Grundwassererkundung in Namibia

– wie finde und erkunde ich einen tiefen Grundwasserleiter?

Georg Houben

S. Kaufhold, M. Wallner, Christoph Lohe, Martin Quinger, Maria Sitnikova, Labore (BGR)

Roy McG Miller (ex GSN), Reginalda Joseph (MAWF)

Meike Noll, Jens Hornung, Matthias Hinderer (TU Darmstadt)

Axel Gerdes (Goethe University Frankfurt), Andreas Gärtner et al. (Senckenberg Dresden)

Stephen T. Hasiotis (University of Kansas)

M. Justin Wilkinson (Texas State Univ., NASA JSC)

Johnson Space Center

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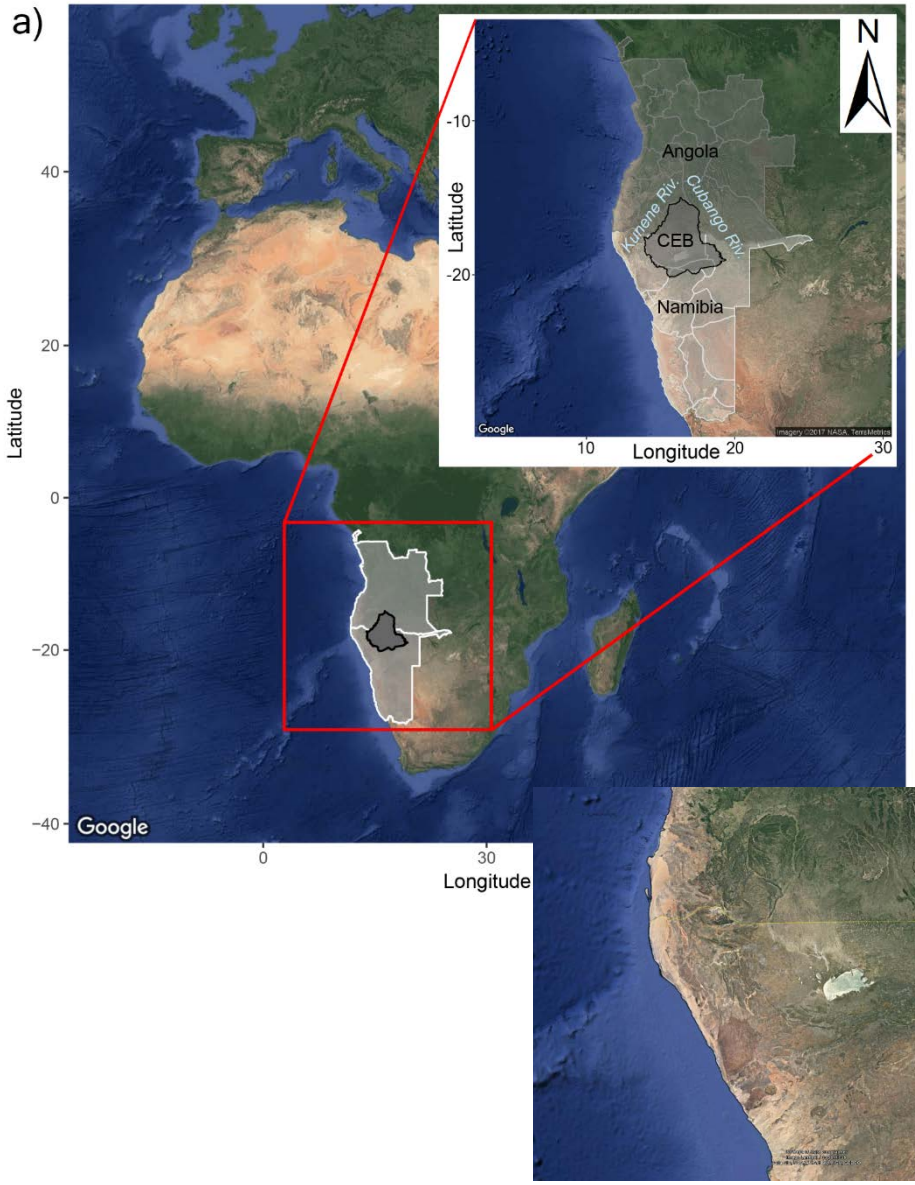
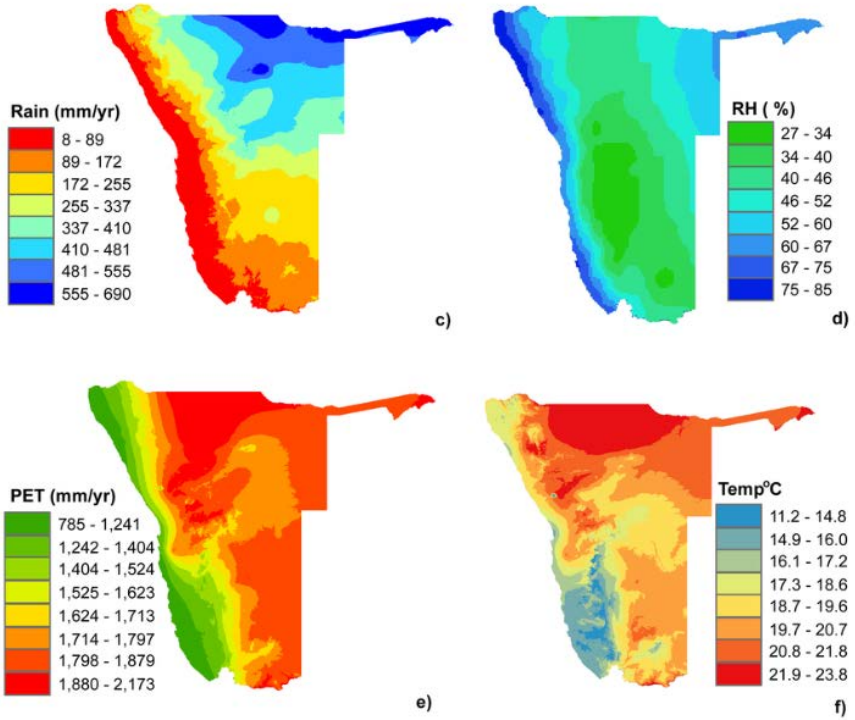
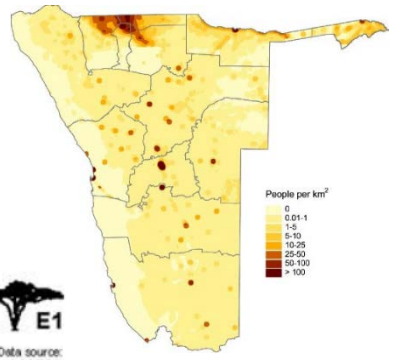
The Cuvelai-Etosha-Basin







