4th SADC GROUNDWATER CONFERENCE

10th -12th of November 2021

VIRTUAL CONFERENCE

GROUNDWATER MANAGEMENT INSTITUTE

Identification of Suitable Sites for Smallholder Irrigation in the Drylands of Zimbabwe using Weighted Overlay Model

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Sub Theme 1: Groundwater, an integral part of the hydrological system

Identification of Suitable Sites for Smallholder Irrigation in the Drylands of Zimbabwe using Weighted Overlay Model

By Bongani Mpofu, Nobubelo Ngwenya and Stephen Hussey

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Introduction

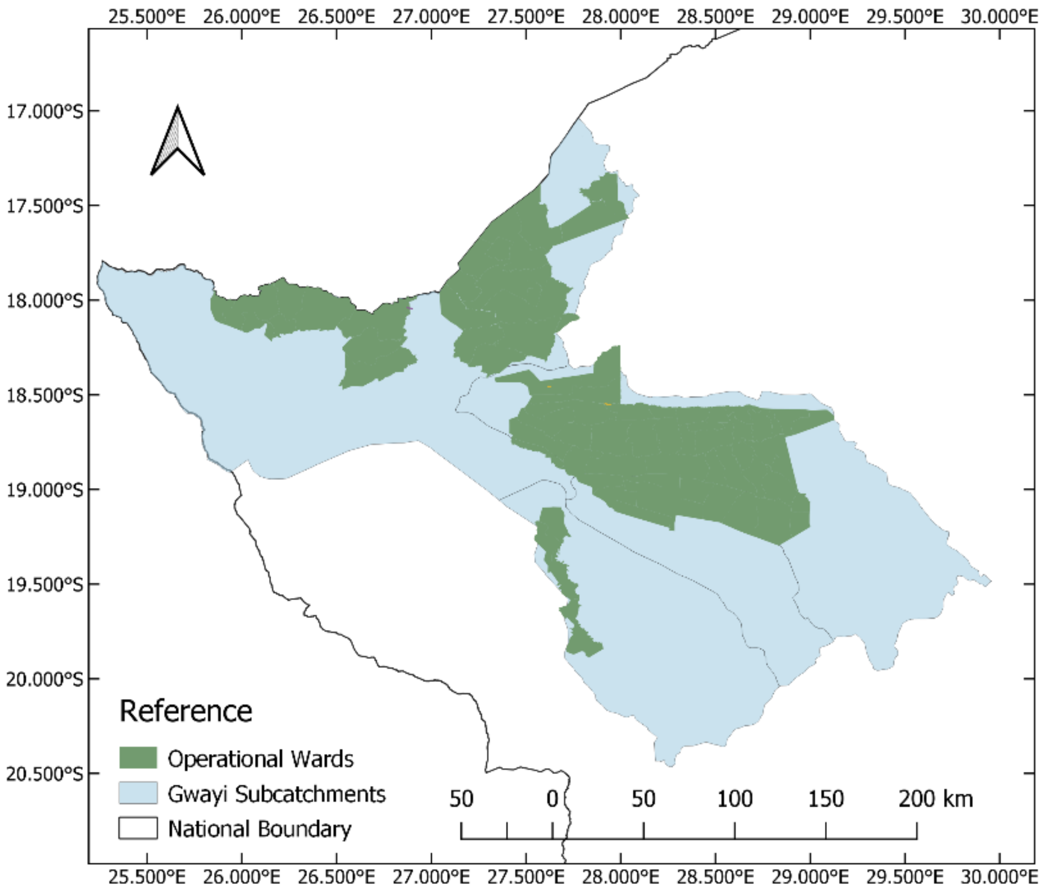


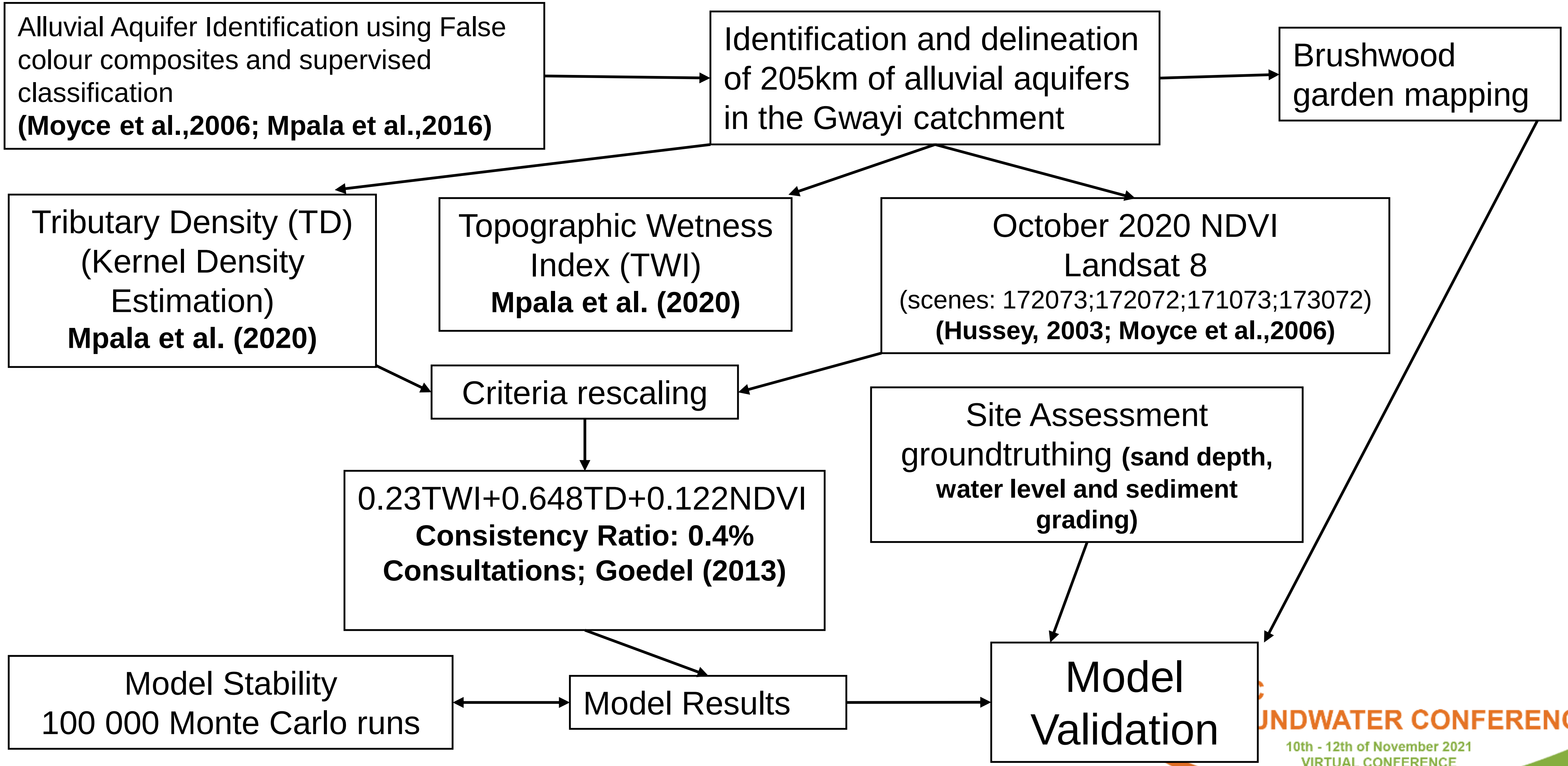
Fig. 1: Study area in the Gwayi Catchment shown in green covering 5 Districts (Tsholotsho, Hwange, Lupane, Nkayi and Binga)

- Alluvial aquifers of sand rivers have been used by rural communities for small holder irrigation for centuries (Mpala et al., 2016).
- To increase resilience of smallholder irrigators, solar powered systems have been adopted (Duker et al.,2020).
- Site investigations now require topographic surveys and specialised equipment. These are also arduous and time consuming.
- The study proposes a GIS based model to remotely identify most suitable river sections for smallholder irrigation development in the Gwayi catchment.

