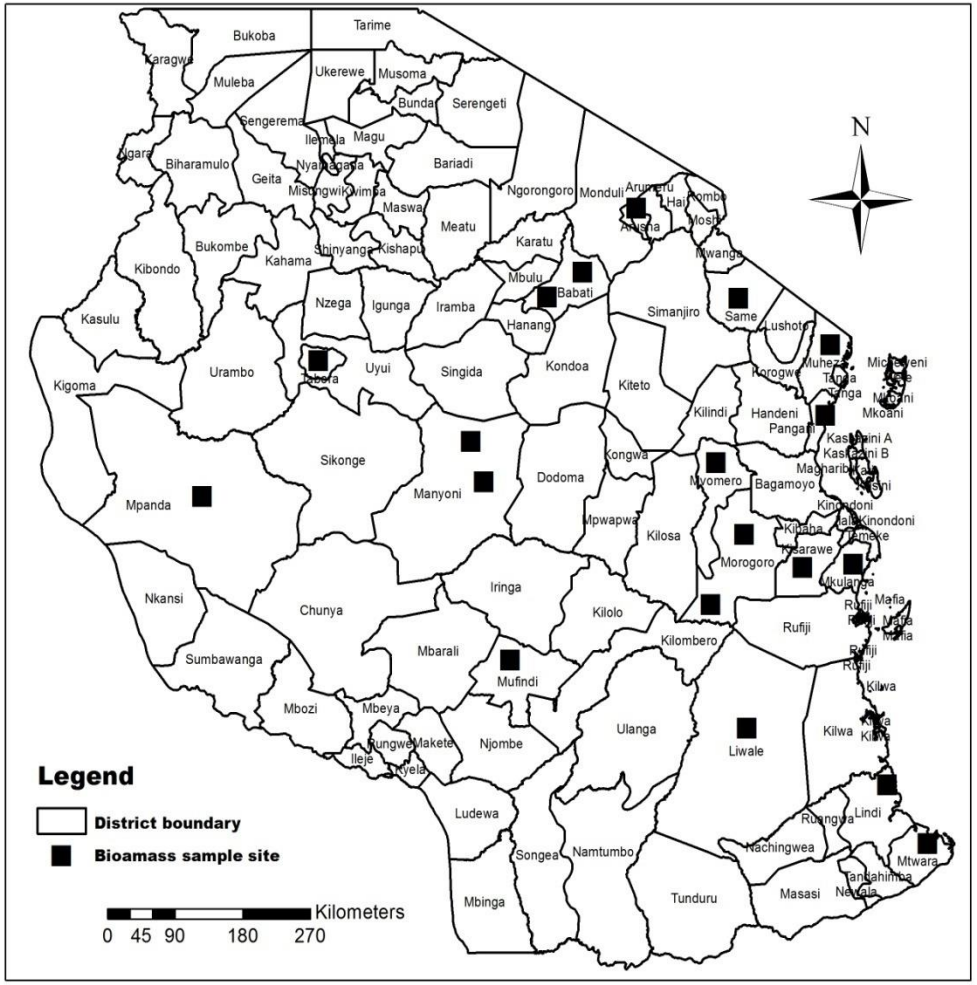
Project in CCIAM-programme

- Main objective:
  - Develop models and methods for assessing and monitoring carbon stocks in Tanzania
- Sub-objective:
  - Develop models for estimating **biomass that c**over all major forest types in Tanzania
- Collaborating institutions:
  - Department of Forest Mensuration and Management, Sokoine University of Agriculture, Tanzania
  - Department of Ecology and Natural Resource Management, Norwegian University of Life Sciences, Norway
- 6 Researchers, 5 PhD-students and 6 MSc-students

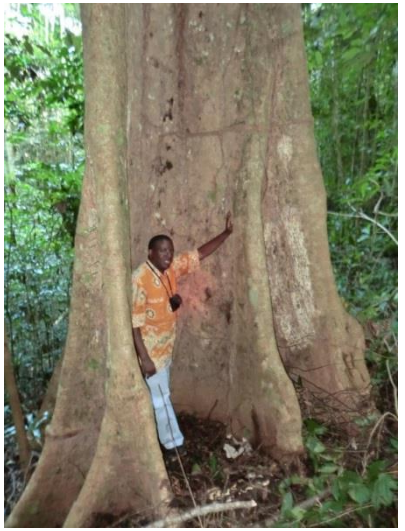
Data for biomass modelling

Forest type/species	Site (region)	No. of trees	
		Aboveground	Belowground
Miombo woodland	Manyara, Lindi, Katavi, Tabora	167	80
Montane rainforest	Tanga	60	29
Lowland forest	Morogoro, Lindi	60	-
Mangrove forest	Tanga, Pwani, Lindi, Mtwara	120	30
Thicket (clumps)	Singida	60	60
Thicket (associated trees)	Singida	30	30
Acacia woodland	Manyara, Kilimanjaro	110	110
Pinus patula plantation	Iringa, Arusha	85	85
Tectona grandis plantation	Tanga, Morogoro	101	101
Coconut trees	Coastal region	46	29
Cashew nut trees	Coastal region	45	45
Baobab	Morogoro	35	-
All		919	599

