Comparative assessment of small water storage structures in semi-arid regions considering hydro-climatic, geological and socio-economic contexts

Presented by: **Mhambi Nyathi**

Co-author(s): Dr. Tibor Stigter
Dr. Gretchen Gettel
Prof. Mário Franca

Research objectives and methods

To assess the feasibility of the different SWSS, namely micro-reservoirs, sand dams and sand rivers, as a function of hydro-climatic, geological and socio-economic contexts

Mapping	Storage	Sedimentation	Water quality	Costs	Management
To map current distribution of SWSS and show the optimal conditions for siting each structure using Remote Sensing (RS) and Geographic Information System (GIS) tools	To assess the storage potential and related challenges of the different SWSS (micro reservoir, sand dam and sand river) using literature and applying the time dependant water balance approach	To analyse the rate of sedimentation and its impacts on the different water storage structures using literature sources	To comparatively assess the main water quality aspects of the different water storage structures using lessons from case studies	To compare the construction, maintenance and abstraction costs of water storage structures and determine when and how the options are cost-effective	To assess how the storage structures are managed at community level, including their planning, implementation and maintenance

Methodology cont.

- The research approaches were based on the six specific objectives

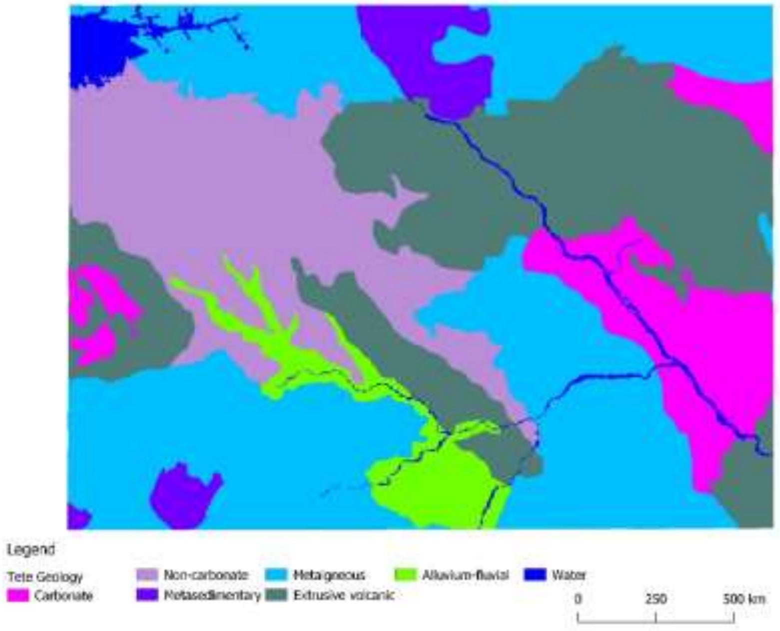
1. Mapping potential sites for structures
2. Comparative assessment for semi-arid regions of sub-Saharan Africa
3. Quantitative assessments

- Data sources- journals, PhD and MSc thesis, technical manuals, internal reports from organisations, technical books and conference papers

