Supporting Marginal Farmers with Appropriate Technologies: the Quelimane Agricola Project in Zambezia

Giulio Castelli
Elena Bresci
Federico Preti
Department of Agriculture, Food, Environment and Forestry (DAGRI)
Università degli Studi di Firenze

Integrated Water Resources Management in the Rural-Urban Transition of Mozambique:
Research Projects in Dialogue
24.04.2020

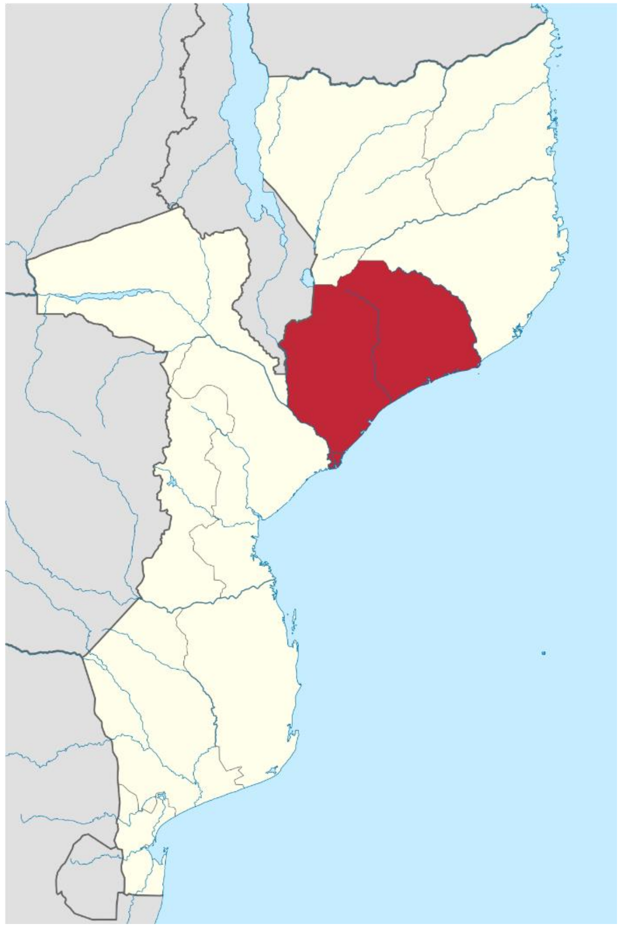
Outline

- Area of study: Zambezia province, Mozambique
- Project framework
- Overall Approach and proposed solutions
- Adaptive innovation piloting and project implementation
- Early findings
- Conclusions

Seasonal lagoon, Nicoadala, Zambezia province

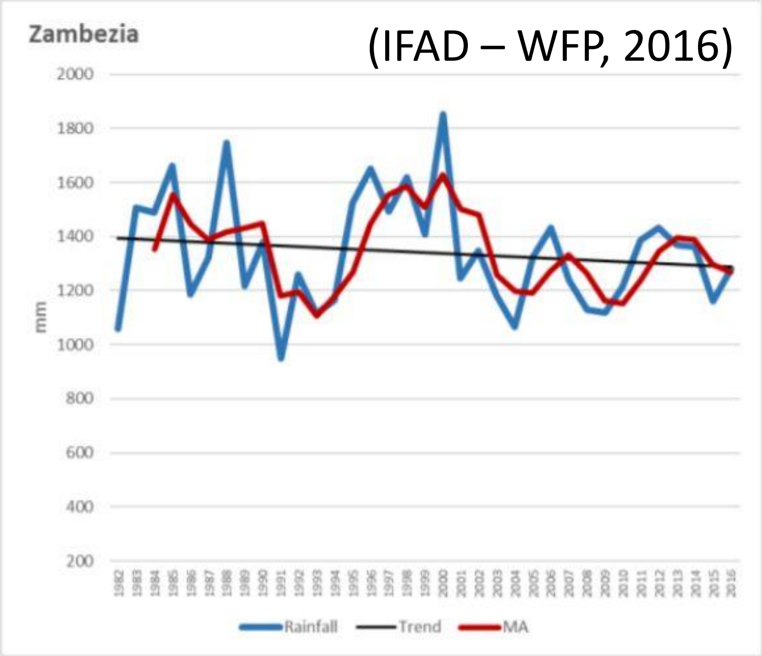
Area of study: Zambezia province, Mozambique

- **Total area** of 103,478 km², much of it drained by the **Zambezi River**
- **Agricultural products** include rice, maize, cassava, cashews, sugarcane, soybeans, coconuts, citrus, cotton, and tea

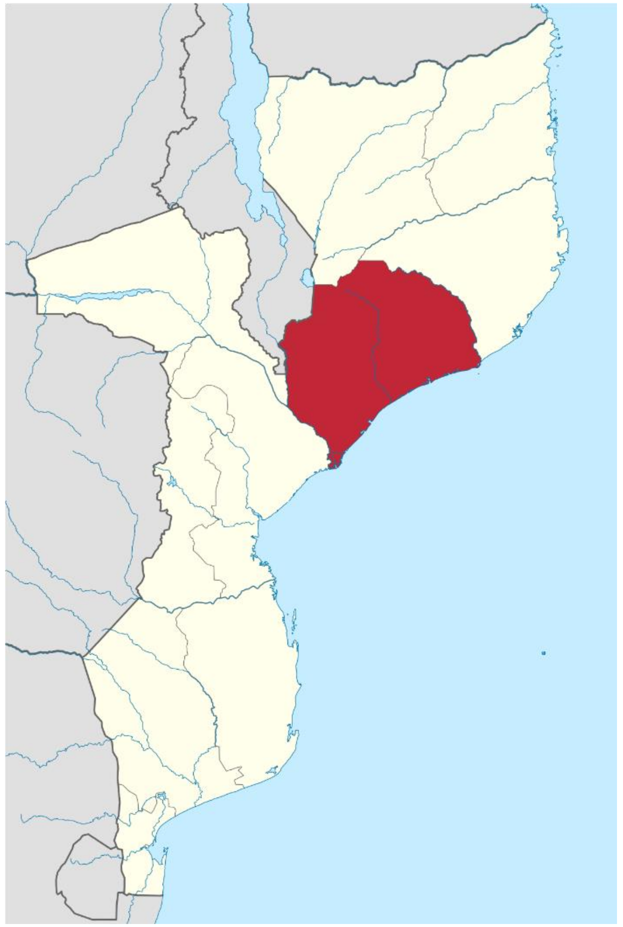


Area of study: Zambezia province, Mozambique

- **Total area** of 103,478 km², much of it drained by the **Zambezi River**
- **Agricultural products** include rice, maize, cassava, cashews, sugarcane, soybeans, coconuts, citrus, cotton, and tea
- Reported **decreasing rainfall trend**

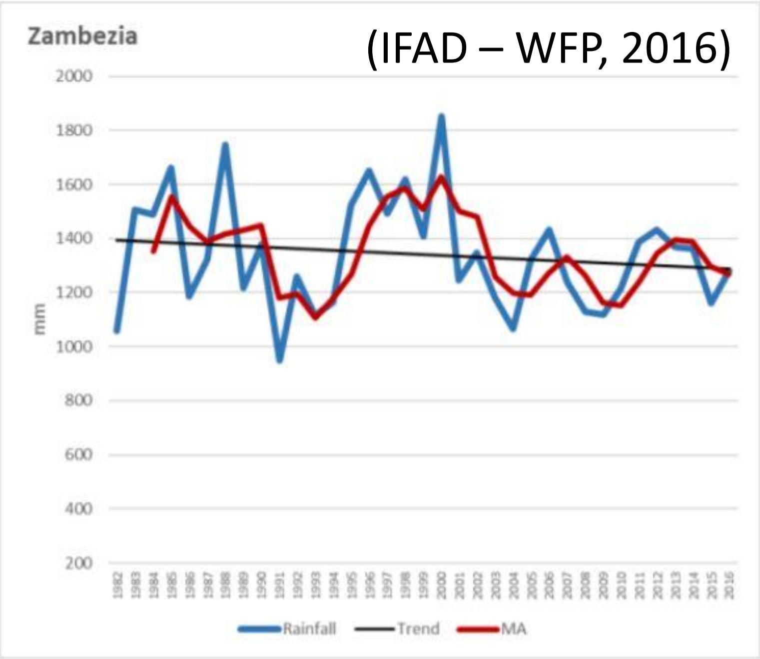


(IFAD – WFP, 2016)

