Estimation of groundwater recharge due to conservation agriculture practice

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ABSTRACT

A review of groundwater recharge studies in Sub-Saharan Africa demonstrates a strong relationship between rainfall and recharge, but with considerable uncertainty due to significant impact of land cover and in particular land clearing and agriculture. This research project focuses on impacts of conservation agriculture (CA) practice on groundwater recharge. Conservation agriculture is being encouraged by governments over conventional methods in the understanding that CA practices such as minimum tillage, retention of crop residue and crop diversity improves crop resilience under dry conditions. However, there has been little consideration of the direct impact of such practices on groundwater. In this study, we setup three experimental sites in Zambia, Zimbabwe and Malawi to quantify recharge patterns under CA in comparison to conventional farming practice. Each site will be instrumented with soil moisture monitoring probes, a weather station, monitoring boreholes and electrical-resistivity tomography (ERT) equipment. Environmental isotopes and tracers (such as CFCs and SF6) and water chemistry will also be analysed. The monitoring will help to elucidate processes in the unsaturated zone around the plant root zone through to groundwater. Ultimately, this will help understand groundwater dynamics and fractioning below surface of CA fields.

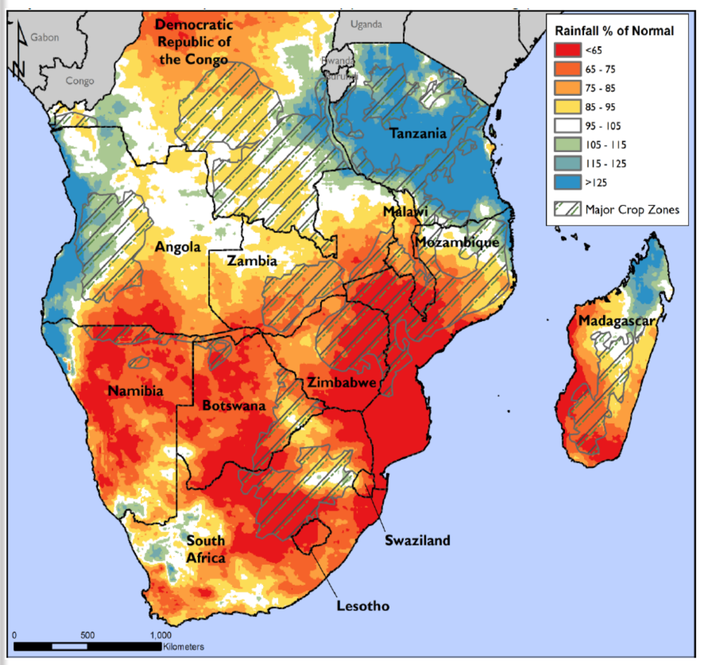
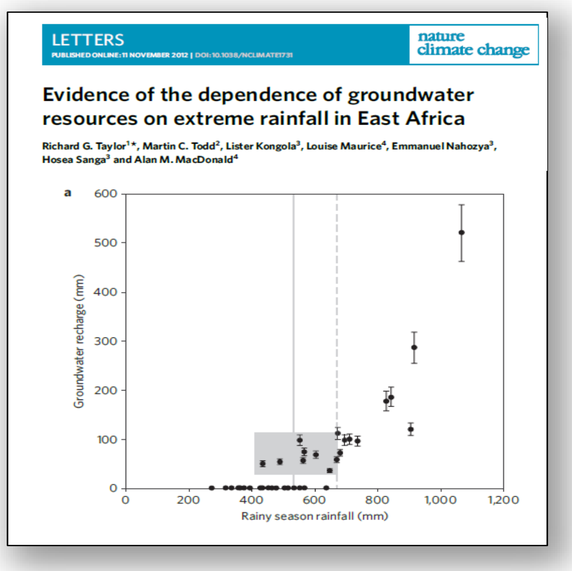


Figure 1: Rainfall anomaly map for Southern Africa for the period October 2015 - February, 2016 (Source: FEWS-NET/USGS)

RESEARCH QUESTION

Does the practice of conservation agriculture result in significant ground water dynamics translatable into practical benefits such as agricultural resilience and ground water recharge?