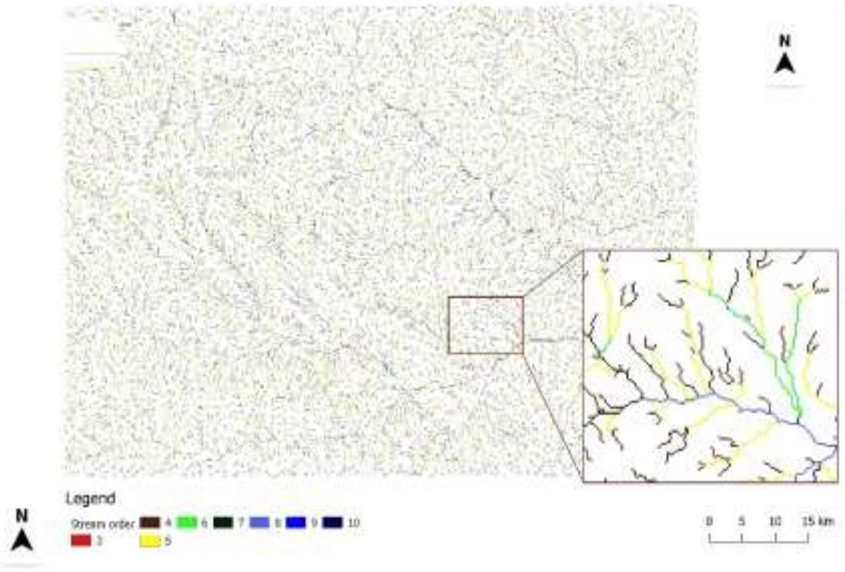
Methodology cont. - Mapping criteria

Parameter	Sand Dam	Micro reservoir	Sand river
Slope	0.5 - 2%	1.5 - 4.5%	0.4 - 1%
Geology (structure foundation)	Granite, Gneiss, Quartzite, Impermeable and unfractured rock	Igneous e.g. Granite or a solid rock, Granite-gneiss, Crystalline metamorphic	Not applicable
Geology (for source material)	Granite, Gneiss, Quartzite	Not applicable	Granite, Gneiss, Quartzite, Sandstone
Stream order	5, 6	6, 7	7, 8, 9, 10