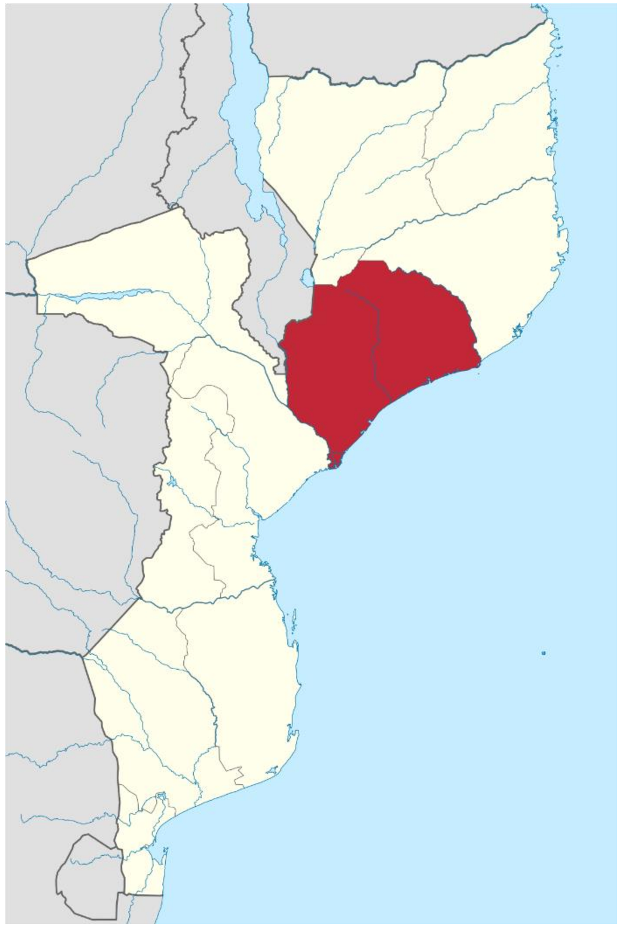


Area of study: Zambezia province, Mozambique

- **Total area** of 103,478 km², much of it drained by the **Zambezi River**
- **Agricultural products** include rice, maize, cassava, cashews, sugarcane, soybeans, coconuts, citrus, cotton, and tea
- Reported **decreasing rainfall trend**
- **Increasing** population



(IFAD – WFP, 2016)



Historical population		
Year	Pop.	±% p.y.
1980	2,500,200	—
1997	3,096,400	+1.27 %
2007	3,890,453	+2.31 %
2017	5,164,732	+2.87 %

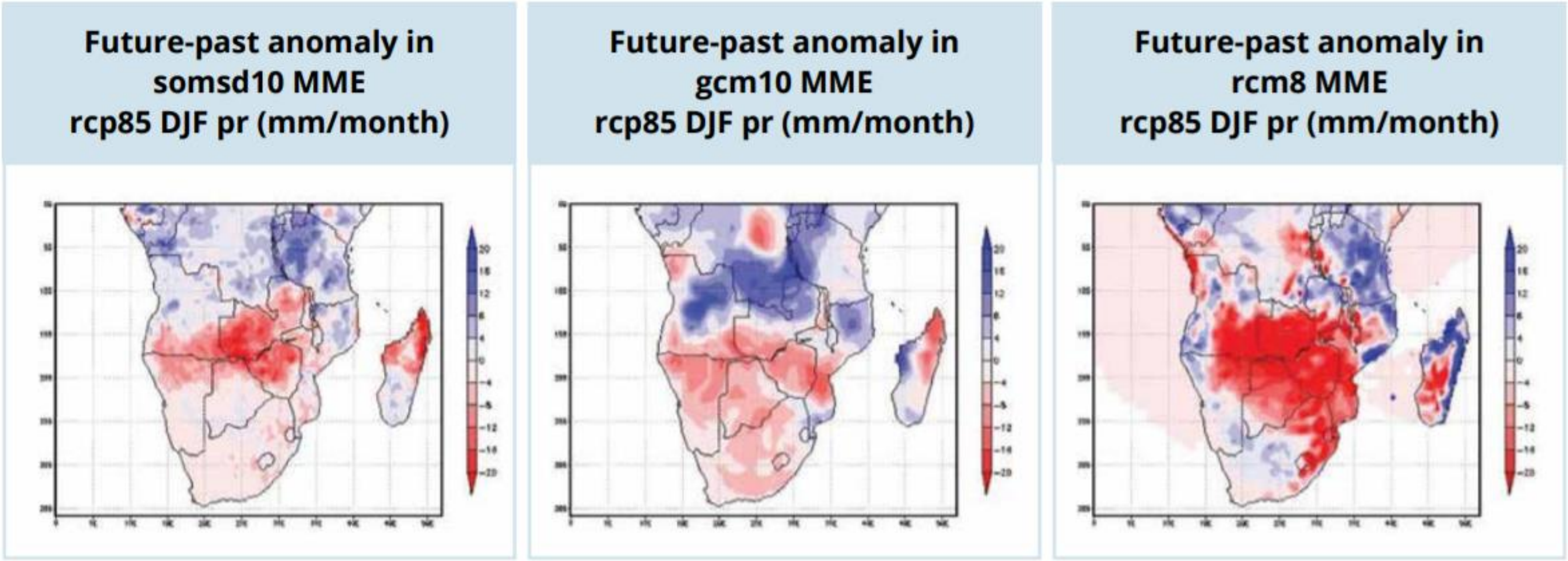
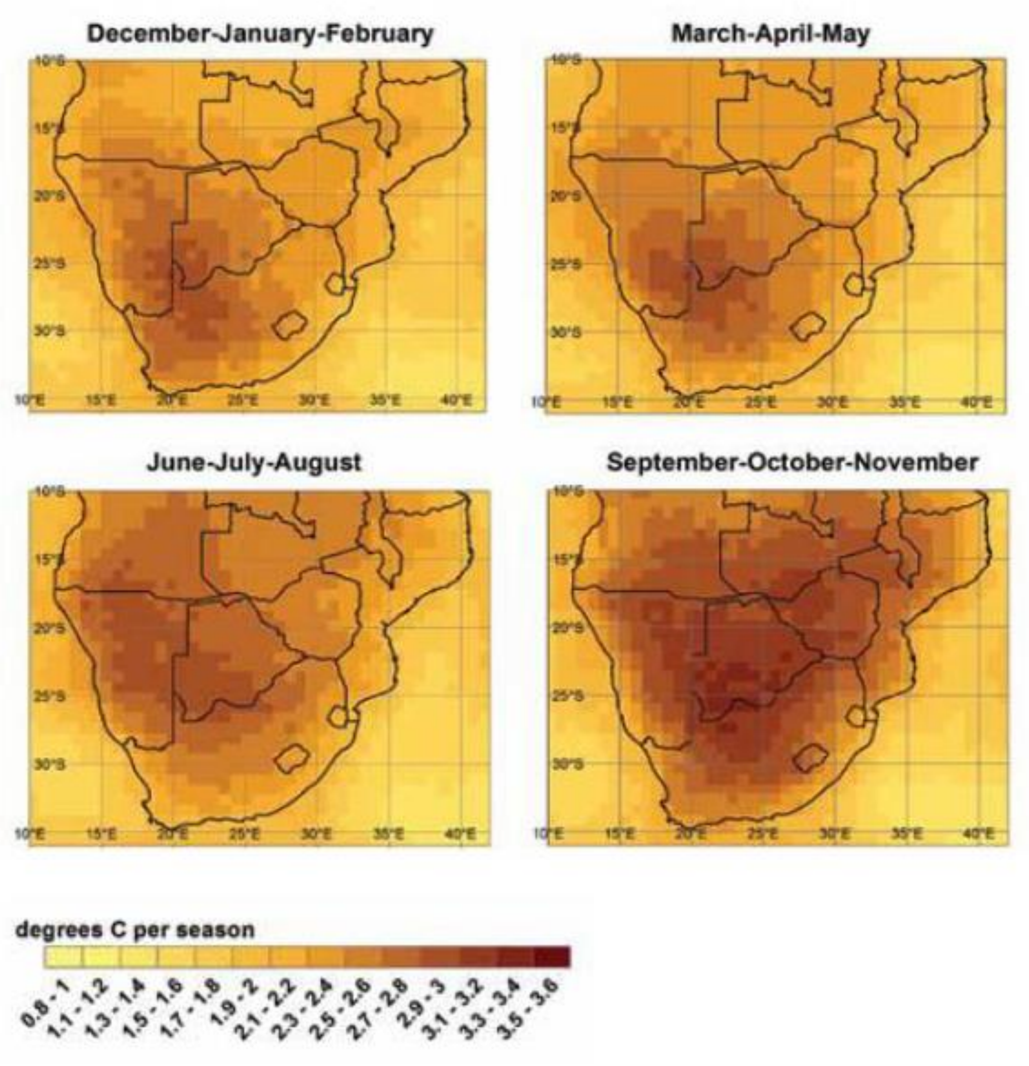