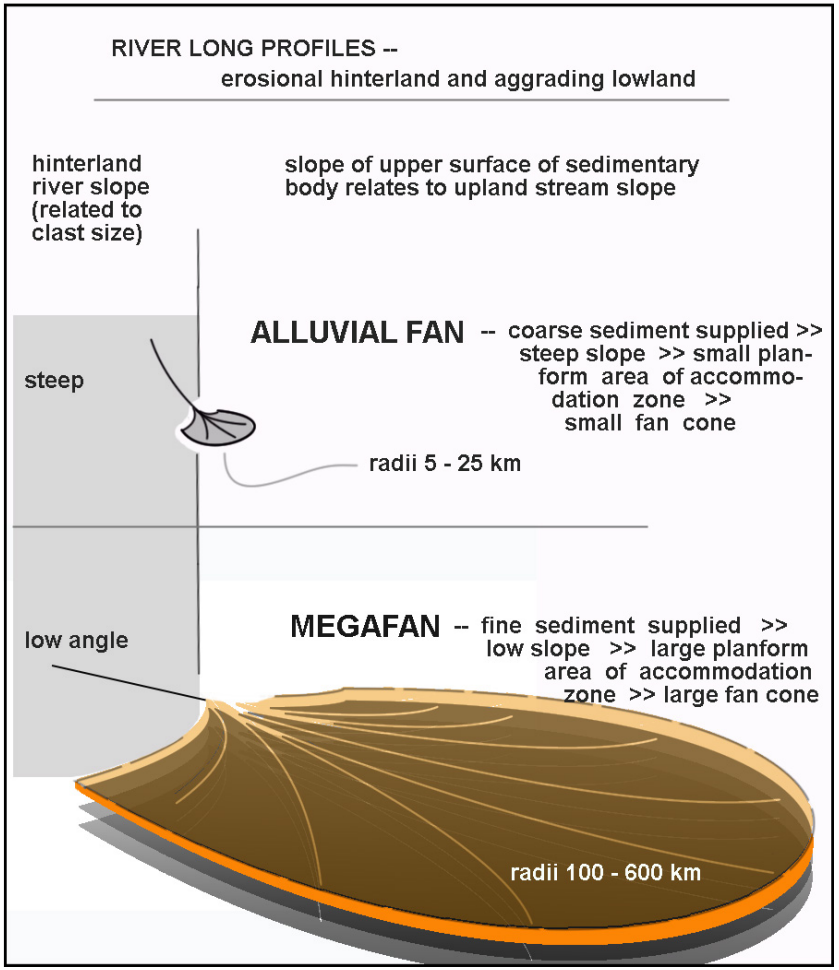
Map produced by
SFB 389 'ACACIA', subproject E1
University of Cologne
E1

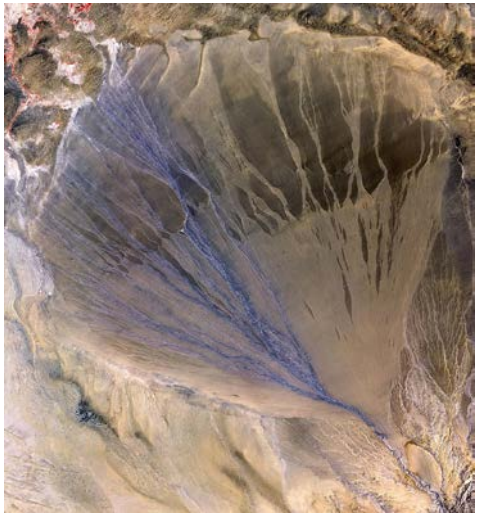
Data source:
Atlas of Namibia Project, 2002, Directorate of Environmental Affairs, Ministry of Environment and Tourism. http://www.dea.met.gov.na (2003)

Faseke et al. (2016)

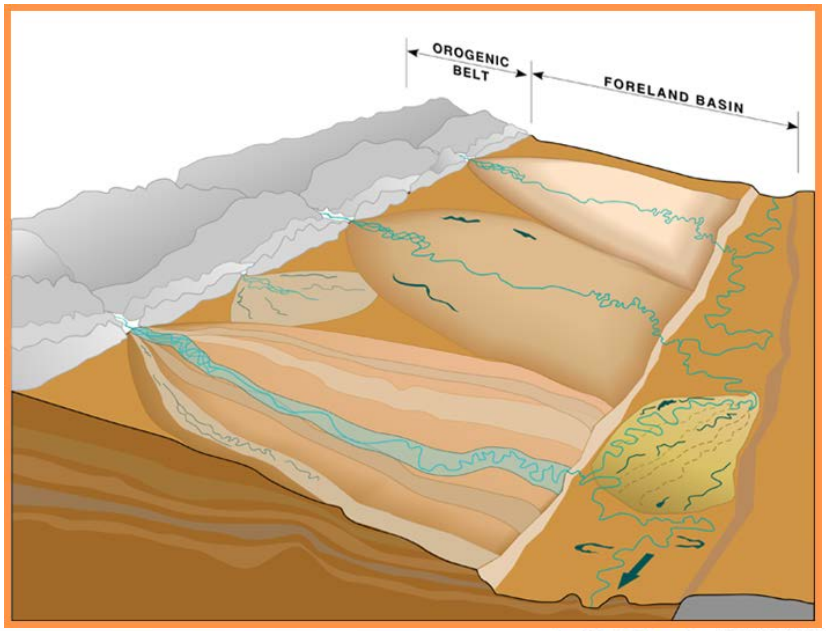
The geology of the CEB: mega-fans

M.J. Wilkinson, NASA/Texas State Univ.





Kunlun-Altun mega-fan
Taklamakan, China
(Wikipedia)



