The importance of heavy rainfall to groundwater recharge in the southwestern Chad basin: evidence from isotopic observations

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Introduction

•The Southwestern Chad basin falls within semi-arid region with rainfall <500 mm a^{-1} and ET > 2000 mm a^{-1}.

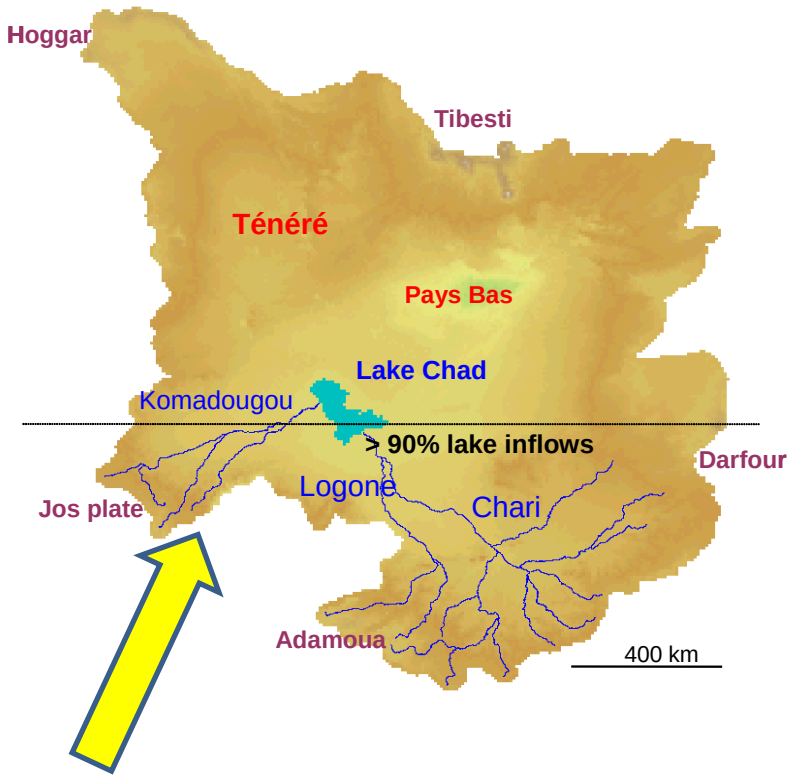
• Surface waters appear seasonally for some months after rainy season; exception being Lake Chad. Therefore perennial supply is from groundwater.

•Water demand is increasing in this region due to rapid population growth.