Figure 2.3: Maps of ensemble median of change in rainfall (2041-2070 period relative to 1976-2005 period), in statistically downscaled ensemble (left), GCM ensemble (middle) and dynamically downscaled ensemble (right), for DJF, under RCP 4.5.

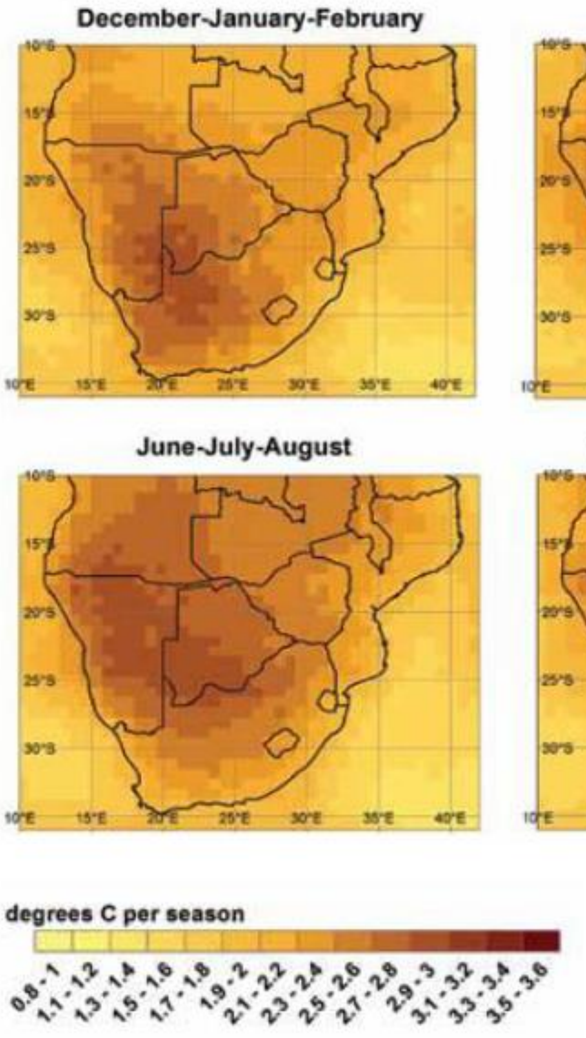
(Davis-Reddy and Vincent, 2017)

Map 1: Projected seasonal temperature change (1980–2050)

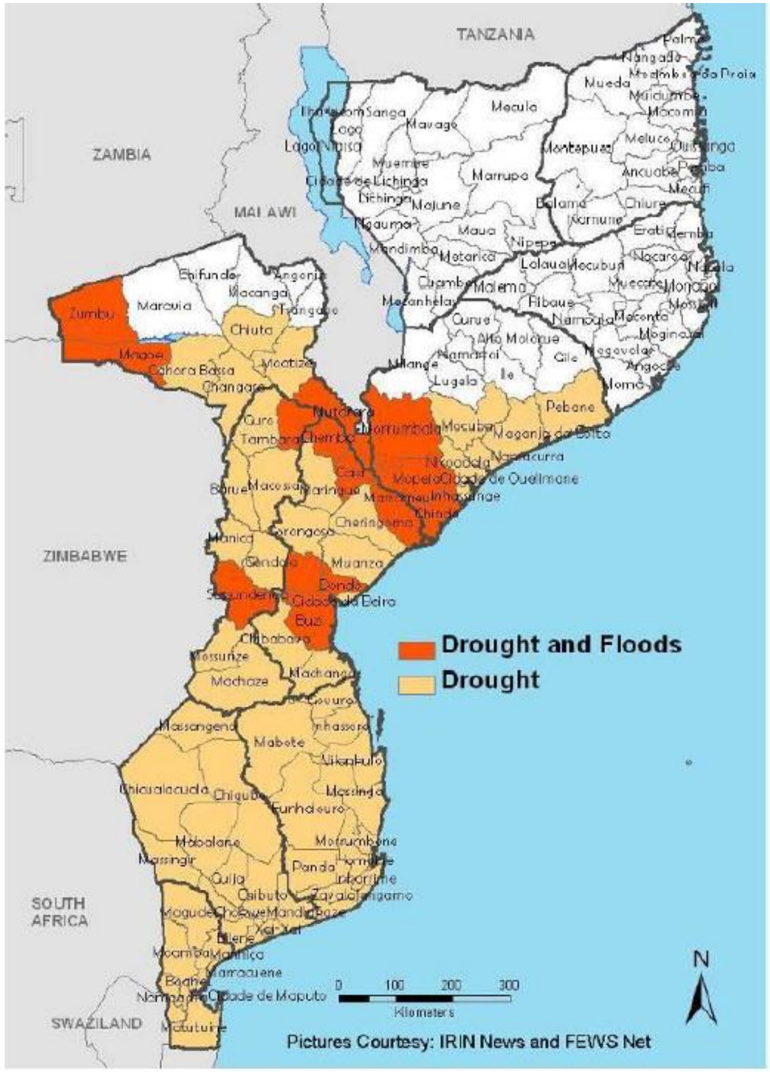


Source: Davis (2011)

Map 1: Projected seasonal temperature change (1980–2050)



Source: Davis (2011)



(Netherlands Commission for Environmental Assessment, 2015)

Project Framework

Quelimane agricola: produce, cresce e consuma sostenibile (2018-2022)

Quelimane Agricola for sustainable production and consumption

Aim: Sustainable agricultural development of Zambezia province (districts of Maquival, Nicoadala and Namacurra)

Leader: Mani Tese NGO (IT)

Funding: Italian Development Cooperation Agency (AICS)

Pillars:

- Improvement of agricultural production
- Improvement of local value-chains
- Creation of improved rural markets

Project Framework

Quelimane agricola: produce, cresce e consuma sostenibile (2018-2022)

Quelimane Agricola for sustainable production and consumption

Aim: Sustainable agricultural development of Zambezia province (districts of Maquival, Nicoadala and Namacurra)

Leader: Mani Tese NGO (IT)

Funding: Italian Development Cooperation Agency (AICS)

Pillars:

- Improvement of agricultural production
- Improvement of local value-chains
- Creation of improved rural markets

Water Management Implications: sustainable water access for irrigation during dry season