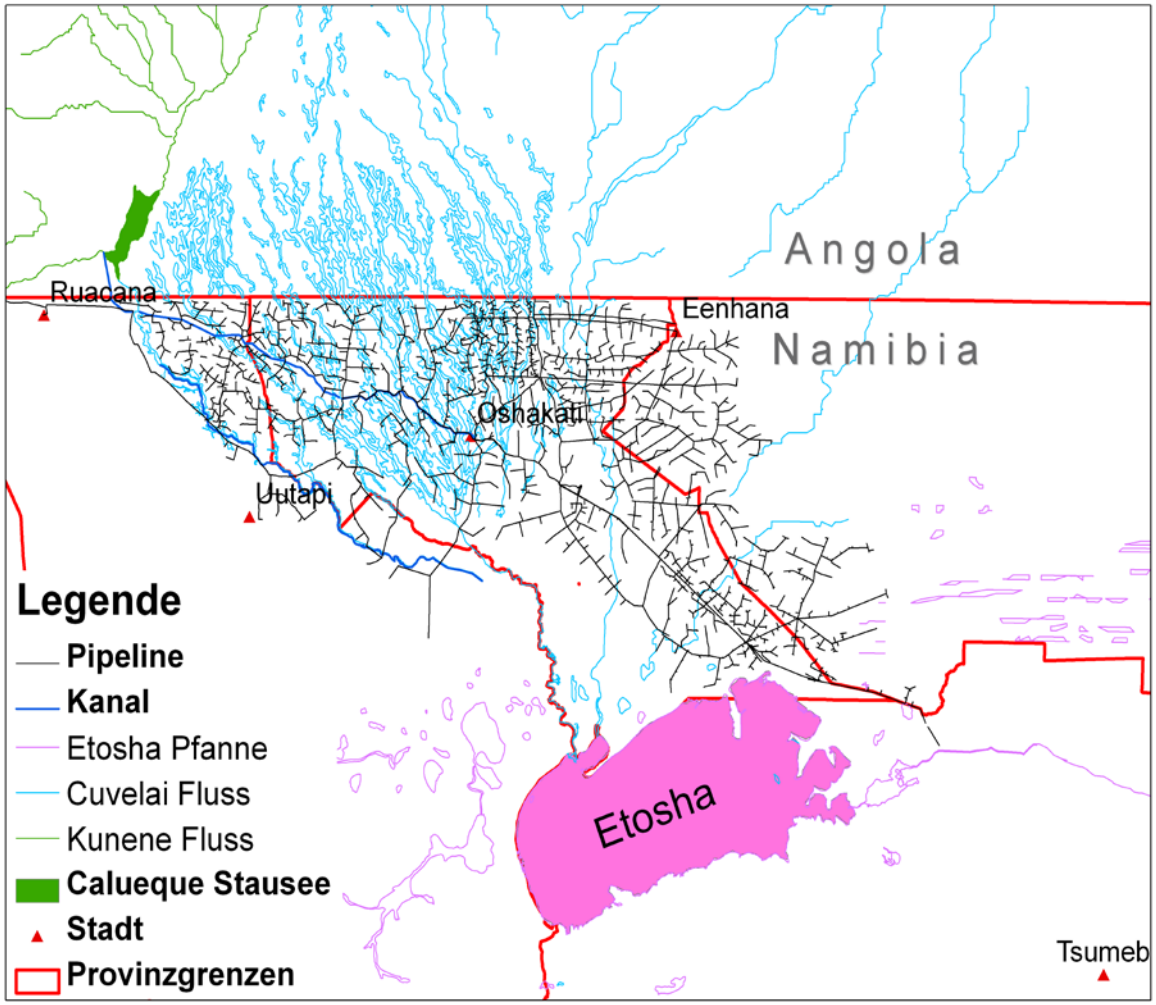
- fan-shaped, large alluvial fans, “inland deltas”
- single outlet (apex)
- very low angle, very flat

Northern Namibia – climatic extremes

- long periods with successive extreme droughts
- extreme droughts 1992, 1993, 2007, 2019 ...
- crop failure and intense loss of livestock

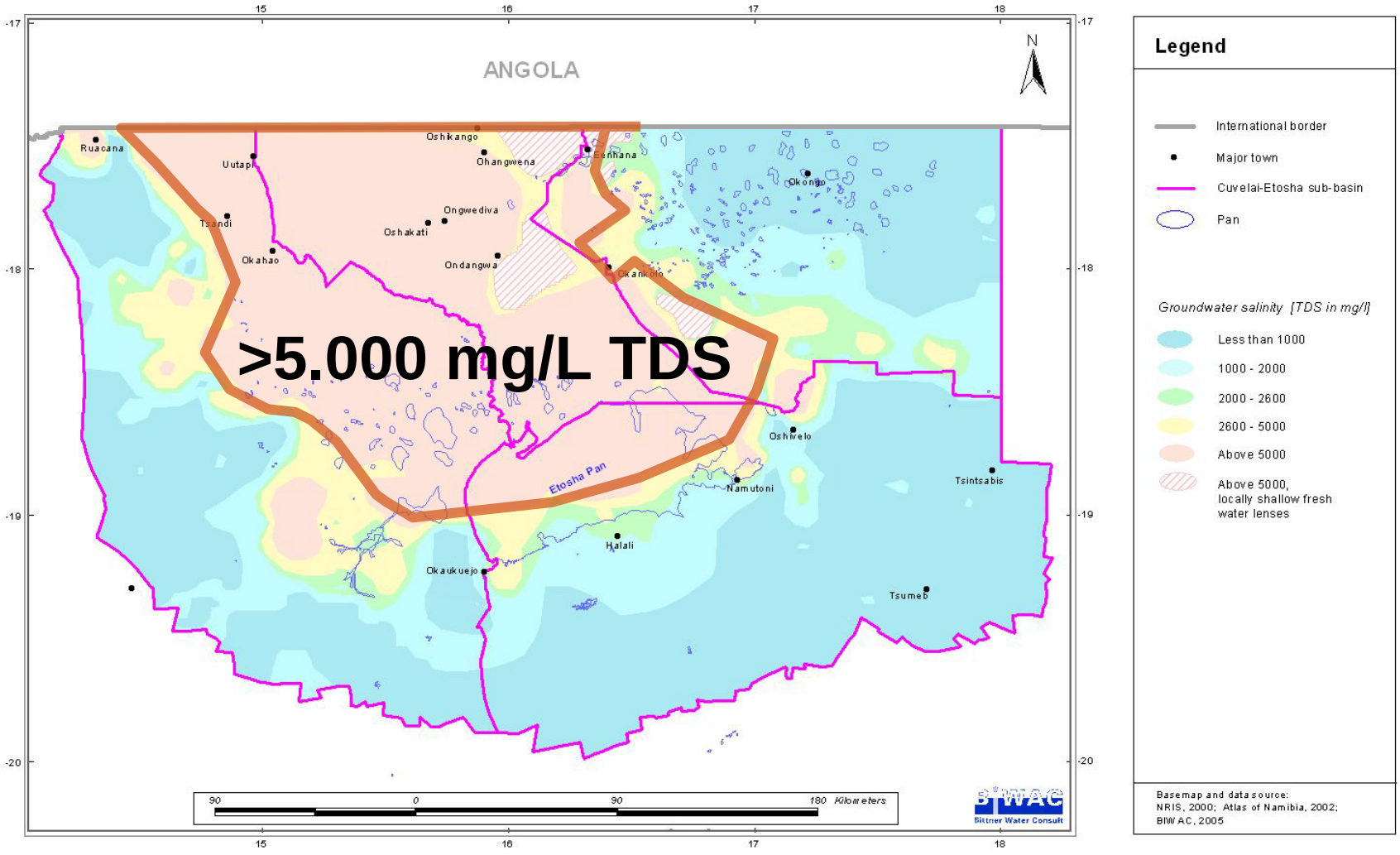
- strong wet periods result in wide-spread flooding
- most prominent 2009 – 2011