ACKNOWLEDGMENTS

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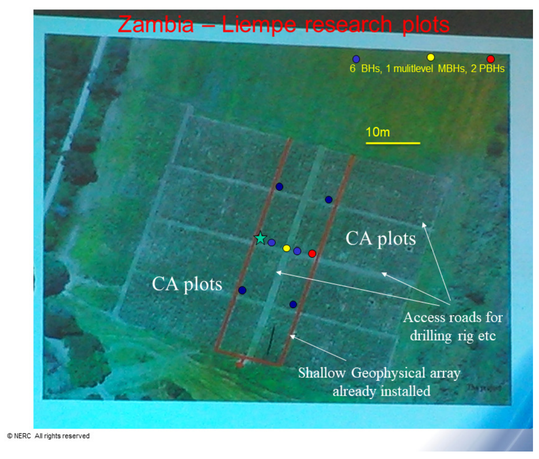
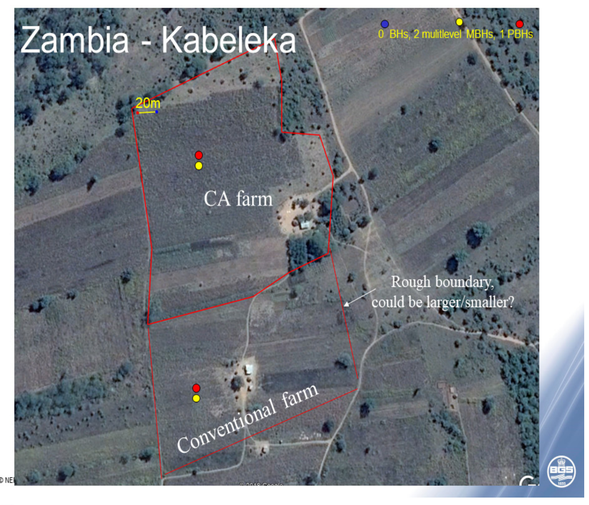
RESEARCH INNOVATION

Food security in Southern Africa is dependent on rainfed agriculture from small scale farmers. This renders it vulnerable to effects of climate change. For example, in the 2015/16 farming season, a severe drought, related to El Nino (Fig. 1), limited crop productivity and exacerbated the current rainy seasons. Although conservation agriculture (CA) is a 'climate-smart' agronomic system, the impact its practices on soil-water dynamics and hence, on agricultural resilience has not been fully elucidated. This knowledge is critical for policy and extension. The limiting factor has been research capacity in the relevant physical sciences

METHODOLOGY





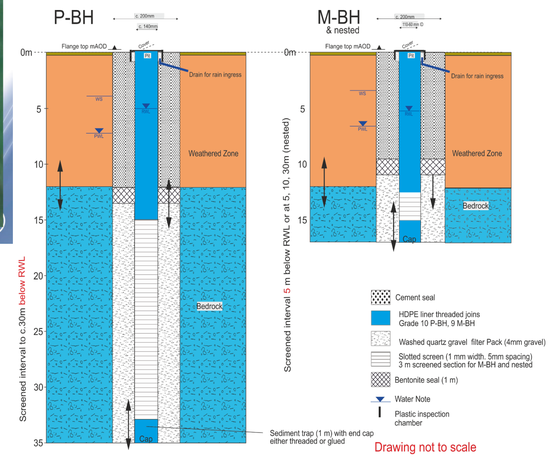


Figure 2: Experimental sites in Zambia and Zimbabwe where both mointoring and pumping boreholes will be drilled. The design of boreholes is shown as well.

Three platform sites have been identified in Zambia, Zimbabwe and Malawi to mointor groundwater dynamics as shown in Fig. 2. Each site is instrumented with soil moisture monitoring probes, a weather station, monitoring boreholes and electrical-resistivity tomography (ERT) equipment. Environmental isotopes and tracers (such as CFCs and SF6) and water chemistry will also be analysed

EXPECTED OUTCOMES

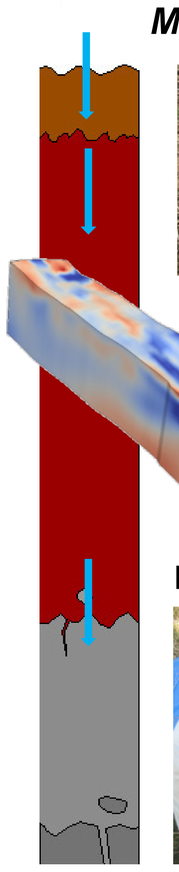
Processes

Available water for crop growth

Profile water recharge — resilience for next season

Groundwater recharge sustaining a key resource

Measurement & modelling

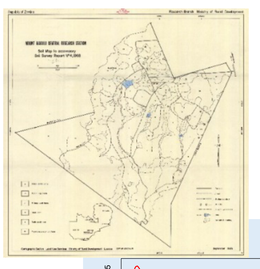


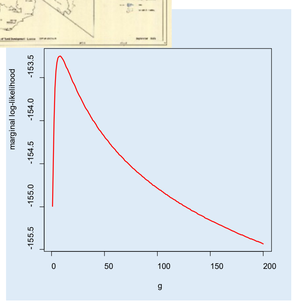
Soil water properties: field and lab measurements

Dynamics and transport between surface and deeper profile: shallow geophysics with PRIME

Recharge processes

Integration





Statistical and process modelling: prediction and upscaling.

Economic assessment

'Transforming innovative research programmes by building capacity in soil physics, shallow geophysics and hydrogeology, integrated by environmental statistics to quantify impacts of agricultural practices on resilience of cropping systems and impacts on groundwater supply'

REFERENCES

Taylor, R. G., Todd, M. C., Kongola, L., Maurice, L., Nahozya, E., Sanga, H. & MacDonald, A. M. 2012. Evidence of the dependence of groundwater resources on extreme rainfall in East Africa. Nature Climate Change, 3, 374.