Overall Approach and proposed solutions

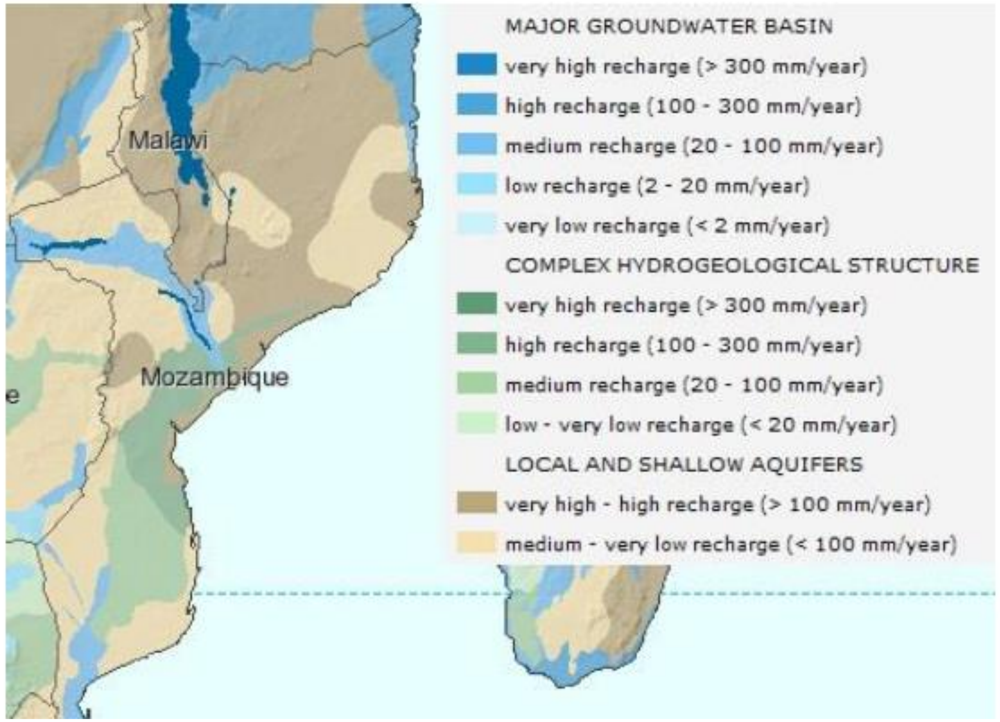
Step 1: Context analysis

Step 2: Learning by other experiences

Step 3: Selection of Appropriate technologies

Overall Approach and proposed solutions

Step 1: Context analysis



(Netherlands Commission for Environmental Assessment, 2015)

Presence of shallow aquifers with high groundwater recharge – Alluvial river aquifers

Shallow well, Maquival, Zambezia province

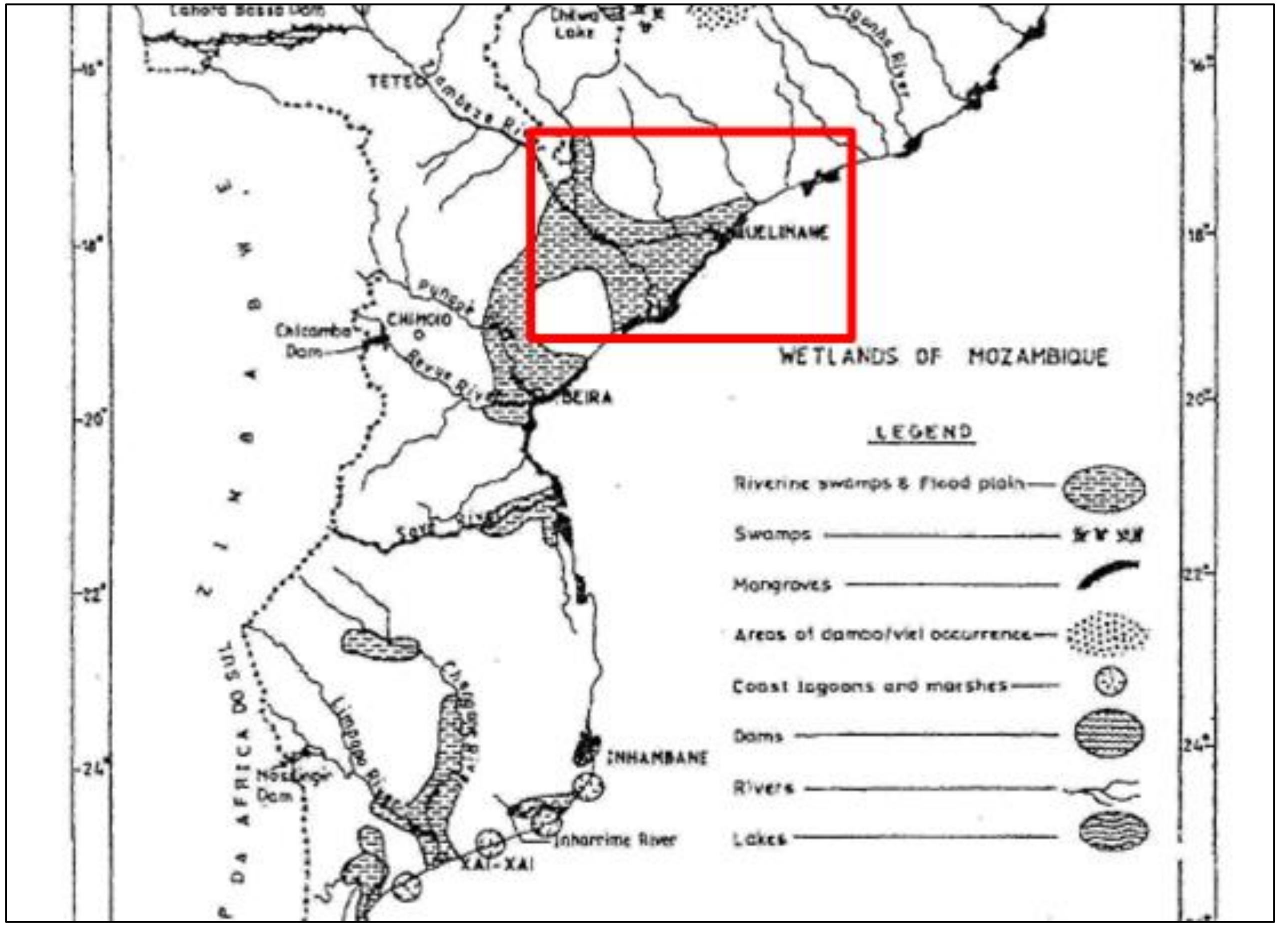
Overall Approach and proposed solutions

Step 1: Context analysis

Presence of shallow aquifers with high groundwater recharge – Alluvial river aquifers

Overall Approach and proposed solutions

Step 1: Context analysis



(FAO-SAFR,1998)