Water Supply: open canals and shallow groundwater

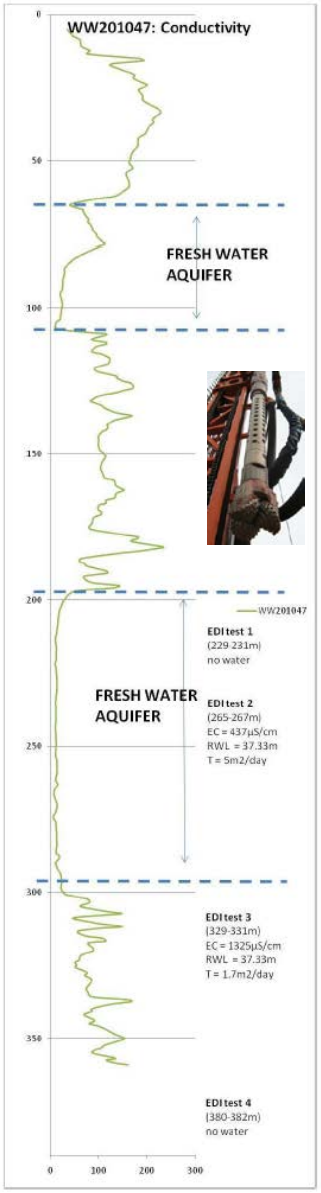


- surface water from the Calenque reservoir lake (Angola)
- shallow groundwater, often saline and microbial contamination

Salinization of shallow groundwater (KOH-1)



New resource: the Ohangwena II aquifer (KOH-2)



Science & Environment

Vast aquifer found in Namibia could last for centuries

By Matt McGrath
Science reporter, BBC World Service

20 July 2012 Share

A newly discovered water source in Namibia could have a major impact on development in the driest country in sub-Saharan Africa.

Pressure from the aquifer means the water is cheap to extract

Estimates suggest the aquifer could supply the north of the country for 400 years at current rates of consumption.

Scientists say the water is up to 10,000 years old but is cleaner to drink than many modern sources.

However, there are concerns that unauthorised drilling could threaten the new supply.

Huge resource

For the people of northern Namibia water is something that they either have too much of or too little.

Scientists urge sustainable development of Namibia's newly found aquifer

The aquifer straddling the border with Angola could provide water for 400 years, but despite the excitement scientists warn it is not a panacea for Namibia


German and Namibian scientists analysing the groundwater near Eenhana in Ohangwena region, northern Namibia. Photograph: Christoph Lohe

FutureChallenges

Thinking global, living local: Voices in a globalized world

Like 0 Tweet 0

The Great Land Grab: The Discovery of a New Aquifer in Namibia

*Written by **Mac-Jordan D. Degadjor** on September 9, 2012. Published in **The great land rush** on **Africa, Namibia**.*

NEW ERA

N$3.00 (incl

Windhoek, Namibia Monday July 10


Hands on... A delegation led by Ohangwena Regional Governor Usko Nghaamwa visiting the drilled boreholes at Eenhana.
Photo: Nuusita Ashipala

Pumping the Ohangwena aquifer's reserves

"It will be that the whole work will not be completed in the next five years, but we must start and have some work done in supplying the community with water."
– *Abraham Nehemia*

Nuusita Ashipala
Eenhana

The estimated volumes of water in the Ohangwena aquifer have ballooned to 20 billion cubic metres, from the earlier estimates of 5 billion cubic metres.

The aquifer is currently supplying 40 cubic metres of water per hour to Eenhana through three boreholes. The agriculture ministry is now looking at extending water provision to areas of Epembe, Oshikunde and Okongo in eastern Ohangwena. These areas currently have no access to piped water and are in dire need of potable water. This was revealed by the deputy

AQUIFER'S on page 2

Low salary no reason to steal - PC

Maria Amakali
Windhoek

The prosecutor general Martha Ima has dismissed the notion that remuneration is the reason ther an increase in the number of prosecutors who have been charge illegal activities, including fraud.

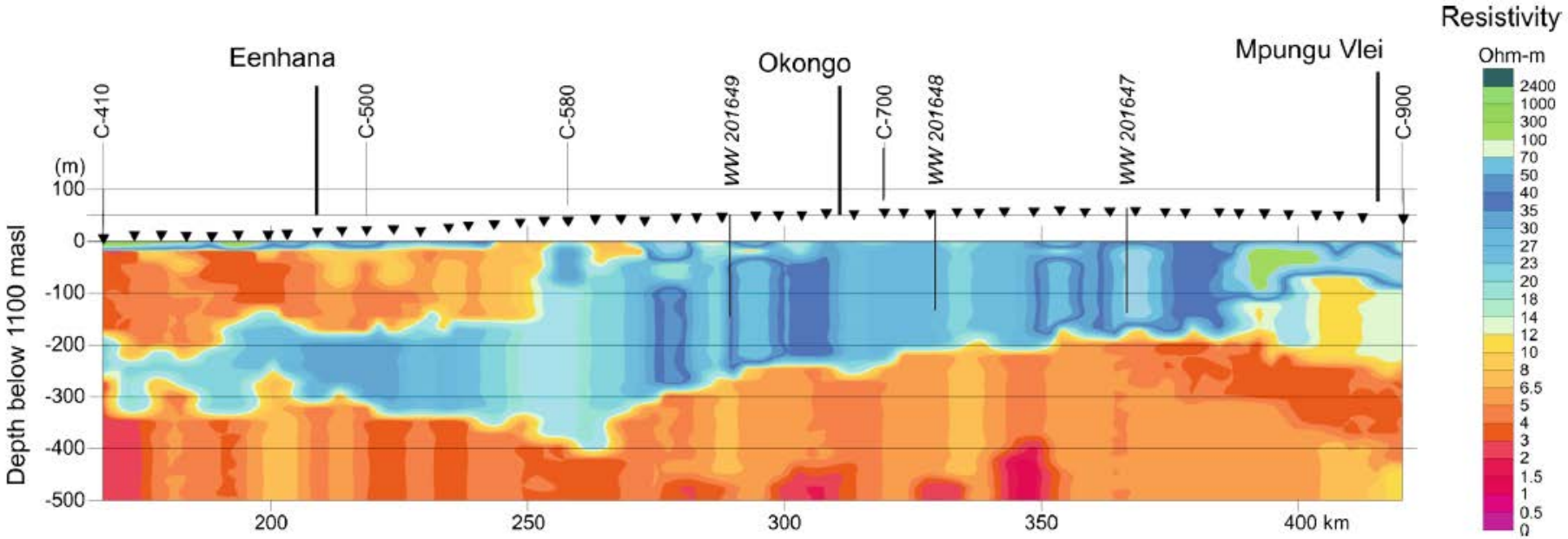
"The salary is not enough as we want it to be, but it is not so little one cannot survive on it. My fe prosecutors, be satisfied with what are getting," said Imalwa, adding she has been fighting for prosec to get a fair salary.