Background

- Application of remote sensing has been limited to identification and delineation of alluvial aquifers (Moyce et al., 2006).
- Mpala et al. (2016) used Landsat images to detect water saturated sand but concluded that manual visual inspection of satellite images is required.
- Walker et al. (2019) used satellite indices (NDWI) to estimate sand river flow and recharge frequency.
- In these studies, aquifer delineation, saturation levels and recharge frequency were successfully determined using remote sensing however identification of suitable sites has not been established.

Methodology



Modelled Sand River sections and Groundtruthing

Table 1: modelled river sections and groundtruthed distance

River (start to end GPS references)	**Length (km)**	**Current Groundtruthed distance (km)**
Shangani river section 1 -19.195079°; 29.004884° to -18.961445°; 28.896183°	35.6	14
Shangani river section 2 -18.879297°; 28.786934° to -18.727345°; 27.637328°	141	2
Gweru -18.720184°; 28.814930° to -18.752794°; 28.731719°	11.5	4
Inyantue -18.393258°; 26.754970° to -18.353686°; 26.808165°	16.2	2

Other visited sand rivers

1. Tinde (Binga)
2. Muchesu (Binga)
3. Lukhosi (Hwange
4. Manziasiya (Binga)
5. Gwayi (Tsholotsho)

Results: Above average potential section

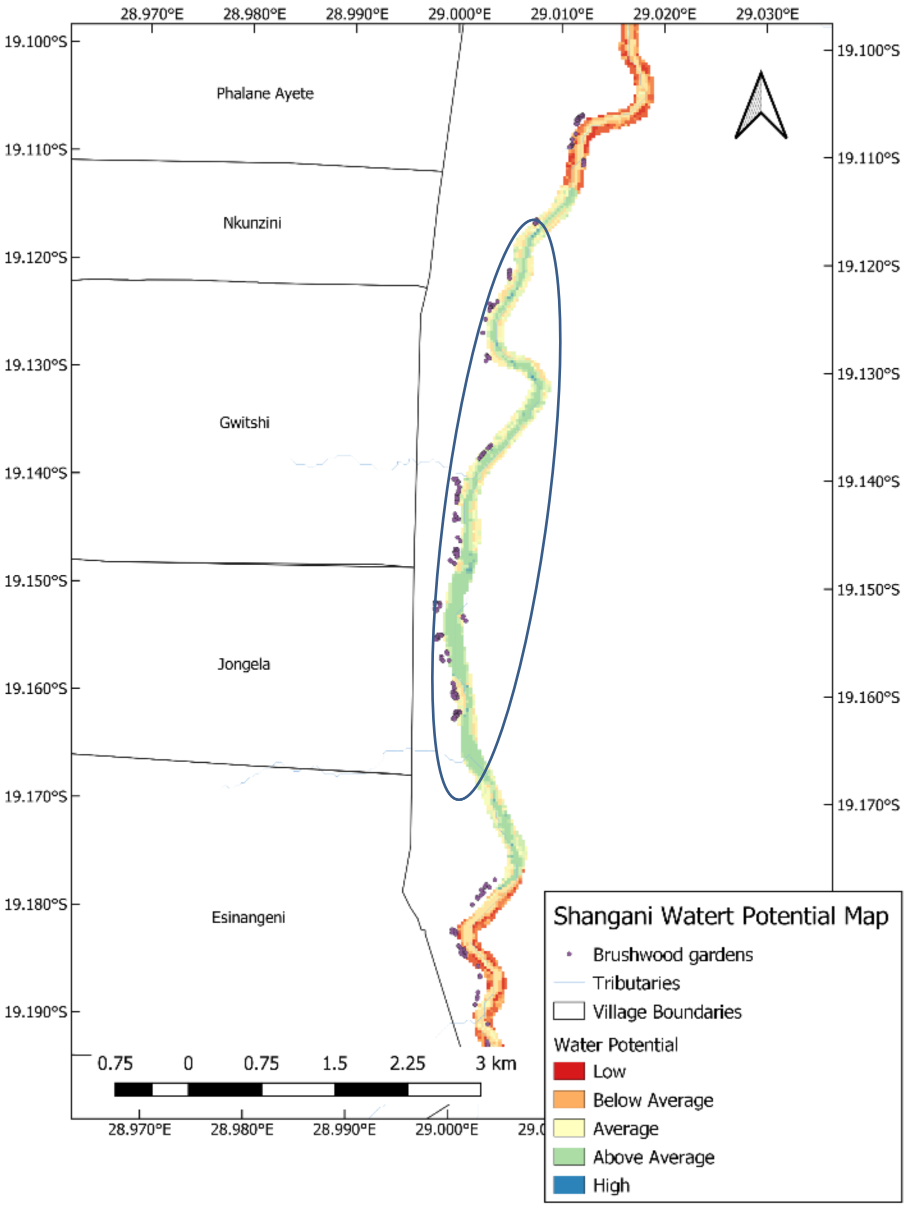


Fig. 2: Water potential of the Shangani river showing above average potential from Esinangeni Village up to Nkunzini Village

Fig. 3: Sand probing indicated depths of >3m. According to Hussey (2003) sections with depths greater than 3m are good for sand abstraction

Fig. 4: Water level at 0.5m below the sand surface (Sept 2021)