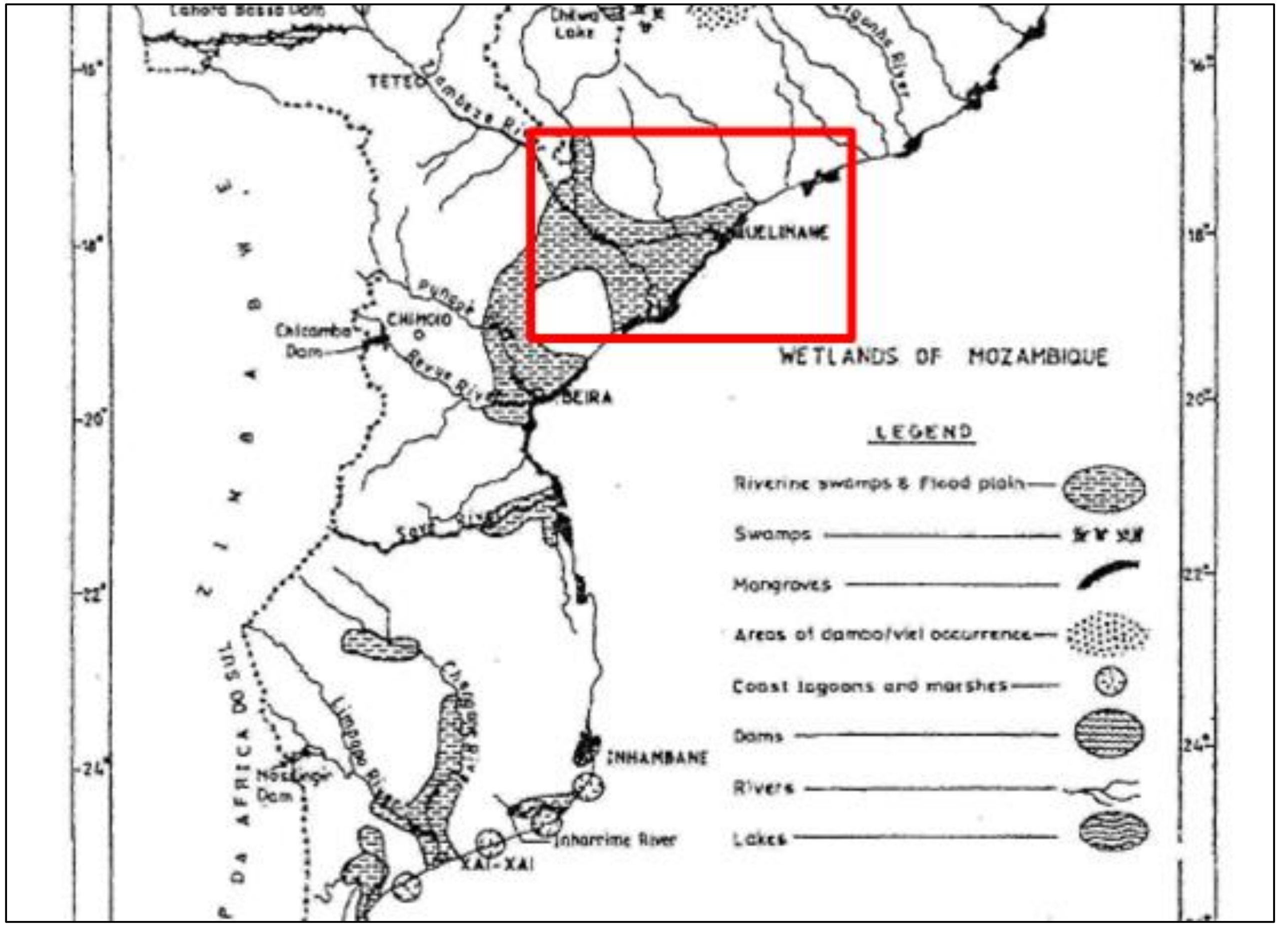
Overall Approach and proposed solutions

Step 1: Context analysis

Typical cropping pattern:

Wet season: *Paddy rice*

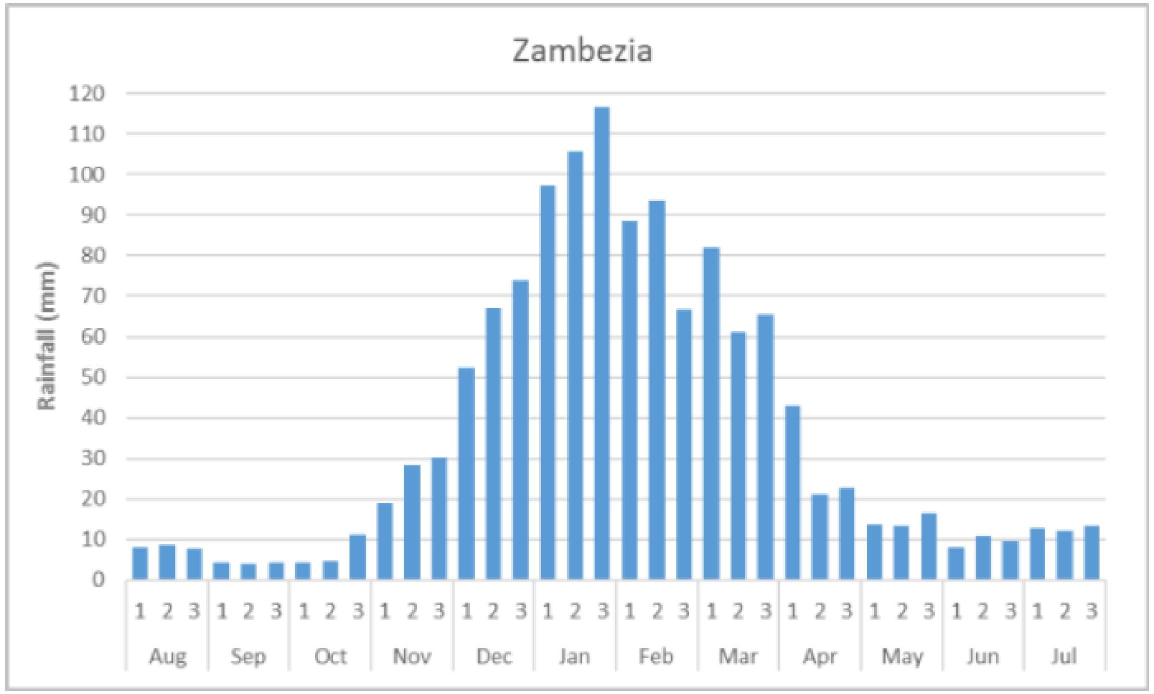
Dry season: *Other crops*



(FAO-SAFR,1998)

Overall Approach and proposed solutions

Step 1: Context analysis



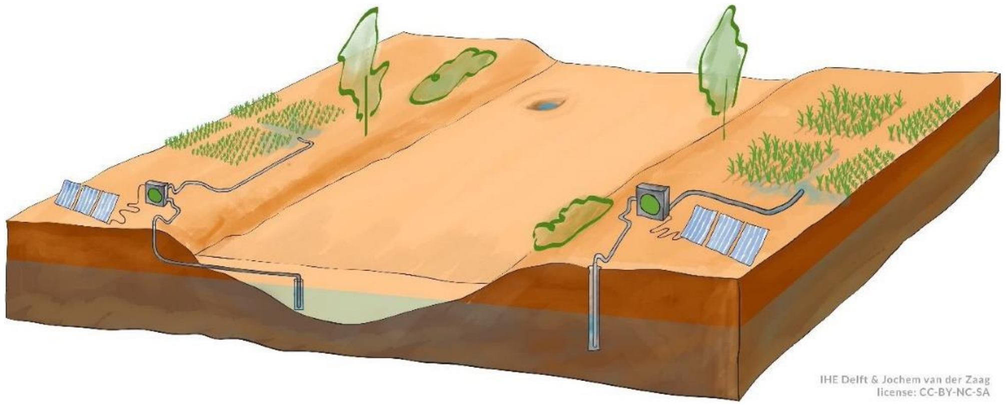
(IFAD – WFP, 2016)

Seasonal hydrology with a very high difference from wet and dry season

Overall Approach and proposed solutions

Step 1: Context analysis conclusions

- Overall idea (1): take advantage of alluvial river aquifers in Zambezia, a yet **underutilised resources in Southern Africa**



(Duker et al., 2020)

- Overall idea (2): Maximise the benefit of **available rainfall**

Overall Approach and proposed solutions

Step 2: Learning by other experiences

What has been done by previous project and research approaches?