Imalwa pointed out that one doc join the prosecution to merely bec rich but rather to serve the interes Namibian people. "There is a sa that money is not for those that e but for those that know how to us said Imalwa.

SALARY on

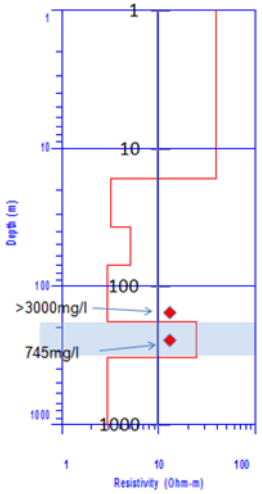
BGR Bundesanstalt für Geowissenschaften und Rohstoffe
GEOZENTRUM HANNOVER

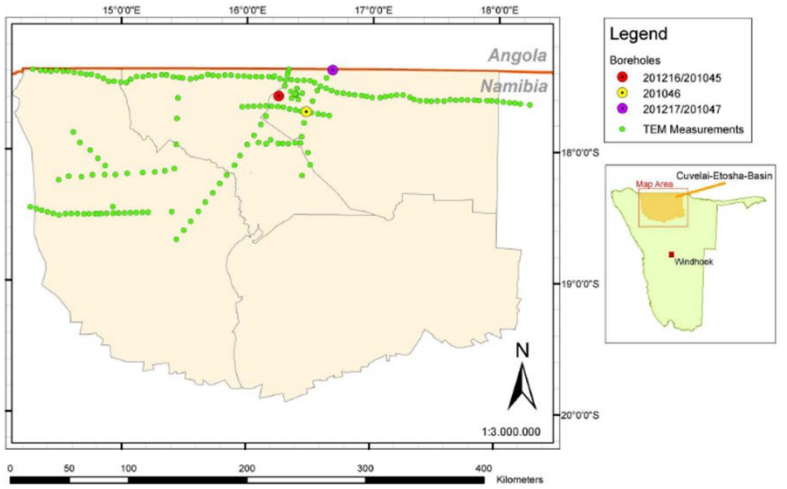
Geophysical exploration: TEM sounding profiles



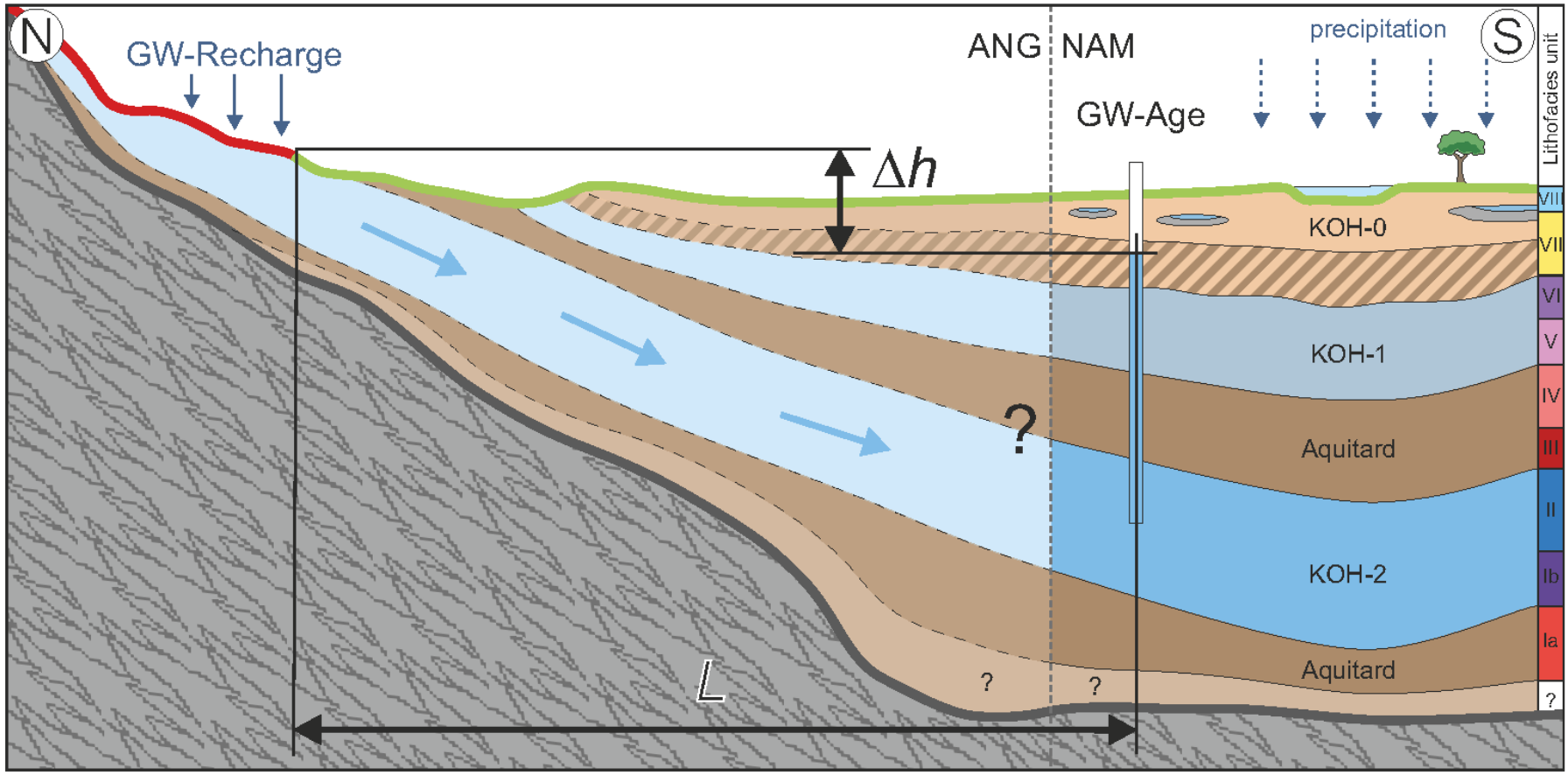
Geophysical exploration campaign:
440 TEM soundings
(300 m x 300 m loop)
Report: Schildknecht (2012)

Boreholes (partially cored):
Dill et al. (2012)
Lindenmaier et al. (2014)





Conceptual model of the aquifer system



Wallner et al. (2017)

Learning something from (almost) nothing

CEB: 160,000 km²

Geophysics: 440 TEM

(300 m x 300 m loop)

