Estimation of suitability for manual drilling in Northern Senegal from textural and hydraulic parameters of shallow aquifers

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In the framework of the program for the achievement of MDG (Millenium Development Goals) for water supply, UNICEF is promoting manual drilling throughout Africa..

Manual drilling refers to those techniques of drilling boreholes for groundwater exploitation using human or animal power (not mechanized equipment). These techniques are well known in countries with large alluvial deposits (India, Nepal, Bangladesh, etc). They are much cheaper than mechanized boreholes, easy to implement as the equipment is locally done, able to provide clean water if correctly applied.

But they can be applied only in those areas with **suitable hydrogeological conditions: thick layers of unconsolidated sediments and shallow groundwater level. Furthermore they require high hydraulic conductivity of aquifer layers. All these conditions are considered in the definition of suitable zones for manual drilling.**

The research has been developed in the framework of the project *"Use of remote sensing and terrain modeling to identify suitable zones for manual drilling in Africa and support low cost water supply*", within the scientific cooperation between
-University of Milano-Bicocca
-University Cheikh Anta Diop (Dakar Senegal) ,
-SNAPE – Service Nationale de Points d'Eau (Conakry Guinea)
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-UNICEF Guinea.
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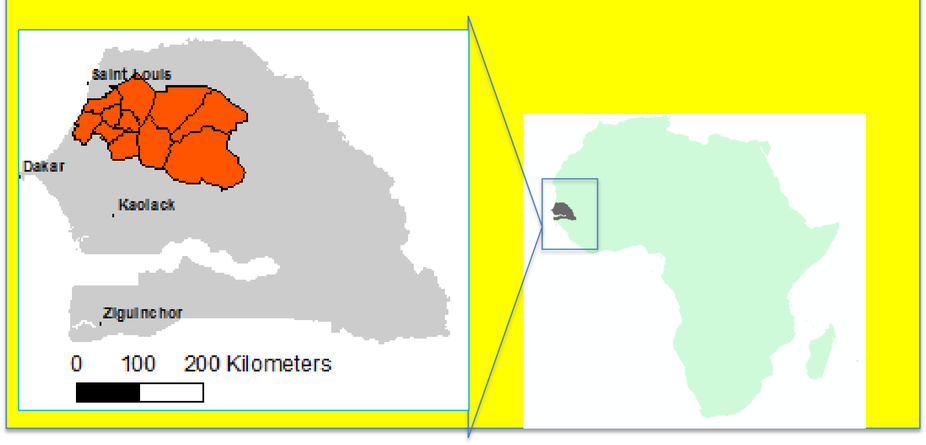
OBJECTIVE OF THE RESEARCH

Estimation of the suitability for manual drilling through semi-automatic interpretation of borehole stratigraphic logs and extraction of textural and hydraulic parameters of shallow aquifers

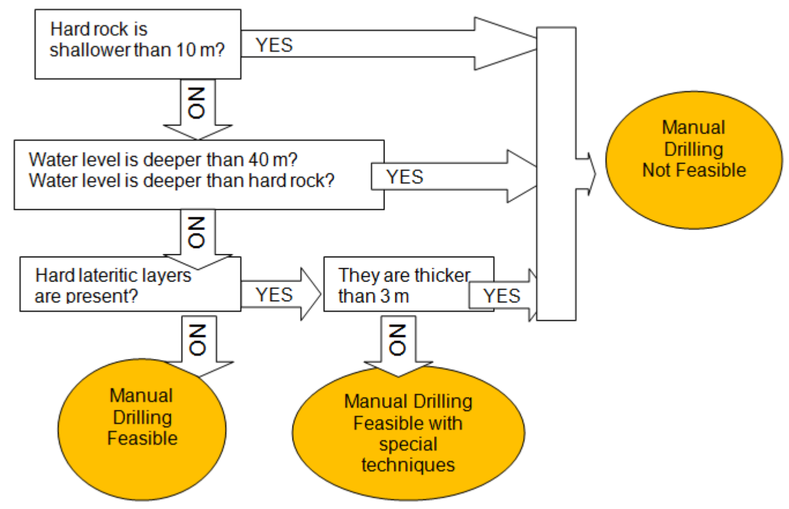
Study area: North-Western Senegal, regions of Louga, Linguere et Kebemere.
- Geology :quaternary sands and sandy clay overlaying a basement of limestone and marl
- Morphology : mainly flat, with small dunes along the coastal strip
- Arid climate, with yearly average rainfall 400 mm (Louga) concentrated between June and October