A4Labs

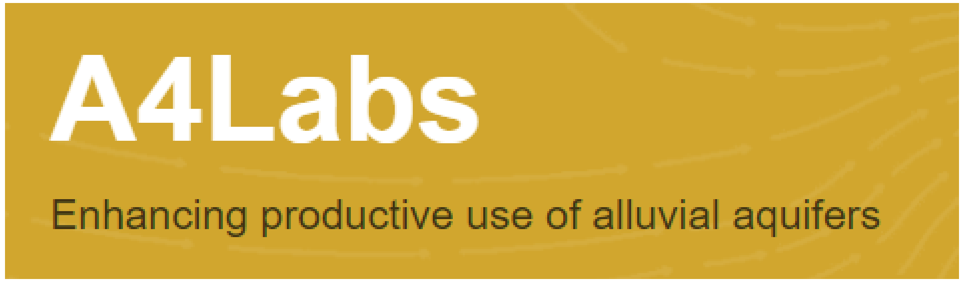
Enhancing productive use of alluvial aquifers

Arid African Alluvial Aquifers - A4Labs
(IHE-Delft)

Overall Approach and proposed solutions

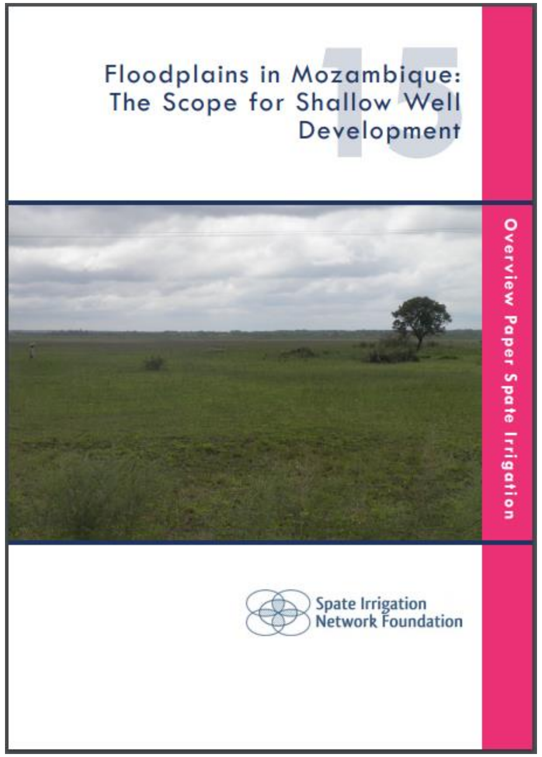
Step 2: Learning by other experiences

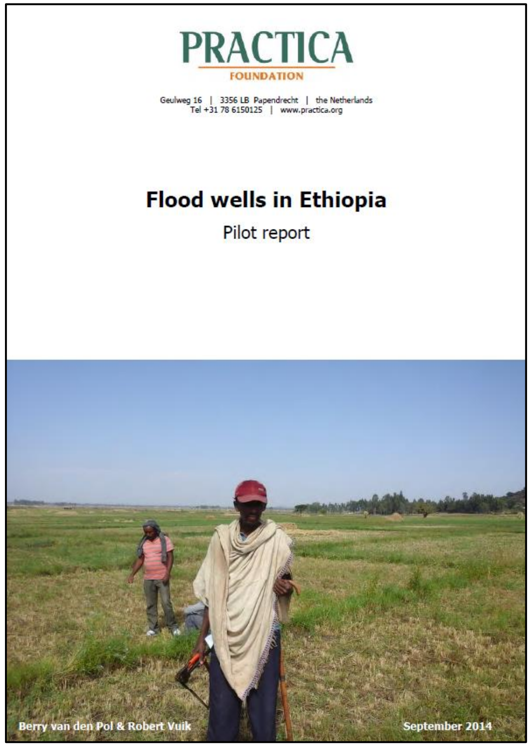
What has been done by previous project and research approaches?



Arid African Alluvial Aquifers - A4Labs
(IHE-Delft)

Floodplains and shallow wells development
(Meta Meta, PRACTICA)





Overall Approach and proposed solutions

Step 3: Selection of Appropriate technologies

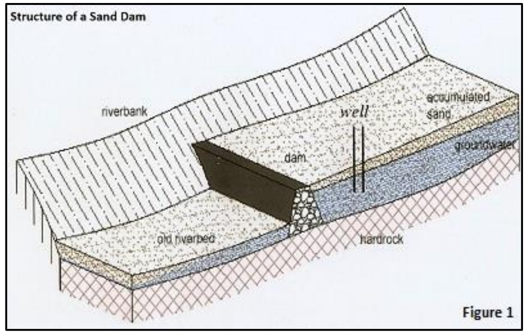
- small-scale
- affordable
- decentralized
- labor-intensive
- energy-efficient
- environmentally sound
- and locally autonomous

Overall Approach and proposed solutions

Step 3: Selection of Appropriate technologies

- small-scale
- affordable
- decentralized
- labor-intensive
- energy-efficient
- environmentally sound
- and locally autonomous

Arid African Alluvial Aquifers - A4Labs
(IHE-Delft)
- **Sand dams**



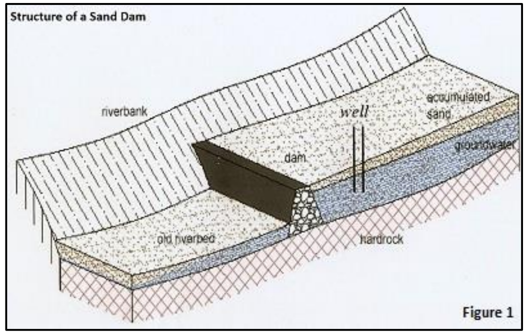
Overall Approach and proposed solutions

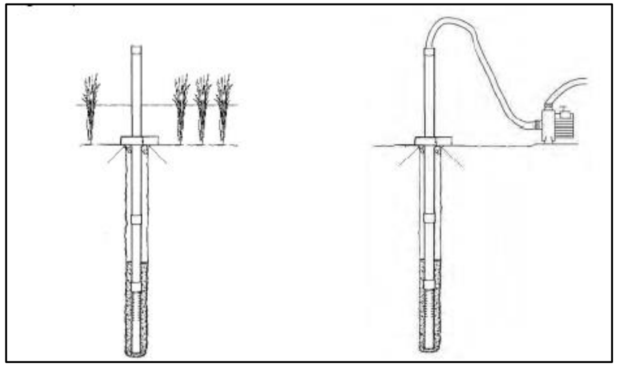
Step 3: Selection of Appropriate technologies

- small-scale
- affordable
- decentralized
- labor-intensive
- energy-efficient
- environmentally sound
- and locally autonomous

Arid African Alluvial Aquifers - A4Labs
(IHE-Delft)
- **Sand dams**
- **Flood Wells**

Floodplains and shallow wells development
(Meta Meta, PRACTICA)
- **Flood Wells**





Overall Approach and proposed solutions

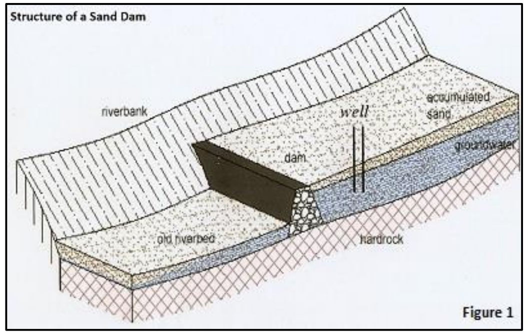
Step 3: Selection of Appropriate technologies

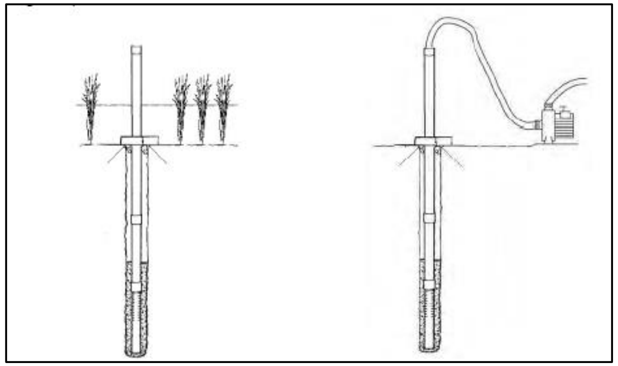
- small-scale
- affordable
- decentralized
- labor-intensive
- energy-efficient
- environmentally sound
- and locally autonomous