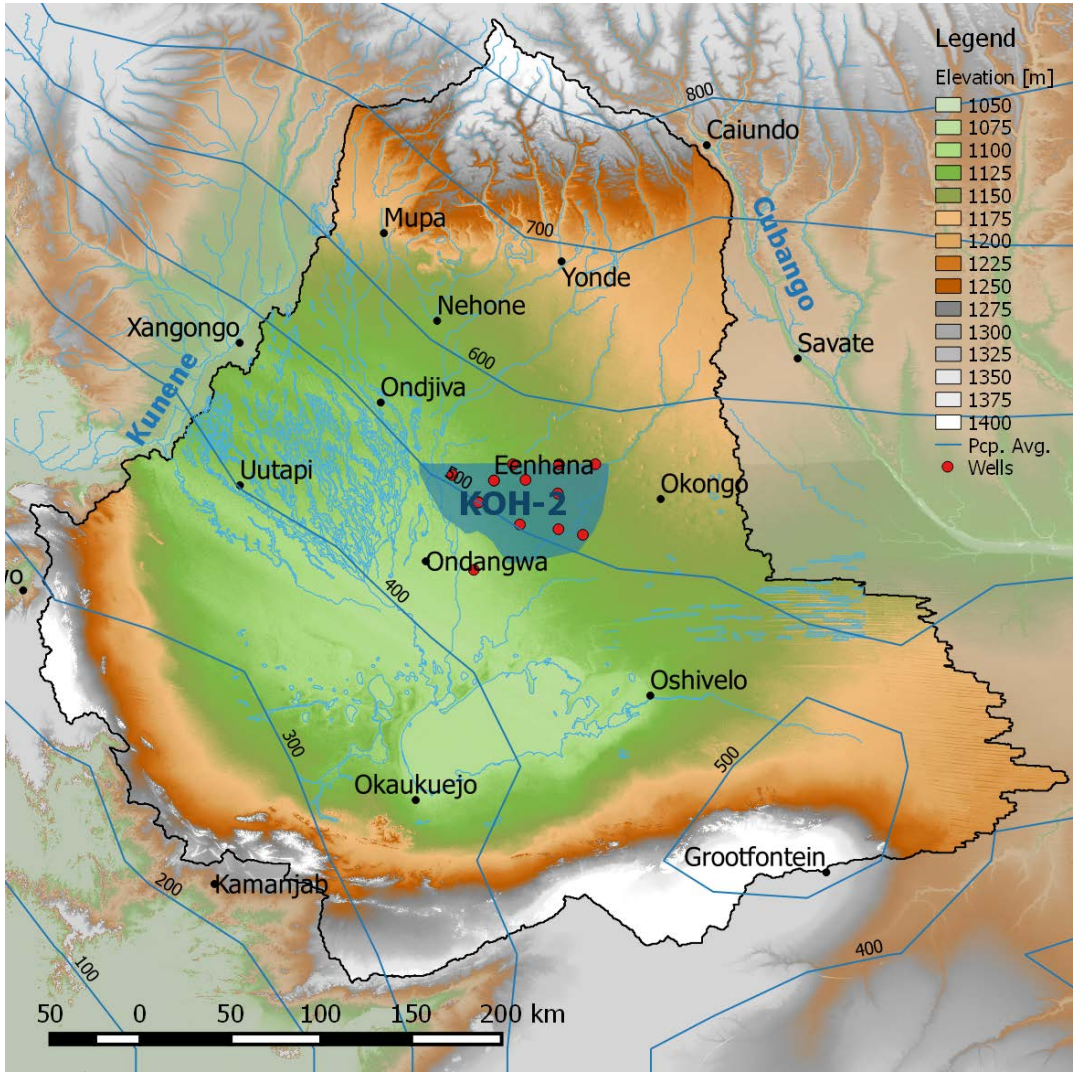
≈ 15 boreholes

≈ 15 pump tests

≈ 15 water samples

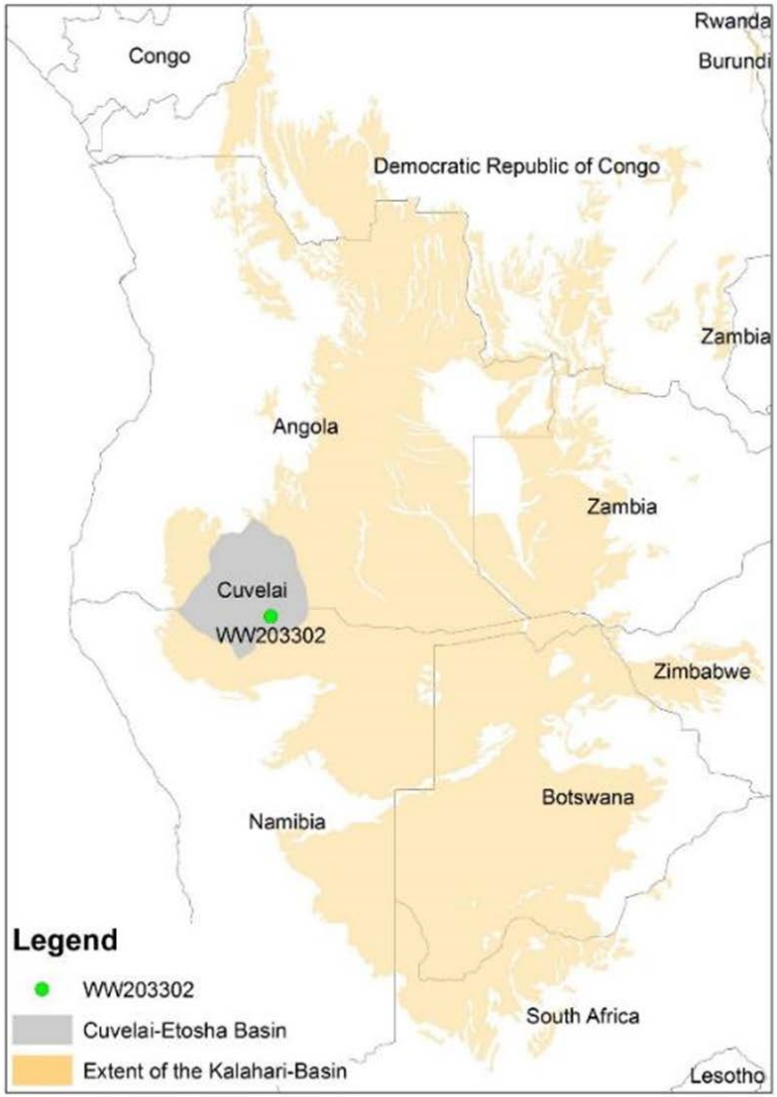
3 core drillings

(one fully cored)



Wallner et al. (2017)