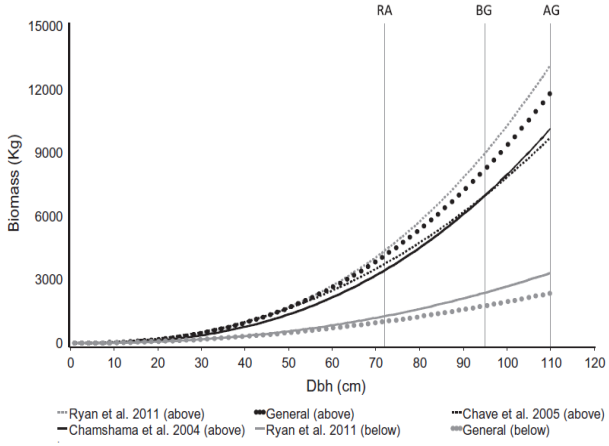
Biomass sample sites in Tanzania



Model development



- Tree selection
- Above- and belowground destructive sampling
- Tree variables
  - dbh, tree height, wood specific gravity
- Model selection
  - RMSE, AIC, MPE
- Comparisons with previous models (local and pantropical)
- Recommendations for application



Tree selection procedures

- Prior systematic sample plot inventories over sites
  → information on species- and size distributions of trees

- Subjective selection of trees based on this information

  – Species:

  →most frequent + random among remaining

  – Size:

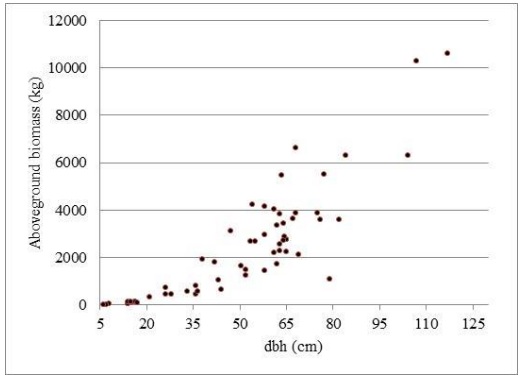
  →Cover dbh range, emphasis on large trees

  – Spatial and altitudinal variation within sites

Tree selection challenges

Forest type	Prior inventory		Selected trees		
	No. of spec.	Dbh-range	No. of trees	No. of spec.	Dbh-range
Miombo woodlands	> 150	5-180	167	60	1-110
Rainforests	> 200	10-270	60	34	6-117

- Size range



- Tree species

Aboveground sampling challenges

- Correct tree variable (dbh, ht) measurement
  - What is diameter and height of these trees?

- Tree component definitions, determination and weighing
  - What is stem and what is branches?
  - And roots?

Belowground sampling

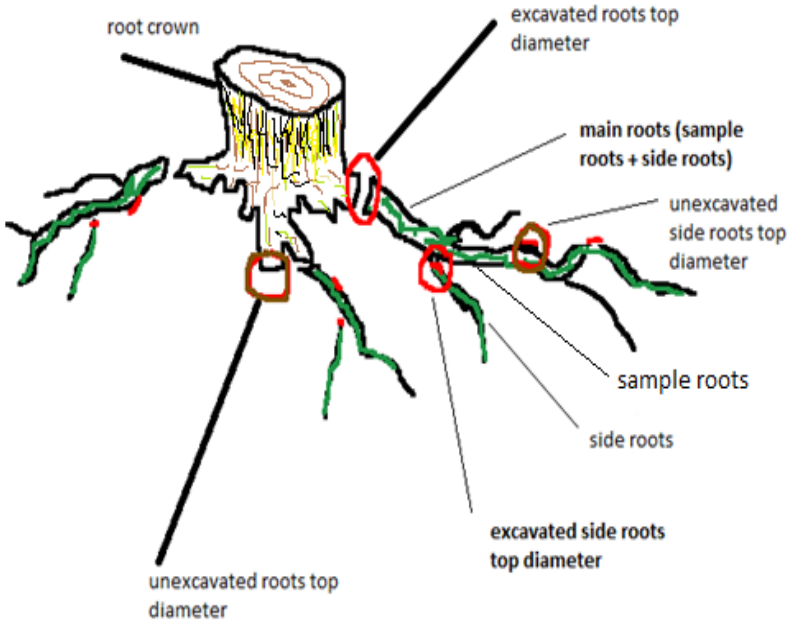
- Laborious and time consuming

- Trade off :
  - few trees fully excavated – higher accuracy – lower variation
  - many trees partly excavated – lower accuracy – larger variation

- Root sampling approach:
  - from each root system, a number of roots are fully excavated, and then the information from the excavated roots is used to estimate biomass for the roots that are not excavated

Belowground sampling

- From the root crown:
  - Three main roots selected, and measured for diameter and green weight
  - Diameter of unexcavated main roots measured
- From each main root:
  - Three side roots selected and measured for diameter and green weight
  - Diameter of unexcavated side roots measured



- Side and main root regression models for estimating biomass of unexcavated parts of root system

Concluding remarks

- Comprehensive database covering more than 150 different tree species
- Data quantity unique for Africa and beyond
- Models cover all major forest types in Tanzania
- To be used for biomass estimation in the NFI, for different REDD-initiatives and for conventional forest management planning
- Documented in per reviewed journals and a book

Project information

- **The project has been part of the Programme**: Climate Change Impacts, Adaptation and Mitigation (CCIAM) + MRV project in Tanzania
- **Funded:** through the Norwegian embassy in Tanzania
- **Researchers:** Rogers Malimbwi, Eliakimu Zahabu, Josiah Katani, Shabani Chamshama, Ole Martin Bollandsås, Tron Eid
- **PhD-students:** Wilson Mugasha (No), Abel Masota (Tz), Marco Njana (Tz), Joseph Makero (Tz), Ernest Mauya (No)
- **Masterstudents (Tz):** Haruna Luganga, Mathias Augustin, Joachim Mshana, Msalika Pastory, Juma Mwangi, Edgar John

Thank you for listening!