rainfall
15 mm/a

500 mm/a

1200 mm/a

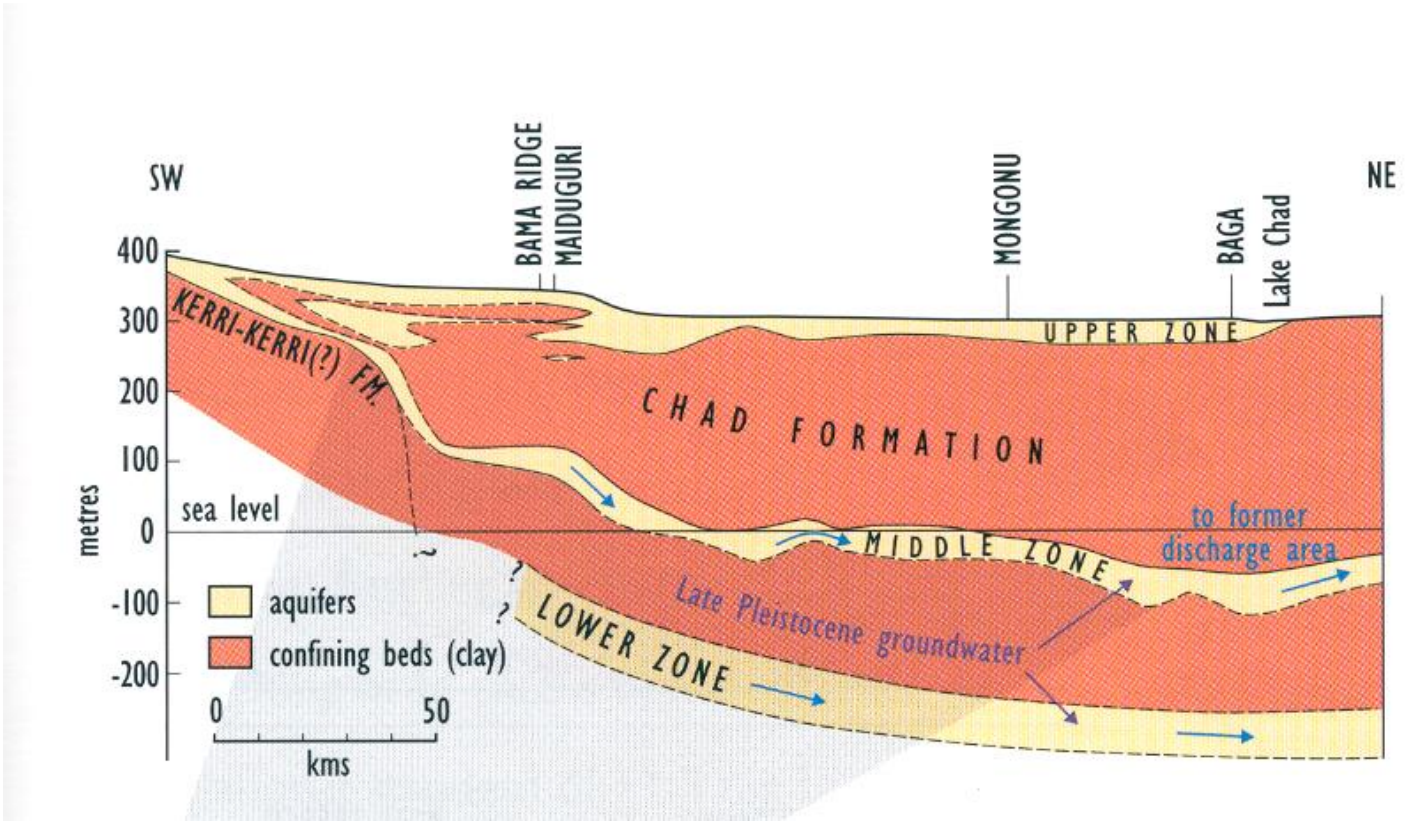


P. evaporation
2200 mm/a

1400 mm/a

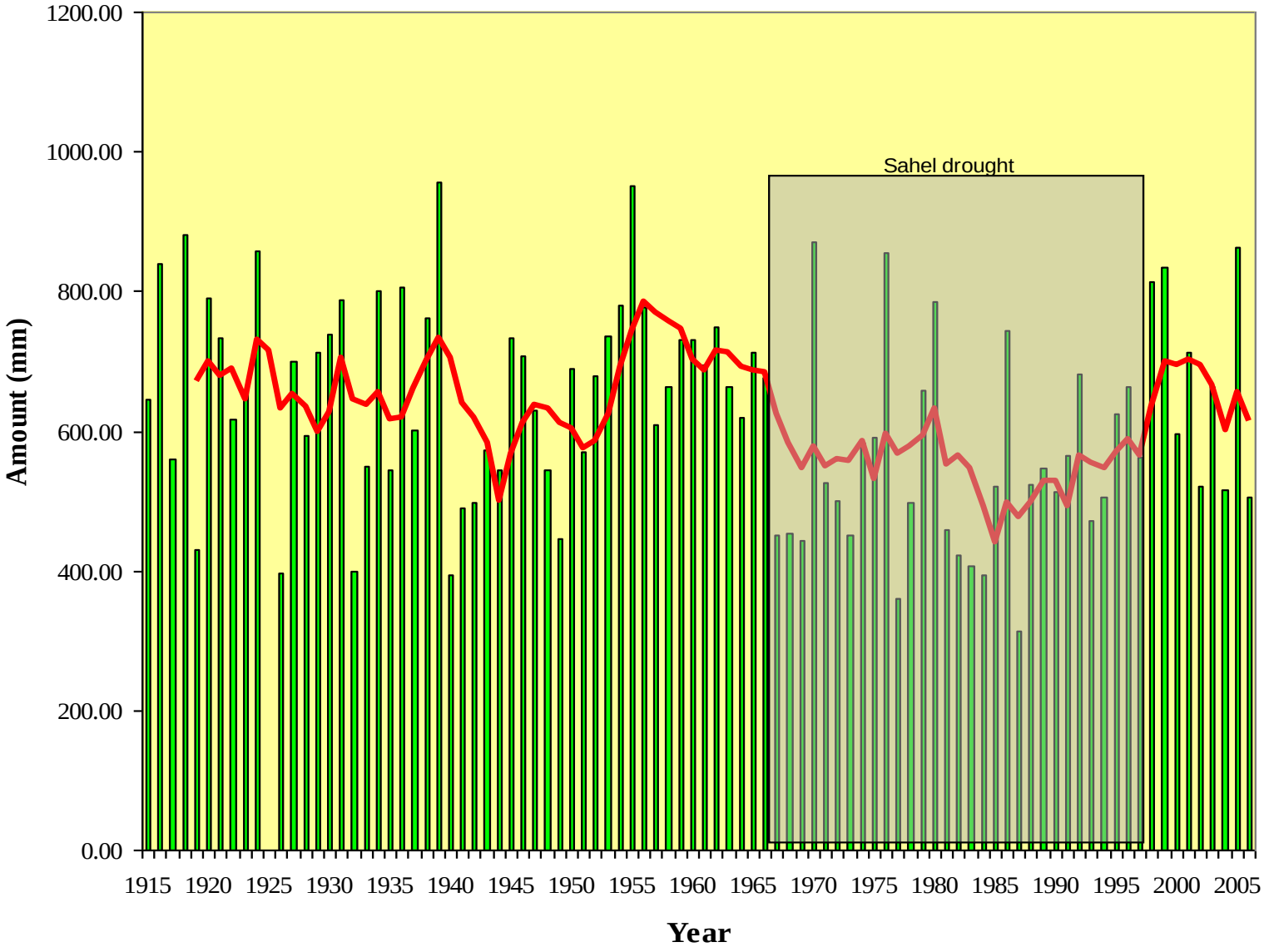
The Chad basin showing the SW part

- Groundwater in this region occurs in shallow phreatic aquifer and in deep confined aquifers.
- Water table data show that in the flood plain aquifer there is a strong seasonal fluctuation but no long term decline.
- In the phreatic aquifer, decline of approximately 1 m y^{-1} have been reported
- In the confined aquifers, piezometric heads of artesian wells have declined from approximately 20 magl in the 1960s to 5 mbgl in the millennium. One of the major reasons for the decline is believed to be the uncontrolled flow of water.