Results: Low Potential Section

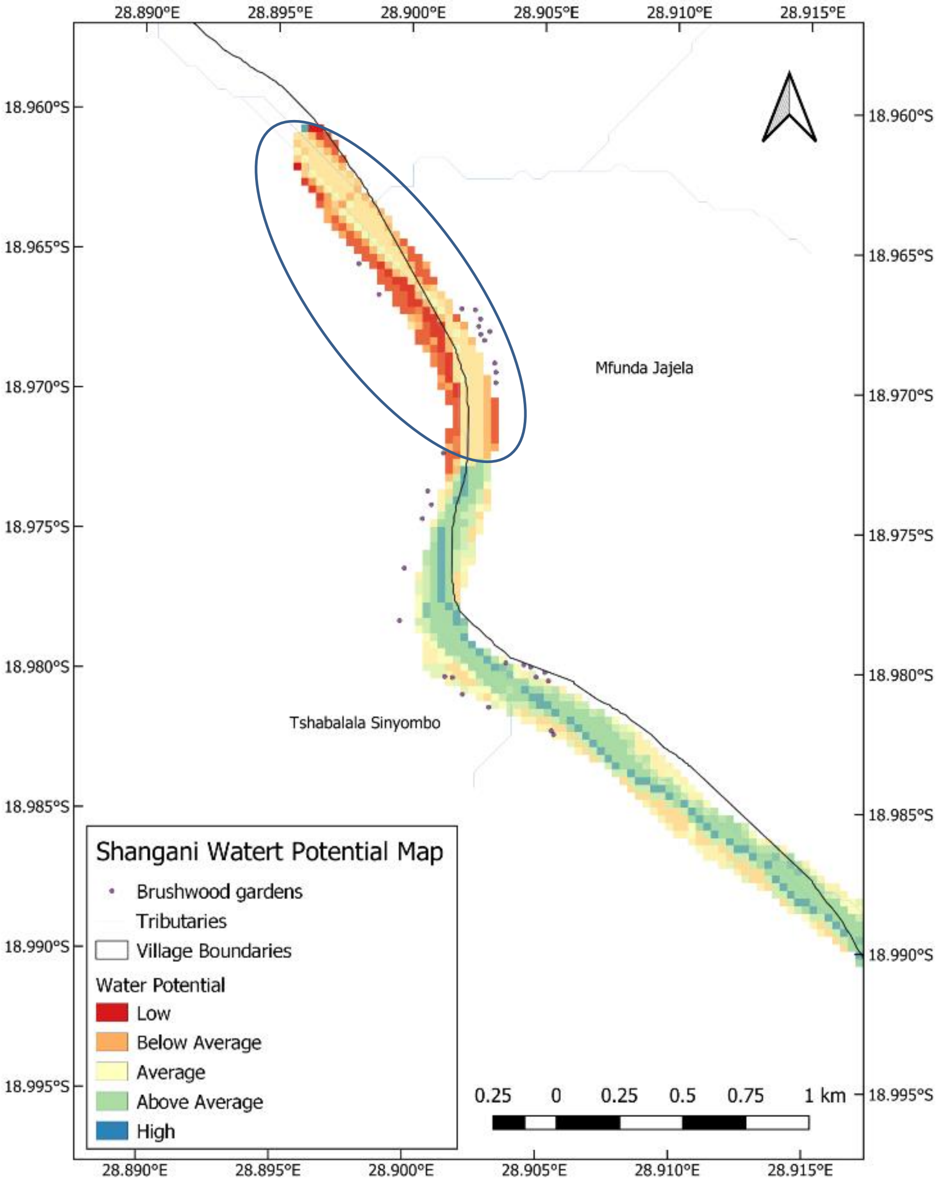