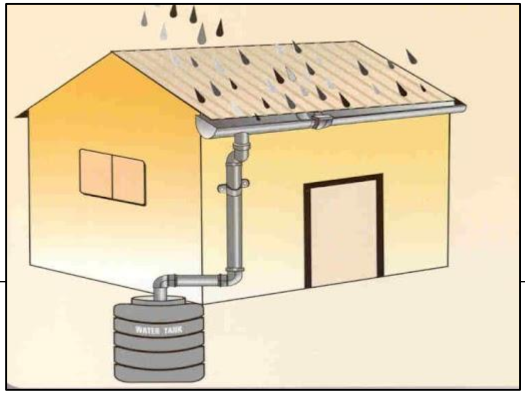
Arid African Alluvial Aquifers - A4Labs
(IHE-Delft)
- **Sand dams**
- **Flood Wells**

Floodplains and shallow wells development
(Meta Meta, PRACTICA)
- **Flood Wells**

UNIFI – Water Harvesting Lab
- **Rooftop Water Harvesting**

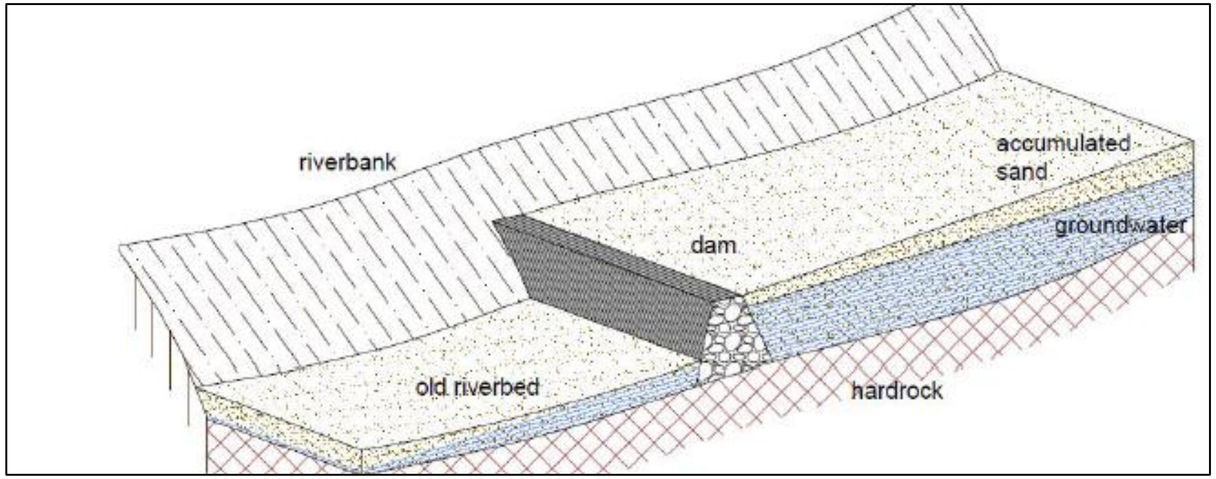






Overall Approach and proposed solutions

Sand dams



Sand storage dam (or sand dam): small dam build on and into the riverbed of a seasonal sand river

- Based **on sedimentation of coarse sand upstream of the structure**, by which the natural storage capacity of the riverbed aquifer is enlarged.

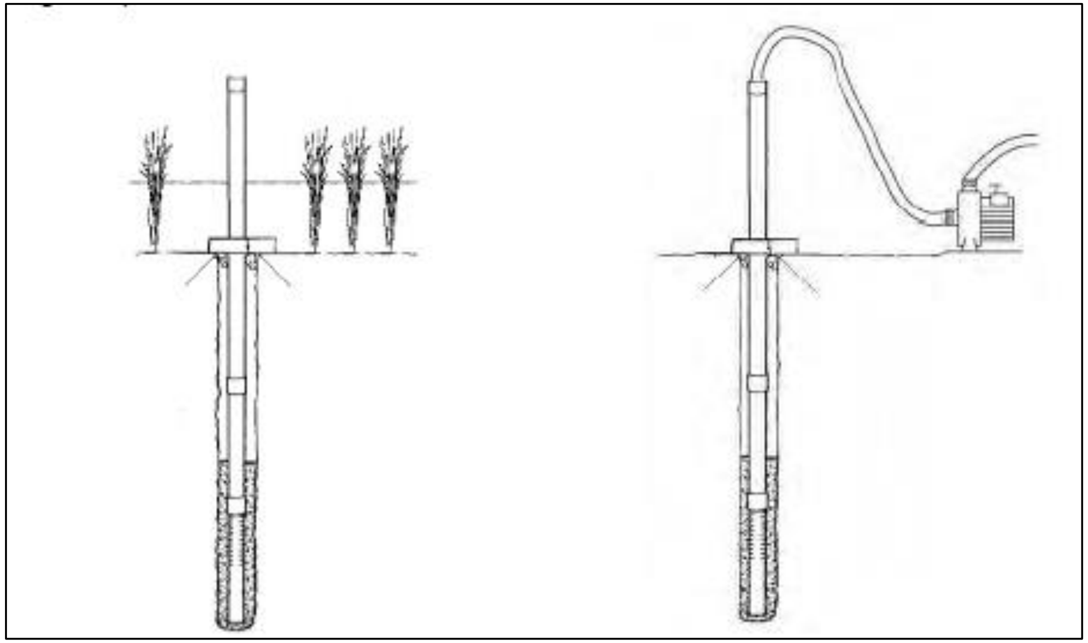
- The **aquifer fills with water during the wet season**, resulting from surface runoff and groundwater recharge within the catchment.

Sand dam

Filtration gallery

Overall Approach and proposed solutions

Flood wells

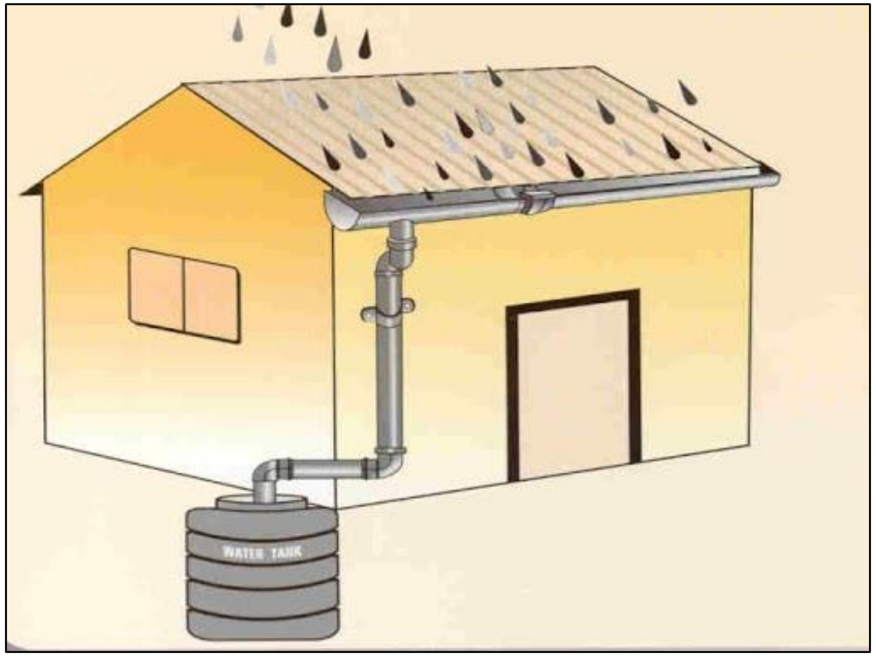


Flood wells are an innovative concept that could provide **smallholder farmers in floodplains** with private access to irrigation water.

- Increase of floodplains productivity drastically, as **their current use is only marginal** while its potential for cash crop production is enormous.
- Contrary to conventional hand-dug wells, **flood wells do not collapse** in the rainy season and allow farmers to irrigate right after the floods recede.