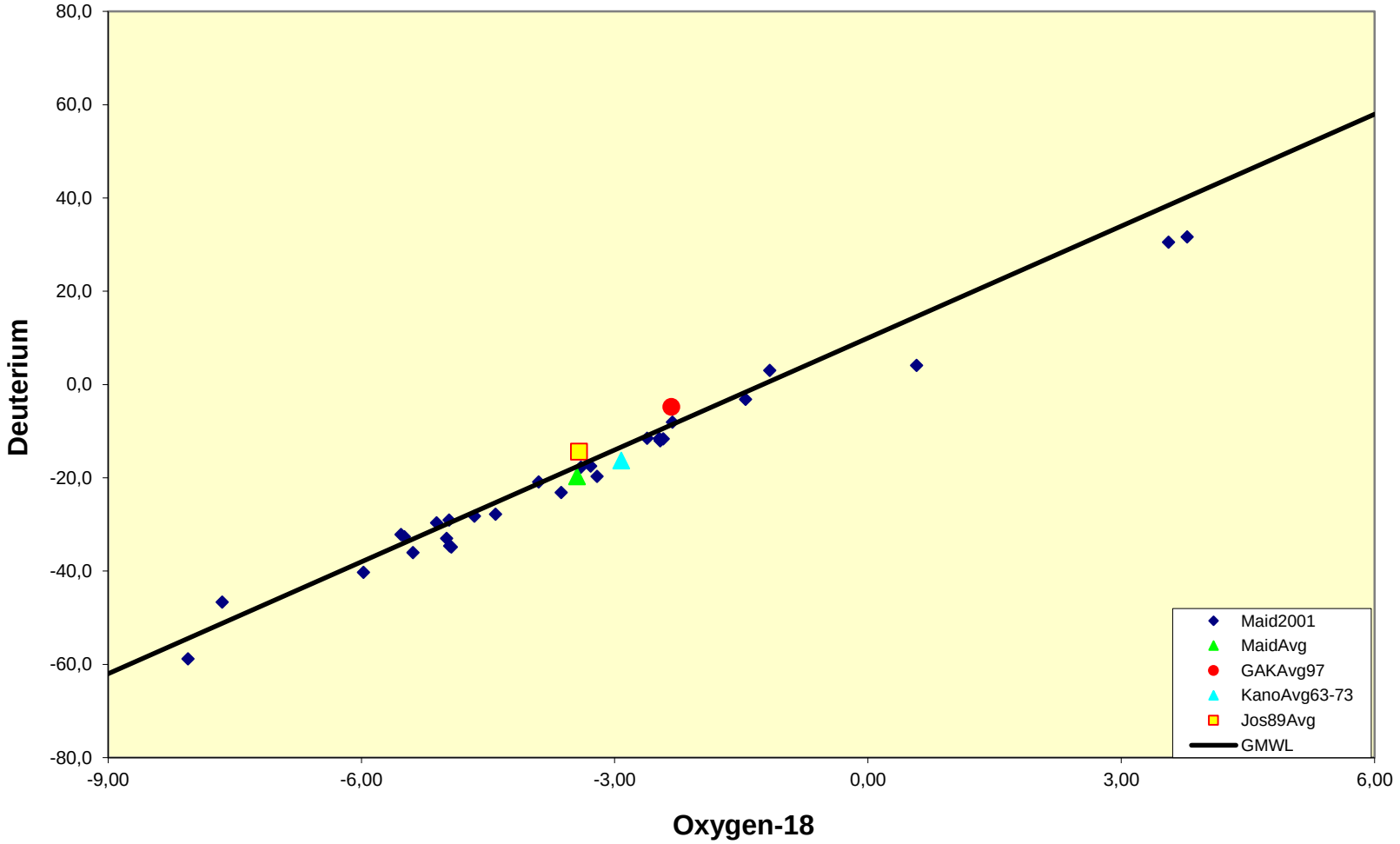


Geological cross section showing the three aquifers of the Chad Formation in Nigeria