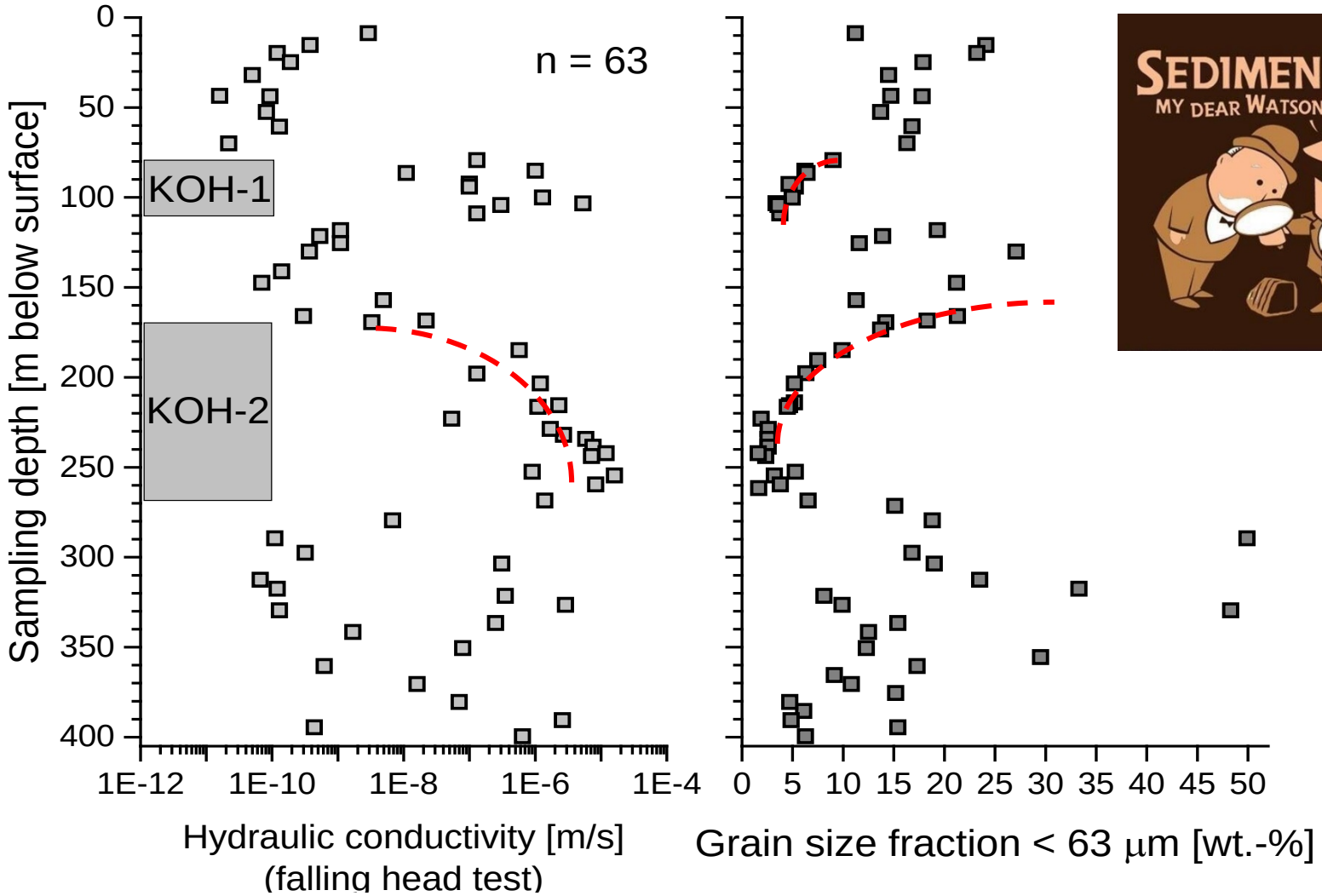
Core drilling WW203302



Continuous core drilling:

- 400 m (losses < 5%)
- 100 mm ID, 3 m length

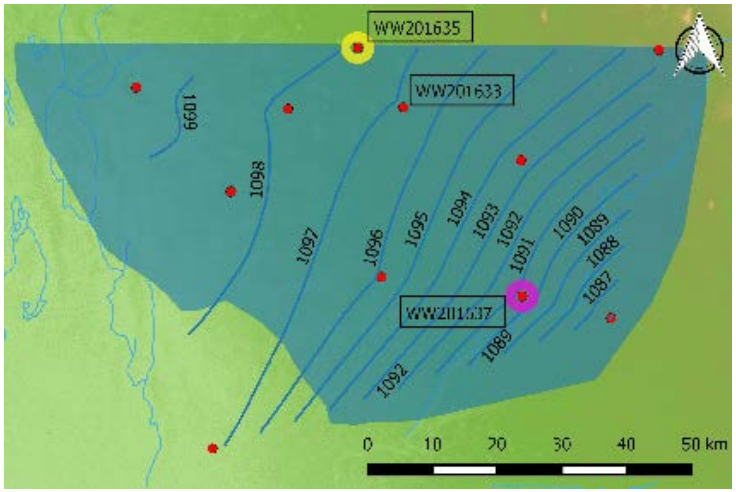
Sedimentology & hydraulic conductivity

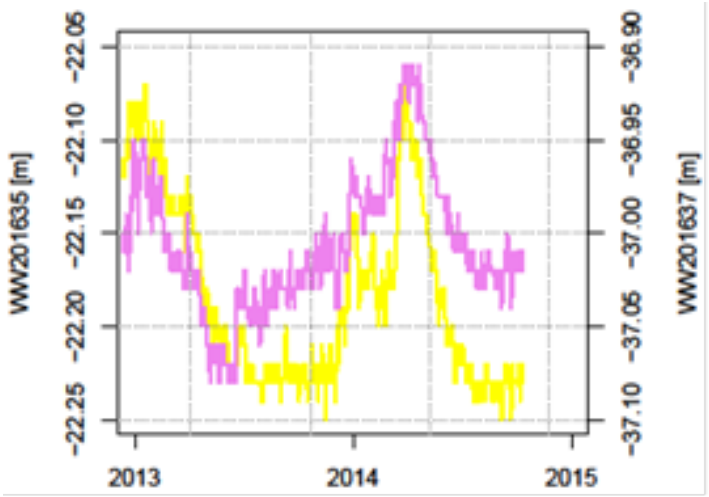


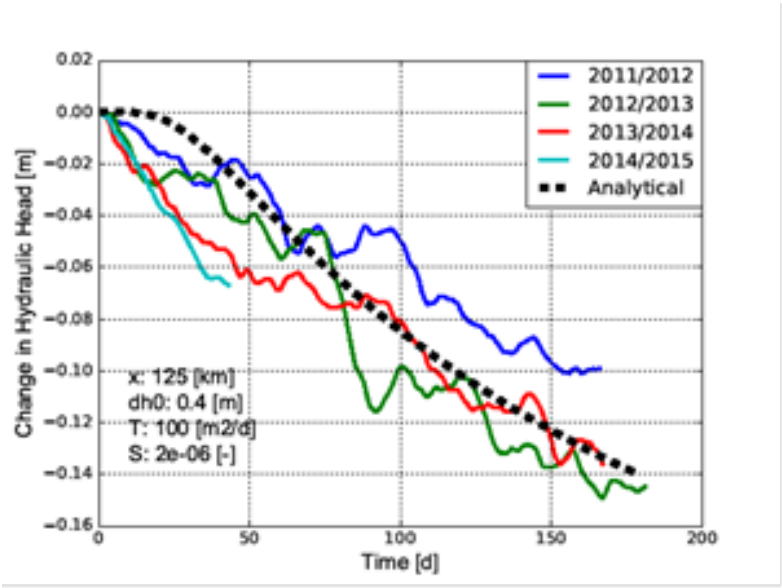
Houben et al. (2020)

Falling head permeameter (German standard DIN18130)

Indications for active ground water recharge?