Overall Approach and proposed solutions

Rooftop Water Harvesting



Water Harvesting Lab
University degli Studi di Firenze

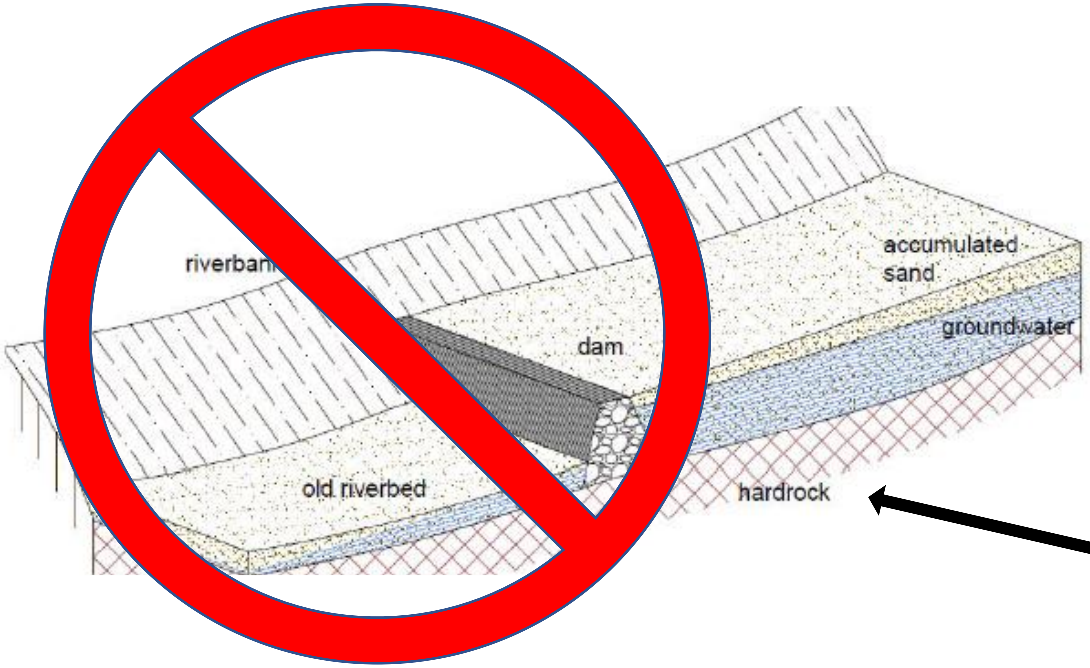
Adaptive innovation piloting and project implementation

Innovation through new water management solutions tested in pilot implementation works

- **YEAR 1:** First installation and initial test
- **YEAR 2:** (Participatory) assessment, re-design, technical improvement and O&M
- **YEAR 3**: Hand over to local communities and scientific follow-up

<u>"Keywords"</u>
Appropriate technologies, materials, test of new infrastructures, operation and management

Early findings



1. No **shallow hard rock found** in the area of study

2. The sand layer is **sufficientely deep**

Early findings

Rooftop Water Harvesting systems

Early findings

Rooftop Water Harvesting systems

- Built on-site with local labor and materials

Early findings

Rooftop Water Harvesting systems

- Built on-site with local labor and materials

Early findings

Rooftop Water Harvesting systems

- Built on-site with local labor and materials

Early findings

Rooftop Water Harvesting systems

- Built on-site with local labor and materials

Early findings

Rooftop Water Harvesting systems

- 20 Systems built for private families, promoting private irrigation for horticultural production
- Built on-site with local labor and materials
- Tank size = 6 cm
- First rain exclusion device
- Mosquito-net filter
- Concrete tank (materials available from a local reseller)

Early findings

- **Rooftop Water Harvesting** do is a new technique for Zambezia
- **Work in remote areas:** low quality of built concrete

Issues to be solved:

- Redesign of **tank cover**
- **Water quality issues** (presence of Coliforms, like most rooftop systems in the world)
- Rooftop Water Harvesting DO is a new technology for Zambezia (its use is imposed by the **negative rainfall** trend)

Early findings

Flood Wells

Preliminary analyses:

- 11 traditional wells tested during the dry season
- Conductivity from 100 to 1000 (uS/cm)
- Maximum water depth = 3.5 m

Water testing, Eduba, Maquival

Early findings

Flood Wells

- Built on-site with local labor and materials

Early findings

Flood Wells

- Built on-site with local labor and materials -> **2 days for a fully operational flood well (around 10 m depth)**





Early findings

Flood Wells

- Built on-site with local labor and materials
- Handed out with manual pumps
- 3 Flood wells built in the first year

Early findings

Flood Wells

Flood Well	Depth (m)	Water Column (m) Wet season	Water Column (m) Dry season	Drawdown (m) Dynamic conditions*
Sareva (Maquival)	7	5.2	2	1
Navilembo (Maquival)	9	8	4	2.6
Curungo (Nicoadala)	9	7	5	3.2

***Kick Start MoneyMaker** hand pump, estimated discharge around 60 l/min

Early findings

Flood Wells

- Built for supporting irrigation **to project communal fields**
- Promising solution
- Low cost, with **locally available materials**
- Up to 9 m depth, **no saline water** even if close to the ocean
- Medium **water availability**
- **Operated with no motor** pumps needed, due to the shallow level of the aquifer
- Relatively clean water

Early findings

Flood Wells

- Need to make new pilots with deeper wells (salinity)
- Proper pumping tests
- Long-term monitoring

Conclusions and takeaways

- A **Project approach** based on learning from past experiences allowed the implementation of **ready-to-use innovations** adequate for the context of Zambezia
- **First round** of a 3-step adaptive innovation methodology: *initial piloting and test + lessons learnt*
- **Second round (2020-2021):** Redesign of innovations and follow up
- **Third round (2021-2022):** Technical and scientific follow up
  - **Rooftop Water Harvesting:** Long term monotoring of water quality, impact on crops, efficiency analysis. Need of training local communities
  - **Floodwells:** Long term analysis, pumping tests, test with solar pumps, water quality analysis, impact on crop production

Thank you

Giulio Castelli

Research fellow – Assegnista di ricerca
Water Harvesting Lab
Department of Agriculture, Food, Environment and Forestry (DAGRI)
Università degli Studi di Firenze

CONTACT: giulio.castelli@unifi.it

Quelimane Agricola project team:

Federico Preti, Elena Bresci, Maria Vittoria Moretti, Giulia Donnici, Sergio Alexandre Ernesto, Oliveira Silva, Francisco Chimote, Matteo Anaclerio

References

Davis-Reddy, C.L. and Vincent, K. (2017) Climate Risk and Vulnerability: A Handbook for Southern Africa (2nd Ed), CSIR, Pretoria, South Africa.

Davis, C.L. (2011), Climate Risk and Vulnerability: A Handbook for Southern Africa. Council for Scientific and Industrial Research, Pretoria, South Africa.

Duker, A., Cambaza, C., Saveca, P., Ponguane, S., Mawoyo, T. A., Hulshof, M., Nkomo, L., et al. (2020) Using nature-based water storage for smallholder irrigated agriculture in African drylands: Lessons from frugal innovation pilots in Mozambique and Zimbabwe. Environ. Sci. Policy 107, 1–6. doi:https://doi.org/10.1016/j.envsci.2020.02.010

IFAD-WFP Joint Climate Analysis Partnership (2016), MOZAMBIQUE: A Climate Analysis

Food and Agriculture Organization of the United Nations (FAO) - Sub-Regional Office for East and Southern Africa (SAFR) FAO-SAFR 1998. Wetland characterization and classification for sustainable agricultural development. Harare, Zimbabwe.

Netherlands Commission for Environmental Assessment (2015), Climate Change Profile MOZAMBIQUE

PRACTICA Foundation (2014), Flood wells in Ethiopia – Pilot Report

Spate Irrigation Network Foundation (2015), Overview Paper 15: Floodplains in Mozambique: The Scope for Shallow Well Development