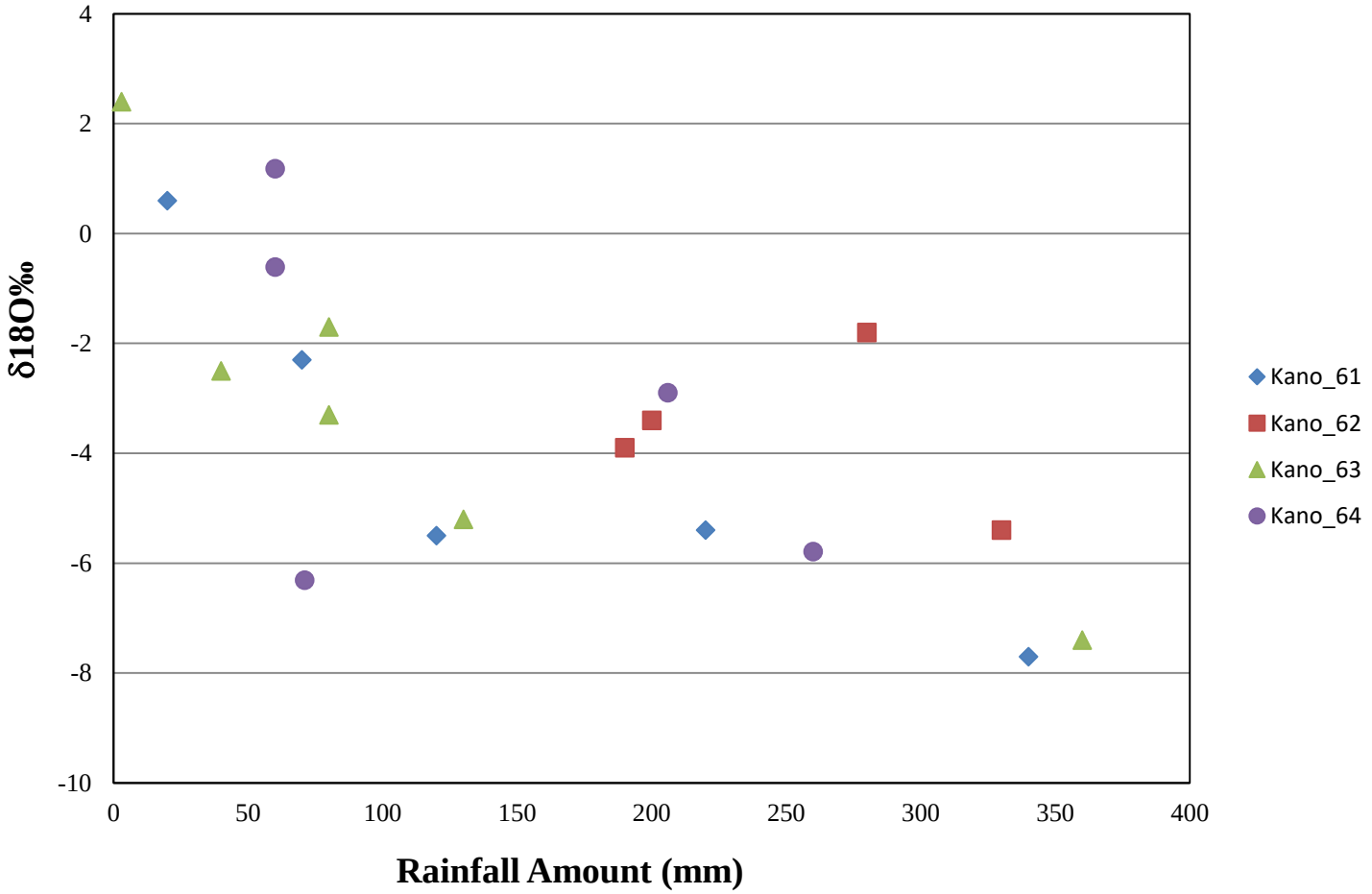
- Because groundwater is the perennial source of water supply in this region, its sustainable management is of fundamental importance.
- Sustainable management, especially from the context of supply planning requires knowledge of renewal rate and thus groundwater recharge.
- Equally important is understanding the characteristic of rainfall that results in recharge. This is more so in view of the added complexity by climate change.



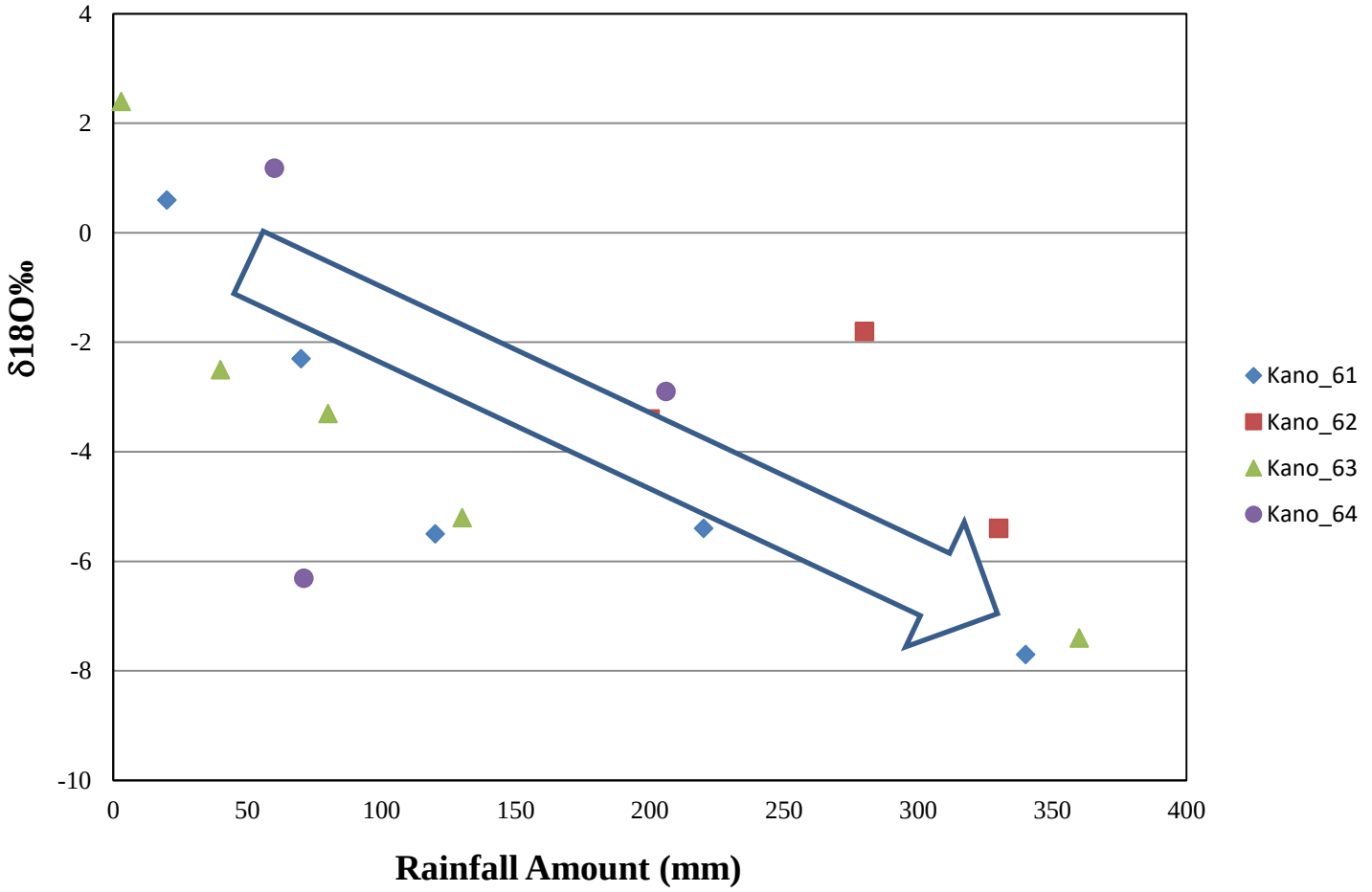
Maiduguri rainfall over the last century