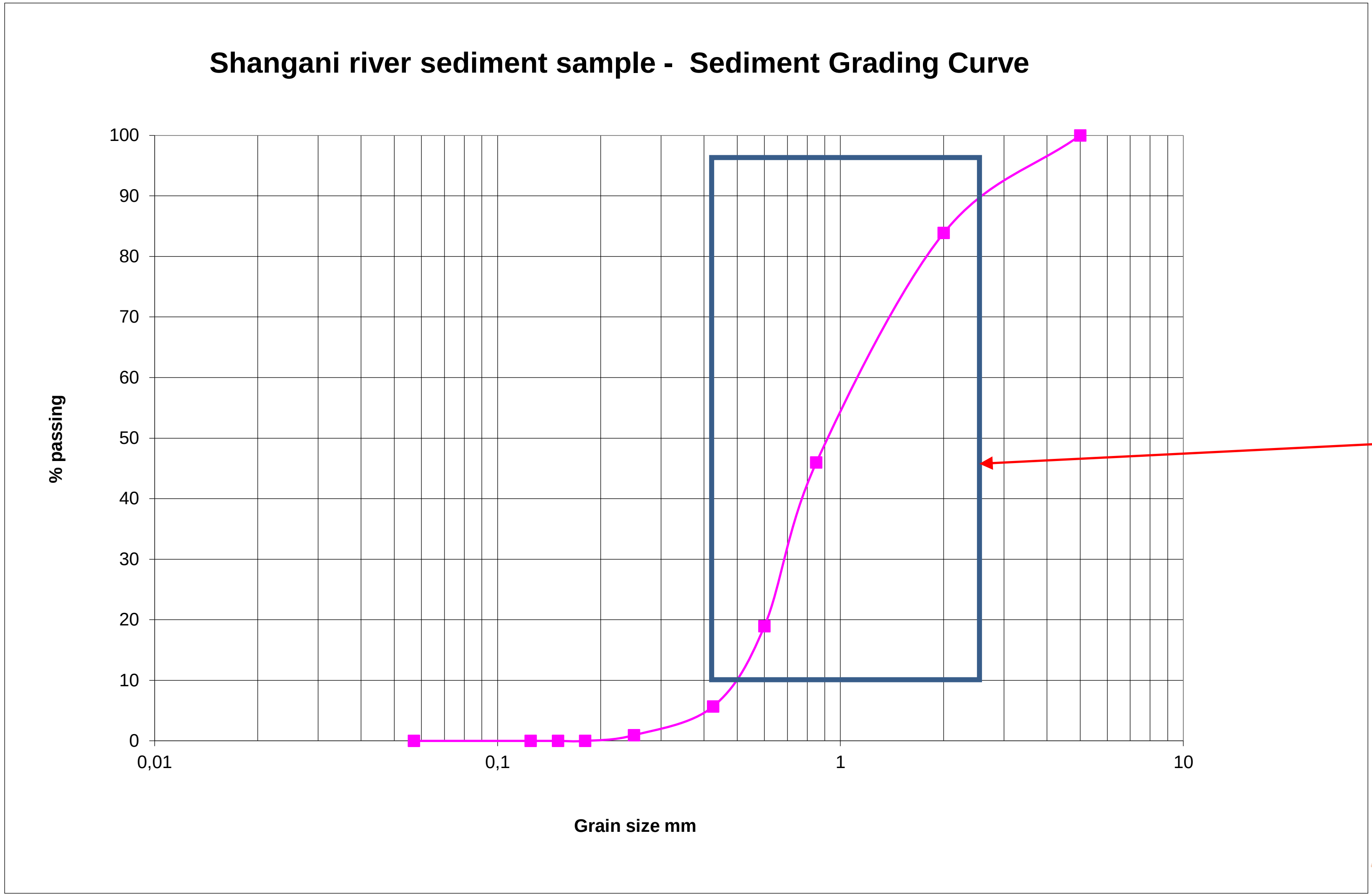