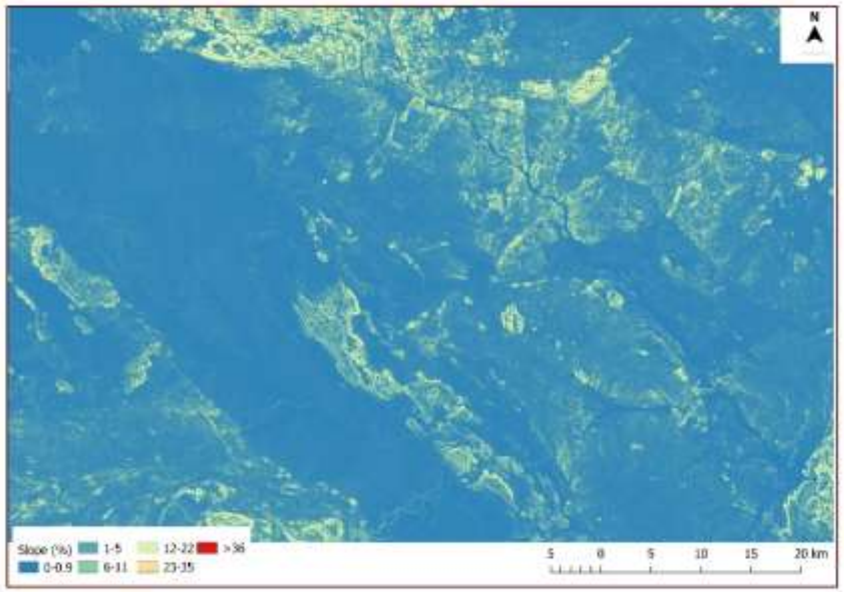
Geology



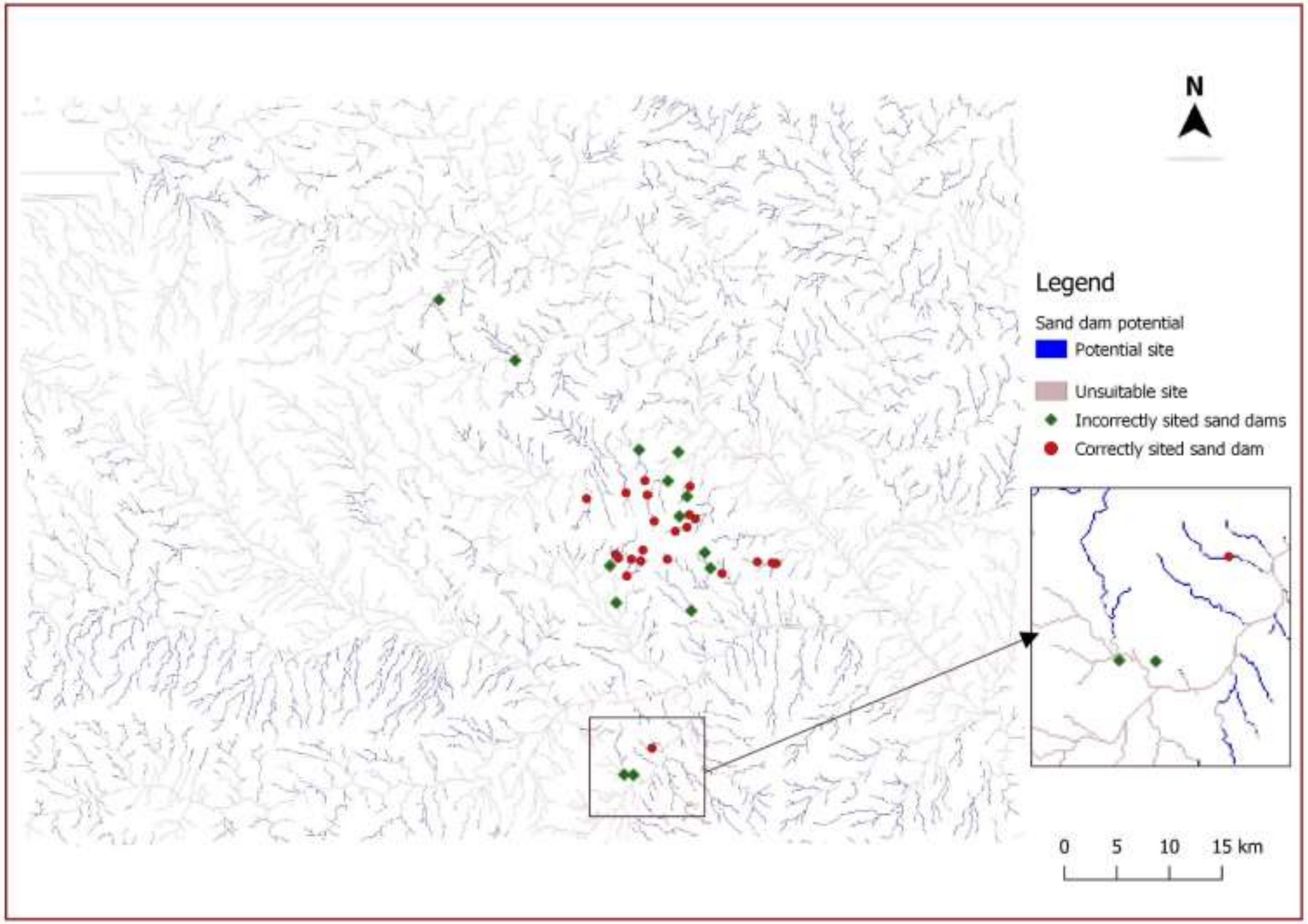
Stream order



Slope

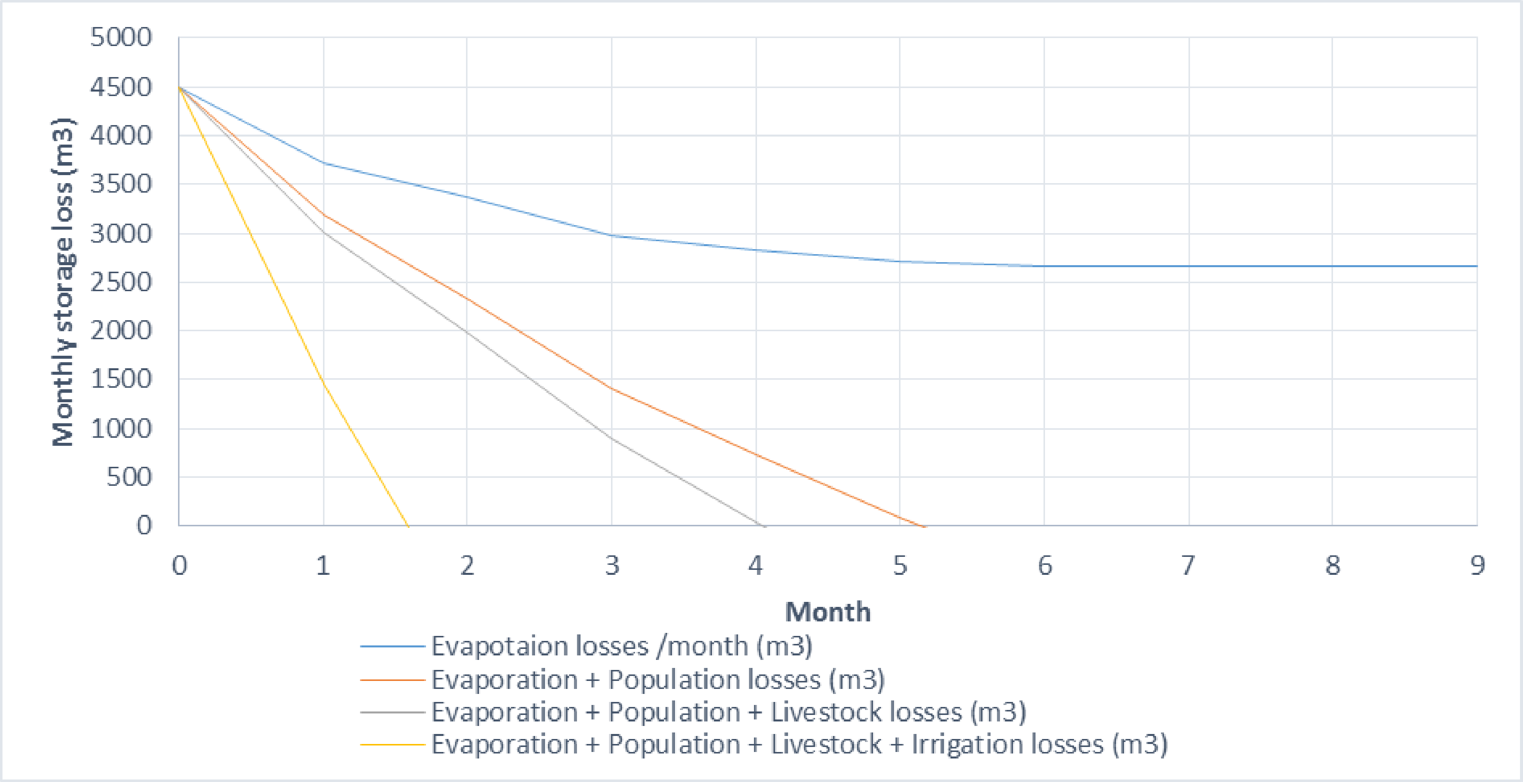


Results: Mapping the sand dam potential



- 64% match with known sites
- What is known about existing sites:
  - Most sand dam sites were silted or acted as open surface reservoirs
- Possible reasons for mismatch:
  - Layers used for classification
  - Wrongly sited sand dams
  - Method of construction

Results: Storage- Chacalanga sand dam water balance (Quantitative assessments)



- Evaporation losses from sand only occur up to the extinction depth
- When water is used for domestic uses only it can last for 5 months
- Including other water users results in a few months on storage

- Similar trends were observed in micro reservoirs
- A larger sand river has the potential of meeting the demand for all sectors because of more storage potential

Results: Literature review

Parameter	Sand dam	Micro reservoir	Sand river
Vulnerability of the structure to water losses/ climate change	Less vulnerable to the impacts of climate change because of water storage in sand	High because of a small storage	Higher storage capacity of sand rivers
Suitability for direct human consumption	Safe but some form of treatment may be required e.g. boiling, for immature sand dams	Unsafe for drinking mainly because of the presence of *E.coli* bacteria	Water from sand rivers is generally clean because of the natural sand filtration (larger sand thickness)
Average investment/maintenance costs	Depends on the size of structure and site conditions however these are low cost structures	Higher capital investment costs	Not applicable
Common management challenges	Projects are implemented but there is no maintenance. There are different priorities for water use between the community and implementing organisation e.g. water for irrigation over water for livestock watering		

Conclusions and recommendations

- Remote sensing (RS) and geographic information system (GIS) tools can be used at planning stages to map the potential of an area for constructing sand dams and micro reservoirs or developing potential water abstraction points along a sand river
- SWSS are mainly affected by bacterial contamination, with micro reservoirs being more vulnerable followed by sand dams (especially immature sand dams)
- Sand dams have lower construction and maintenance costs since they are smaller compared to micro reservoirs
- A structure may be properly sited but if there are no management structures in place, it is at the risk of failure
- **Sand dams:**
  - Instead of constructing sand dams at once, construct in 0.3 m stages
  - Terracing upstream, to reduce erosion rates
- **Micro reservoirs:**
  - Proper siting of the structure is important as it will ensure maximum storage and reduce the possibility of silting
- **Sand rivers:**
  - Higher storage potential is achieved if the river channel is wide, deep and is composed of coarse sediments on a flat riverbed

Thank you