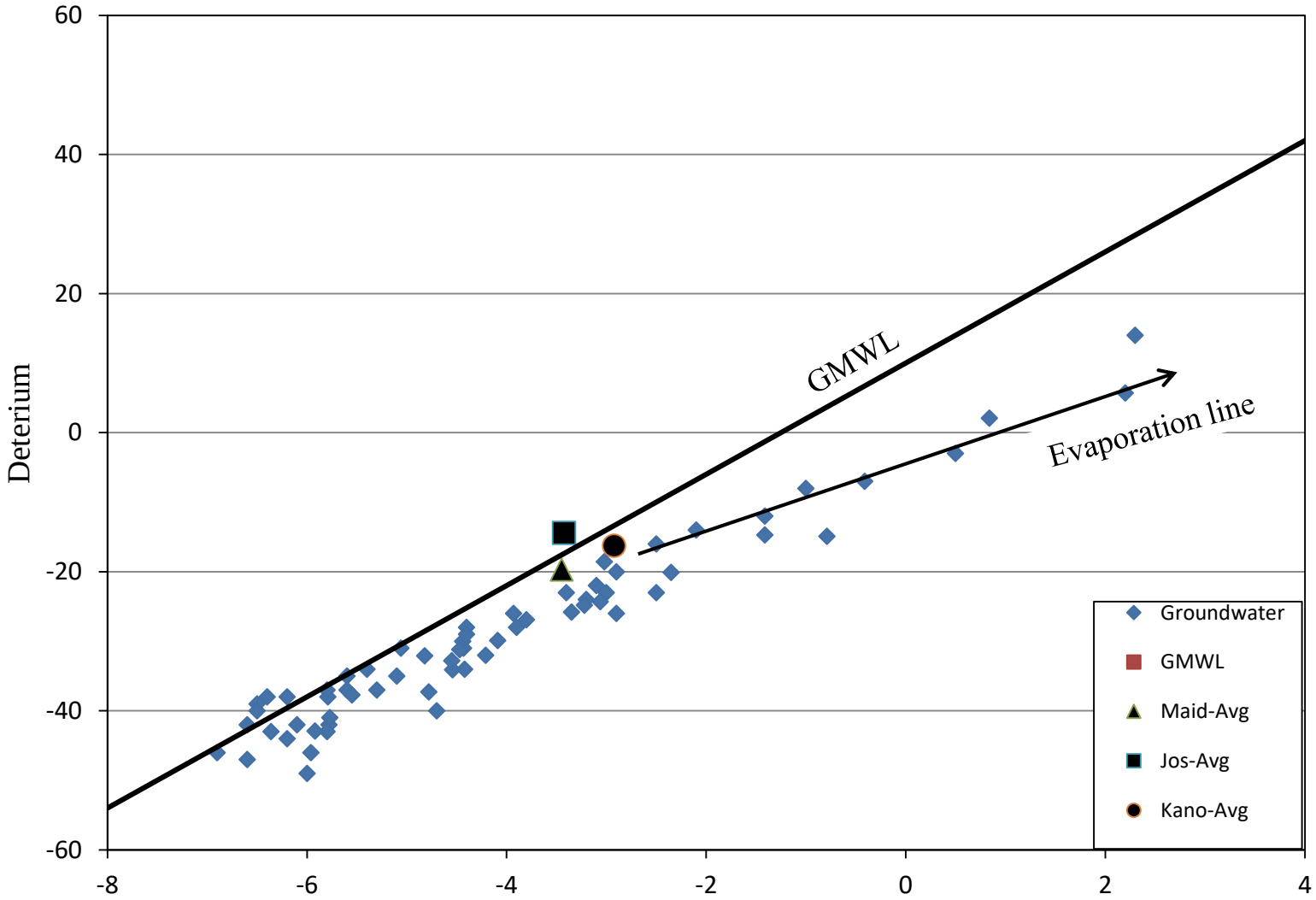
Stable isotope contents of event rainfall from Maiduguri station and weighted mean for other stations in Nigeria.