Fig. 5: Water potential of the Shangani showing below average to low water potential along Tshabalala-Sinyombo and Mfunda-Jajela Villages

Fig. 6&7: Rock bars in the river limiting the depth of sediment and hence water potential at the section. However the rock bars act as a sand dam impeding sub-surface flow. This is shown by visible water pools in the river surface upstream of the rock bars.

Results: Sediment Grading Analysis



As the most appropriate grade of sediment is between 0.5mm and 2.5mm (Hussey, 2003), The assessed sites have samples with a high proportion in this range indicating suitability for sand abstraction.

Fig. 8: Sediment grading curve of sample obtained from most suitable river section

Discussion: Small sand rivers

- The identification process and model works well for wide sand rivers (>40m).

- Smaller sand rivers cannot be delineated accurately using low resolution images. This was also stated by Walker et al. (2019).

- The small rivers were missed by the methodology however the groundtruthing exercise showed that these support communal irrigated gardens.

Fig. 9: Woman using a Rowa pump to abstract water from the Tinde river which is 15m wide (Binga)

Discussion: Community Consultations

- According to Hussey (2003), the most assured way of site selection is through community consultations.
- The presence of brushwood gardens give an indication of site suitability however patterns of river flow can only be understood through community consultations.

Fig. 10: Women abstracting water from an open scoop hole on the Mucheso river (Binga). Users of the rivers will be consulted to give insight on flow patterns and recharge.

Continual Research: Next Steps

1. The use of high resolution images (Sentinel 2) for aquifer identification in narrow sand rivers
2. Groundtruthing of more river sections
3. Consultations with users of the modelled rivers

Conclusion

1. The model results seem to agree with the groundtruthing data indicating that the model can be successfully used to remotely identify suitable sites for communal irrigation. This will ensure that no potential sites are missed and only the more promising sites are surveyed.
2. Application of the model will reduce assessment time and costs by guiding physical surveys to delineated areas which show high suitability

References

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Acknowledgements

The authors like to acknowledge Dabane Trust Water Workshops for enabling the groundtruthing exercise.