Suitability for manual drilling:

the proposed model combine two factors:

Feasibility:
It depends on
-depth of hard rock
- depth of water level
- thickness of hard lateritic layers



Potential for exploitation

-It depends on thickness and hydraulic conductivity (K) of saturated exploitable layer (between 0 and 50 m deep)
-It is obtained from assigning class of potential based on Hydraulic Transmissivity from 0 to 50 m (Texp).
- Hydraulic conductivity of fractured hard layers is not considered (as not suitable for manual drilling)

DATA PROCESSING

It is the combination of semi-automatic analysis with a specific software (TANGAFRIC) developed at the University Milano Bicocca, followed by calibration of texture and hydraulic parameters through field measurements

MANUAL CODIFICATION OF BOREHOLES LOGS FROM DATABASE OF DGPRE (NATIONAL WATER AUTHORITY, SENEGAL)

IDENTIFICATION OF MOST FREQUENT CATEGORIES (NOUNS AND ADJECTIVES) → ASSIGNING STRATIGRAPHIC CODES

Obtained from existing national database (PROGRES) | Manual input with TANGAFRIC

	Code forage	Limite sup (m)	Limite inf (m)	Description Lithologie	Stratigraphic codes: Main texture component	Secondary texture component	Texture adjective	Status adjective	Color Adject.
Borehole 1	275X0001	0	5	argile	Argile				
	275X0001	5	10	argile latéritique	Argile		latéritique		
	275X0001	10	16.15	schistes barioles	Schiste	Quartz			bariolé
	275X0001	16.15	20	schistes a passes de quartz	Quartz				
	275X0001	20	40	quartz	Quartz				
	275X0001	40	75	gres quartzites	Gres	Quartzite			
Borehole 2	025X0007	0	6	sable moyen a grossier + ou - ferrugineux	Sable			moyen	
	025X0007	6	11	sable argileux + latérite	Sable	Laterite	argileux		
	025X0007	11	32	sable moyen a grossier avec gravillons de laterite	Sable	Laterite			
	025X0007	32	35	calcaire greseux	Calcaire			greseux	

AUTOMATIC EXTRACTION OF TEXTURAL AND HYDRAULIC PARAMETERS

DATABASE OF WATER POINTS AND CODIFIED STRATIGRAPHIC LOGS FOR SENEGAL AND GUINEA

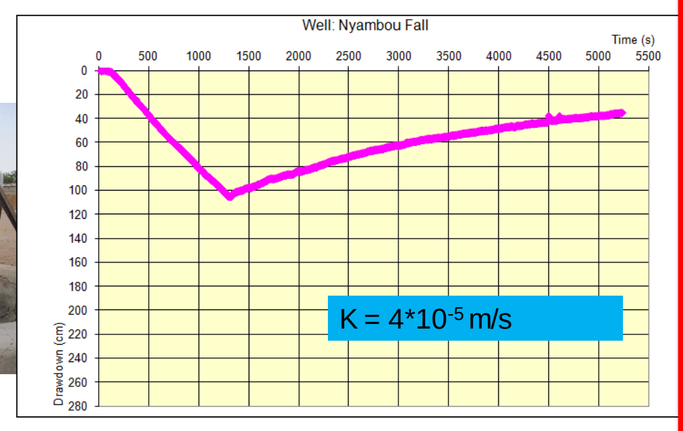
Piezometric data	*Administrative data*	*Stratigraphic Layers data*
Code of log	Code of log	Code of log
Static Water level	Village	Layer nr
Date of SWL measurement	District	Upper limit
	Coordinate X	Lower limit
	Coordinate Y	Description
	Elevation	Main texture component
		Secondary texture component
		Texture adjective
		Status adjective
		Colour adjective

PROCESSING OF STRATIGRAPHIC AND PIEZOMETRIC DATA

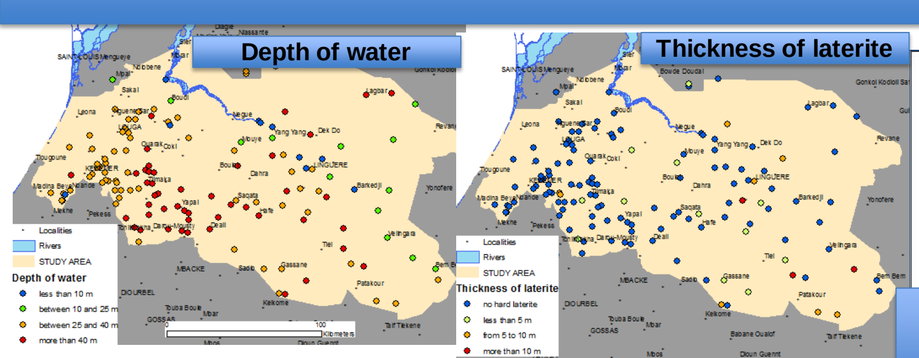
DEPTH OF HARD ROCK,
DEPTH OF WATER TABLE
THICKNESS OF HARD LATERITIC LAYERS
HYDRAULIC CONDUCTIVITY (K) OF SHALLOW LAYERS