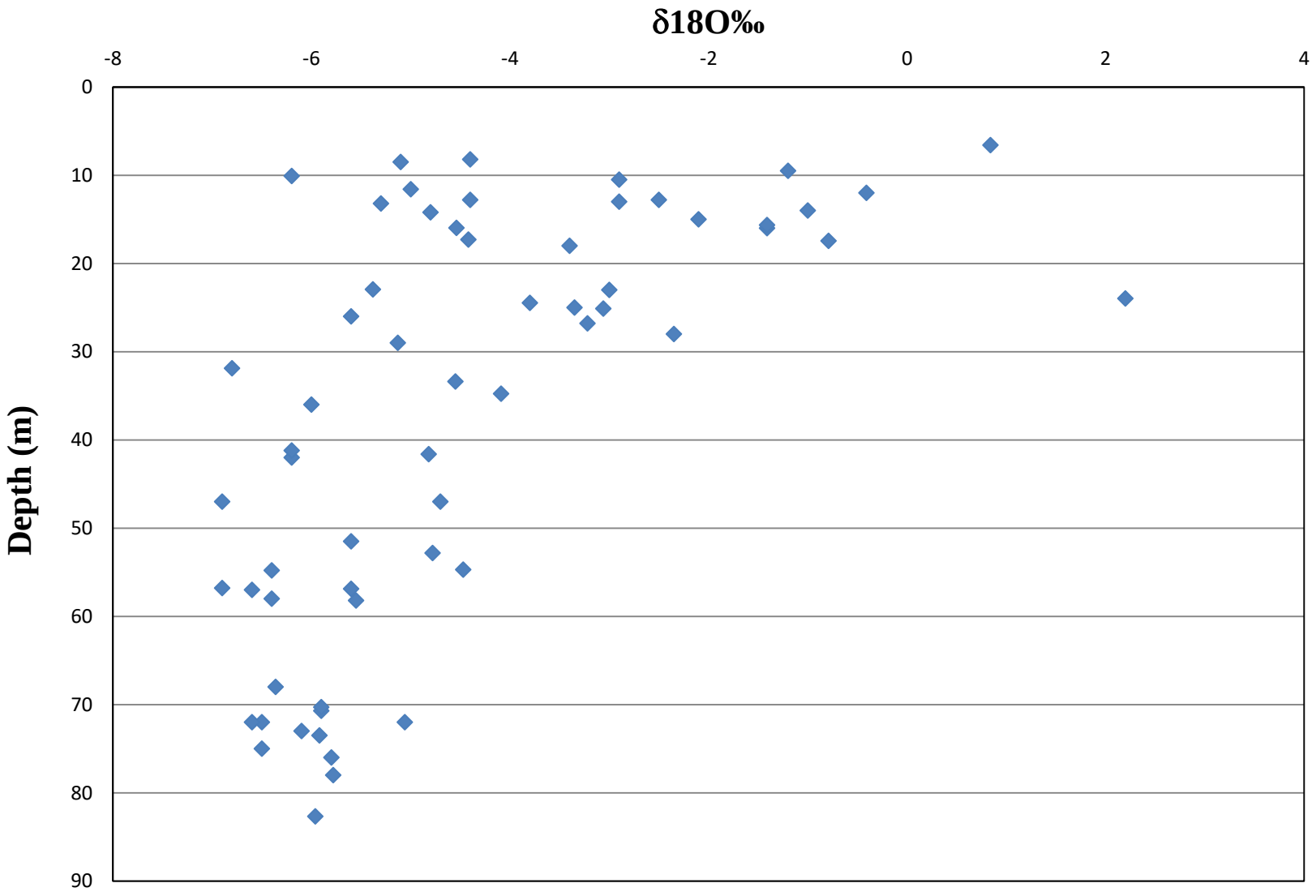
Plot of Oxygen -18 to monthly rainfall amount for the Kano station