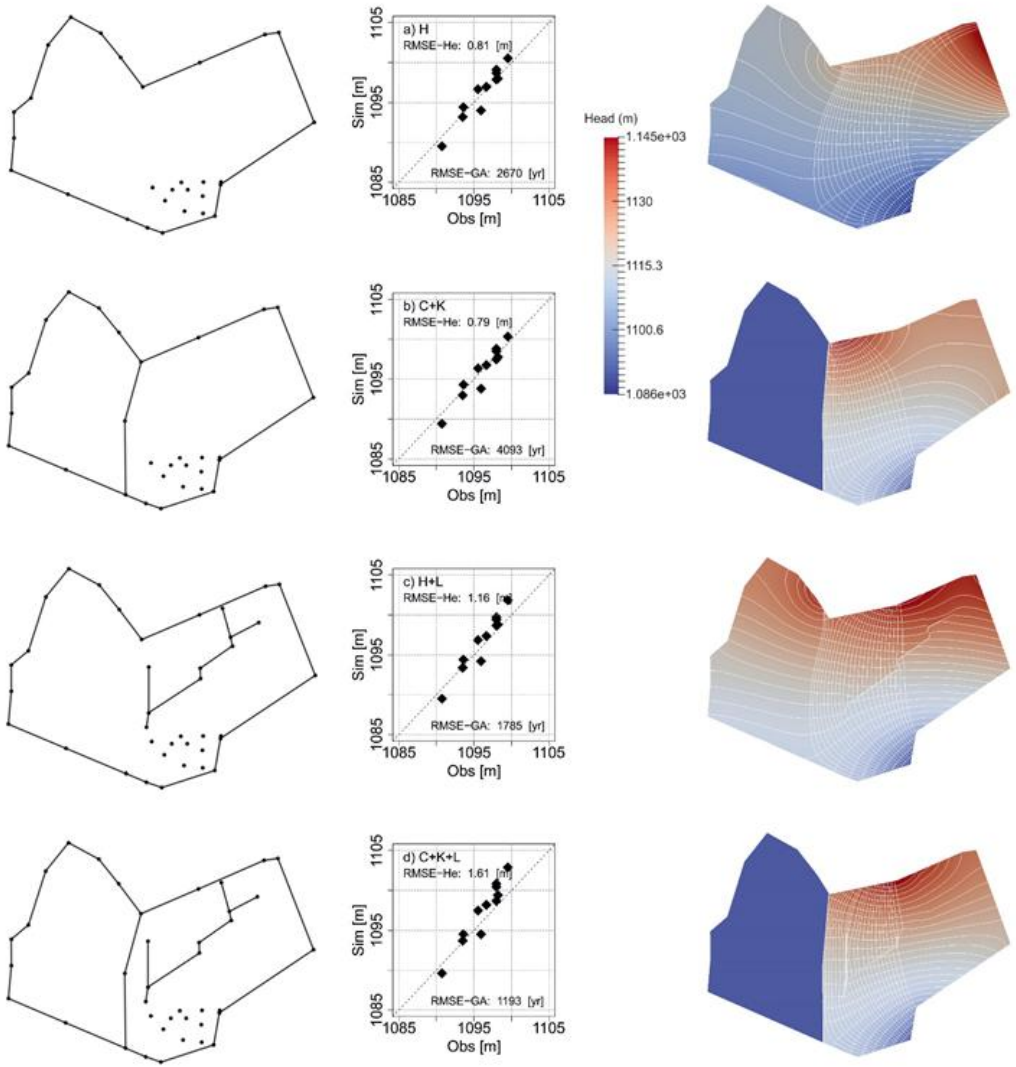




Groundwater levels rise after rainy season and decay afterwards

→ active system
→ active recharge?

Groundwater modelling (in the absence of data)



OpenGeoSys (FE)
150 gw models

Systematic variation of boundary conditions:

- inflow Kunene megafan
- inflow Cubango megafan
- inflow from both
- inflow Cubango River
- faults

target: measured heads & gw ages (^{14}C): 10-30 ka

→ 2-3 mm/a recharge

Wallner et al. (2017)

Overall conclusions

- Ohangwena-II aquifer (KOH2): game changer for N Namibia
- Geology: megafan deposition
- Exploration: geophysics, drilling, hydraulics, modelling, dating:
  - spatial extent of aquifers & aquitards
  - active recharge? Yes, but only 2-3 mm/a, mostly paleo-water
- Sustainable use possible?
- General problems
  - data scarcity (Angola = 0)
  - transboundary issue

More data & understanding needed!

WORK IN PROGRESS!
New CUVECOM project

Thank you for your attention!

Funded by:

Federal Ministry
for Economic Cooperation
and Development

Groundwater for the North of Namibia
BMZ 2009.2096.7

Dill, H., Kaufhold, S., Lindenmaier, F., Dohrmann, R., Ludwig, R., and Botz, R., (2012) Joint clay-heavy-light mineral analysis: a tool to investigate the hydrographic-hydraulic regime of Late Cenozoic deltaic inland fans under changing climatic conditions (Cuvelai-Etosha Basin, Namibia): International Journal of Earth Science, v. 102, p. 265 – 304.

Lindenmaier, F., Miller, R., Fenner, J., Christelis, G., Dill, H. G., Himmelsbach, T., Kaufhold, S., Lohe, C., Quinger, M., Schildknecht, F. Symons, G., Walzer, A., and van Wyk, B., (2014) Structure and genesis of the Cubango Megafan in northern Namibia: implications for its hydrogeology: Hydrogeology Journal 22(6): 1307–1328.

Hamutoko, J.T., Post, V.E.A., Wanke, H., Beyer, M., Houben, G., Mapani, B. (2019) The role of local perched aquifers in regional groundwater recharge in semi-arid environments: evidence from the Cuvelai-Etosha Basin, Namibia. Hydrogeology Journal, 27 (7), 2399-2413.

Houben, G.J., Kaufhold, S., Miller, R.M., Lohe, C., Hinderer, M., Noll, M., Hornung, J., Joseph, R., Gerdes, A., Sitnikova, M., Quinger, M. (2020) Stacked megafans of the Kalahari Basin as archives of paleogeography, river capture, and cenozoic paleoclimate of Southwestern Africa. Journal of Sedimentary Research, 90 (9), 980-1010.

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