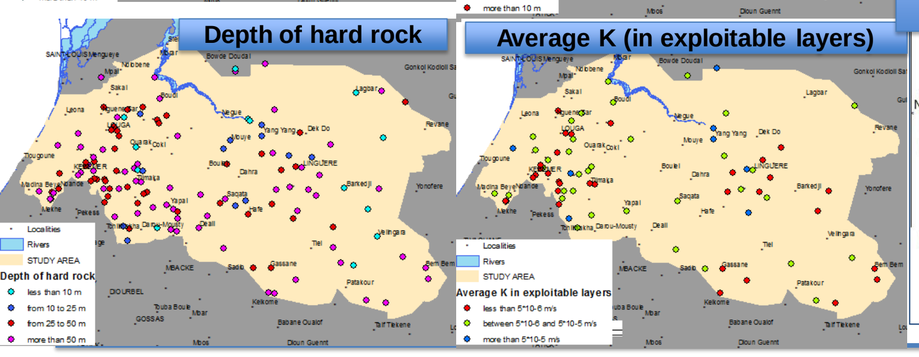
CALIBRATION OF HYDRAULIC PARAMETERS THROUGH FIELD MEASUREMENTS

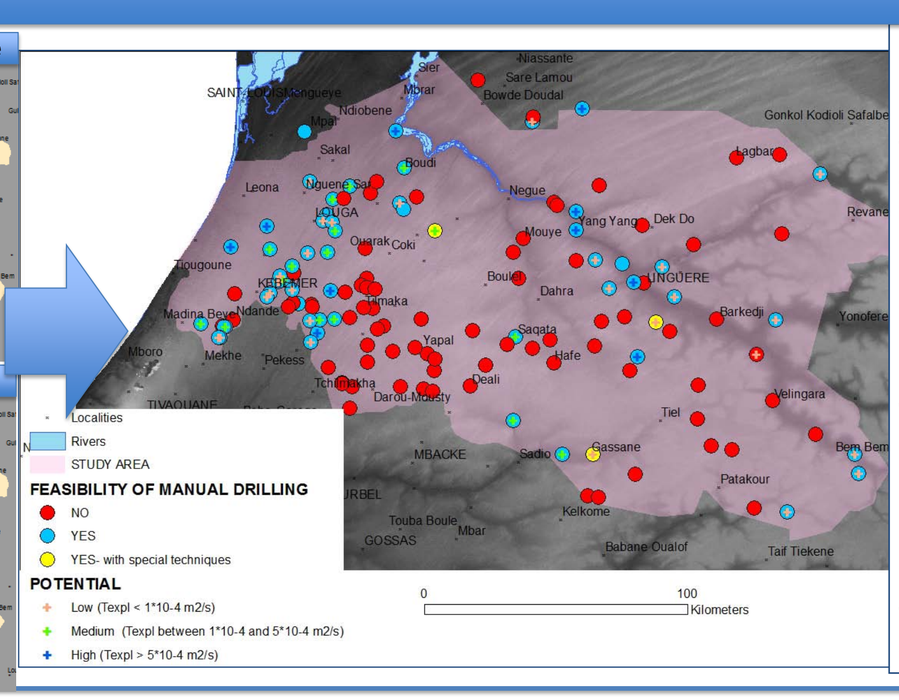
Pump and recovery test in hand dug wells



RESULTS AND CONCLUSION







CONCLUSIONS

In the whole study area, two main zones are suitable for manual drilling:
-The western part , up to 20 km east of Louga and Kebemer
-The zone NW of Linguere, along the Ferlo valley
-The highest potential is expected along the coast (W of Louga), between Kebemer and Tamaka, and in the Ferlo valley

Water depth is the main limiting factor for the use of manual drilling up (considering a maximum depth of 50 m)

Hard laterite is not representing an obstacle to manual drilling in this area, although it is likely that percussion techniques must be used when it is implemented in some localities south of Linguere

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