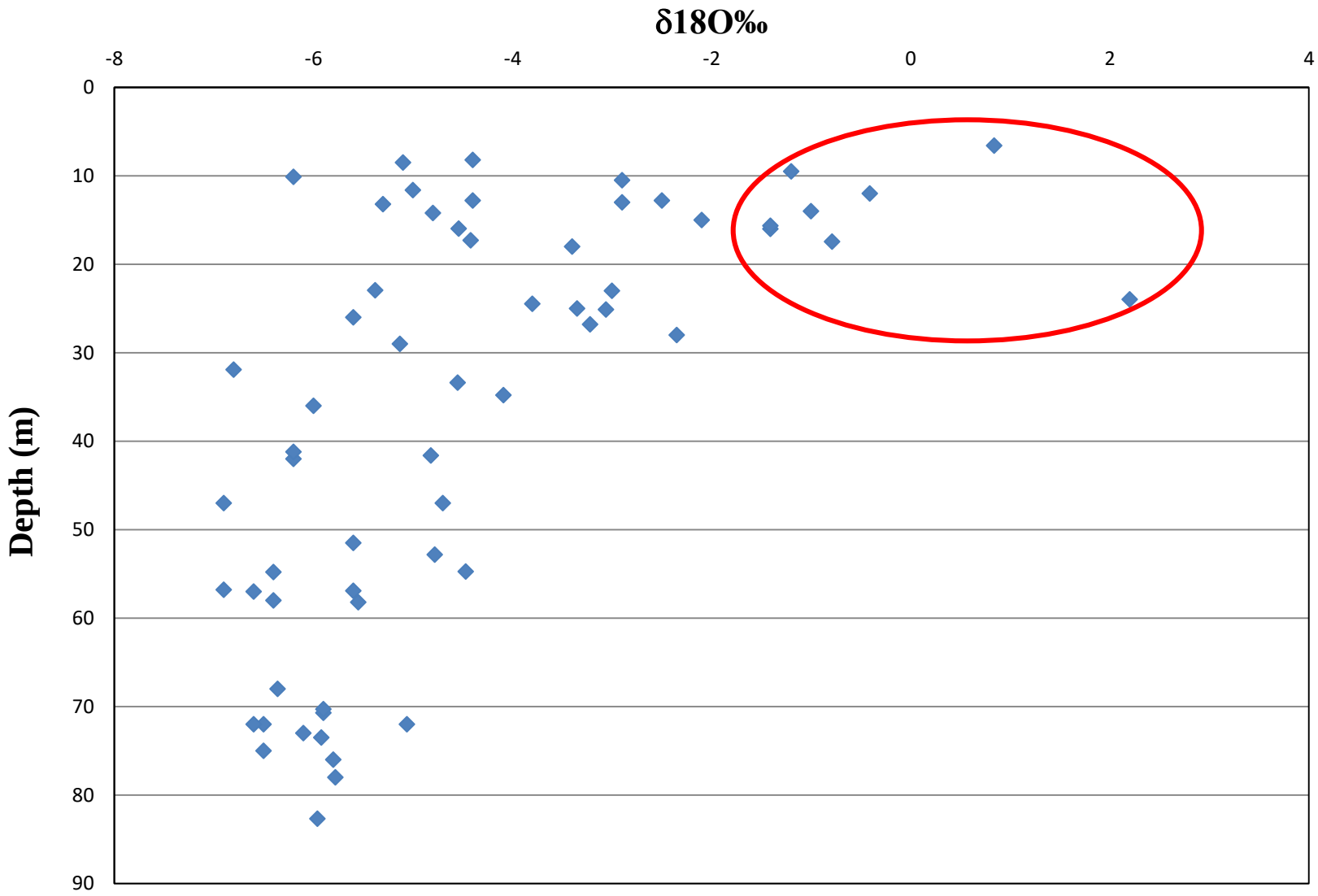
Plot of Oxygen -18 to monthly rainfall amount for the Kano station with an arrow showing the amount effect



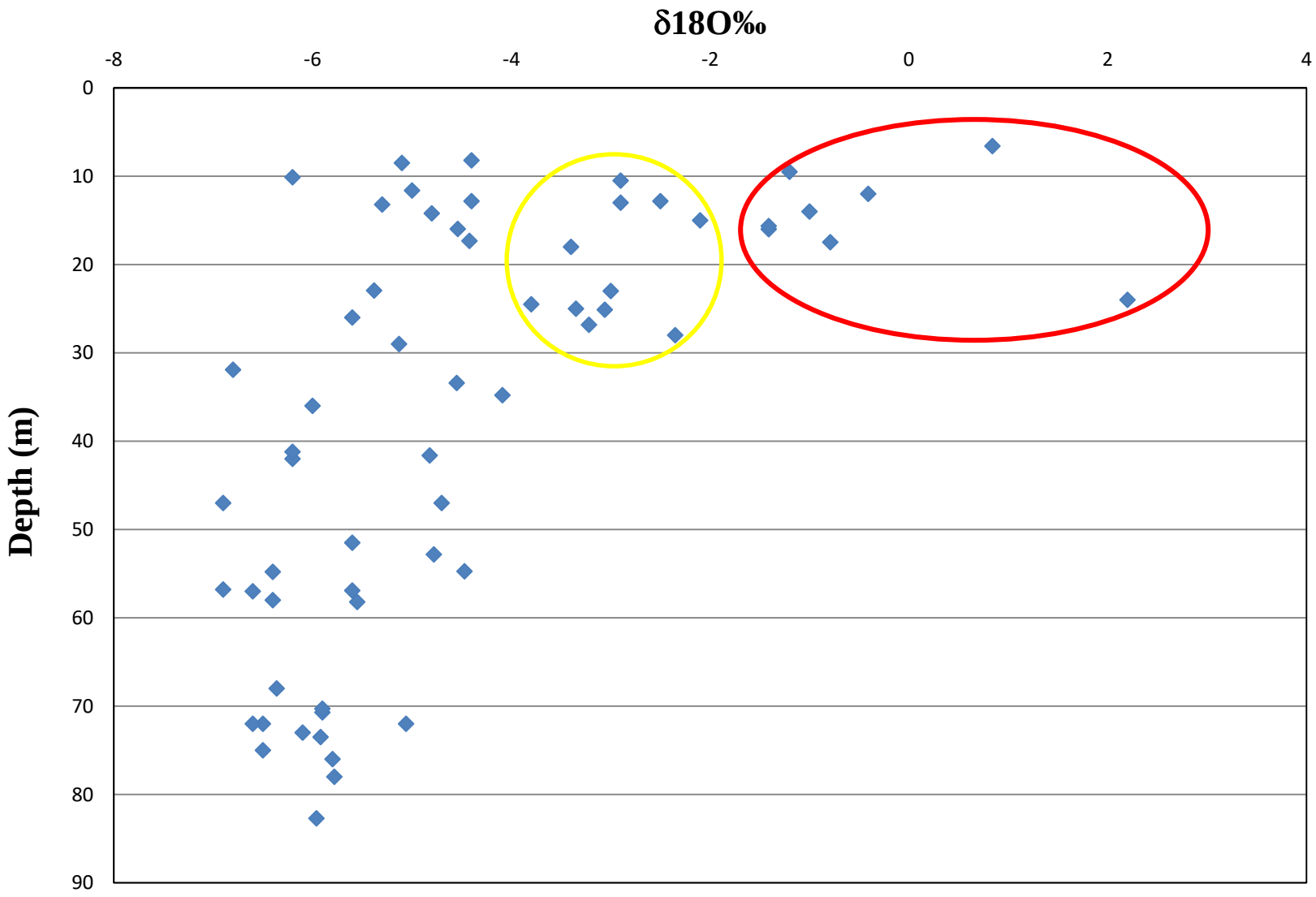
Stable isotope contents of average rainfall for stations in the study area, that of groundwater and evaporation line



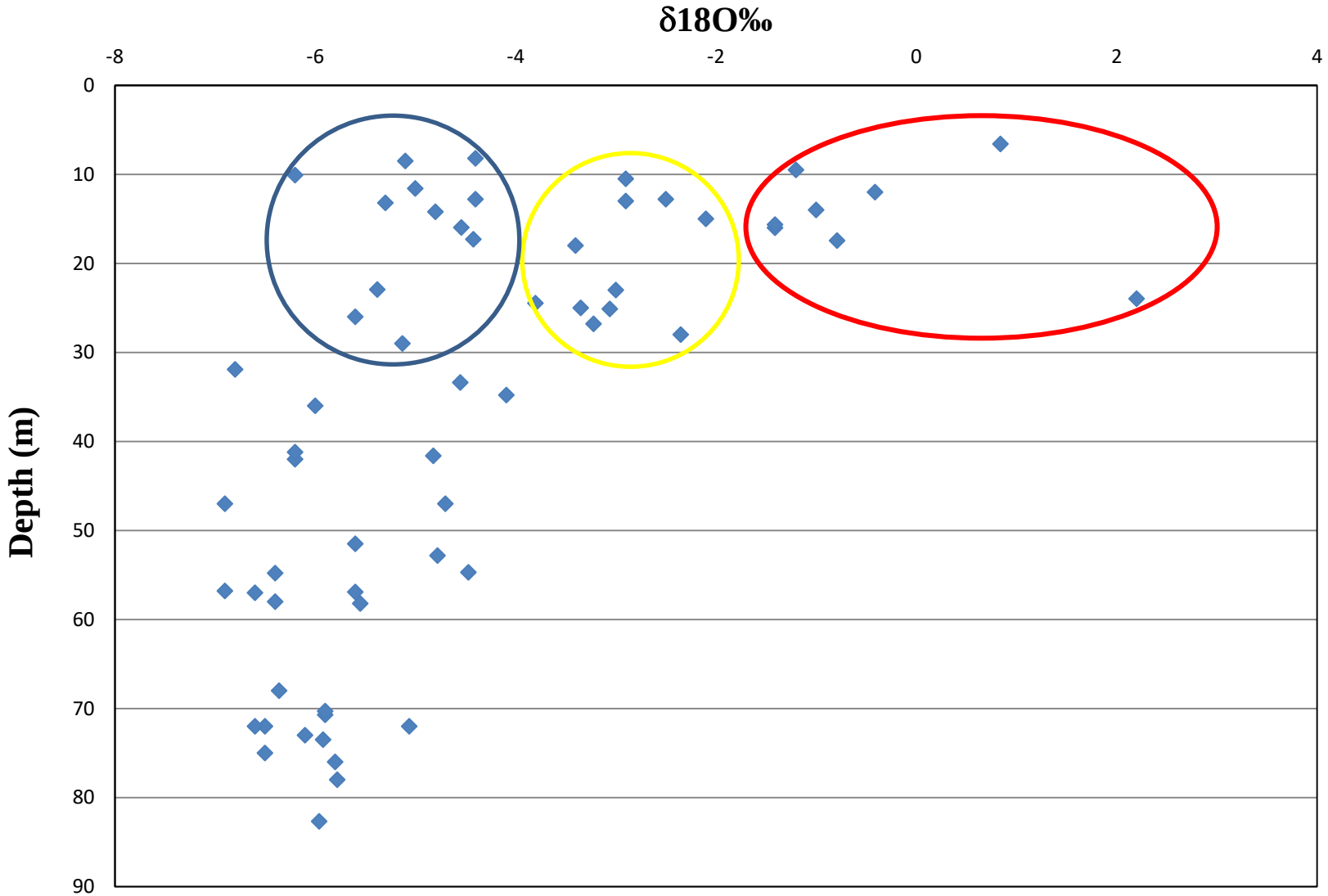
Plot of Oxygen -18 to groundwater depth for the study area



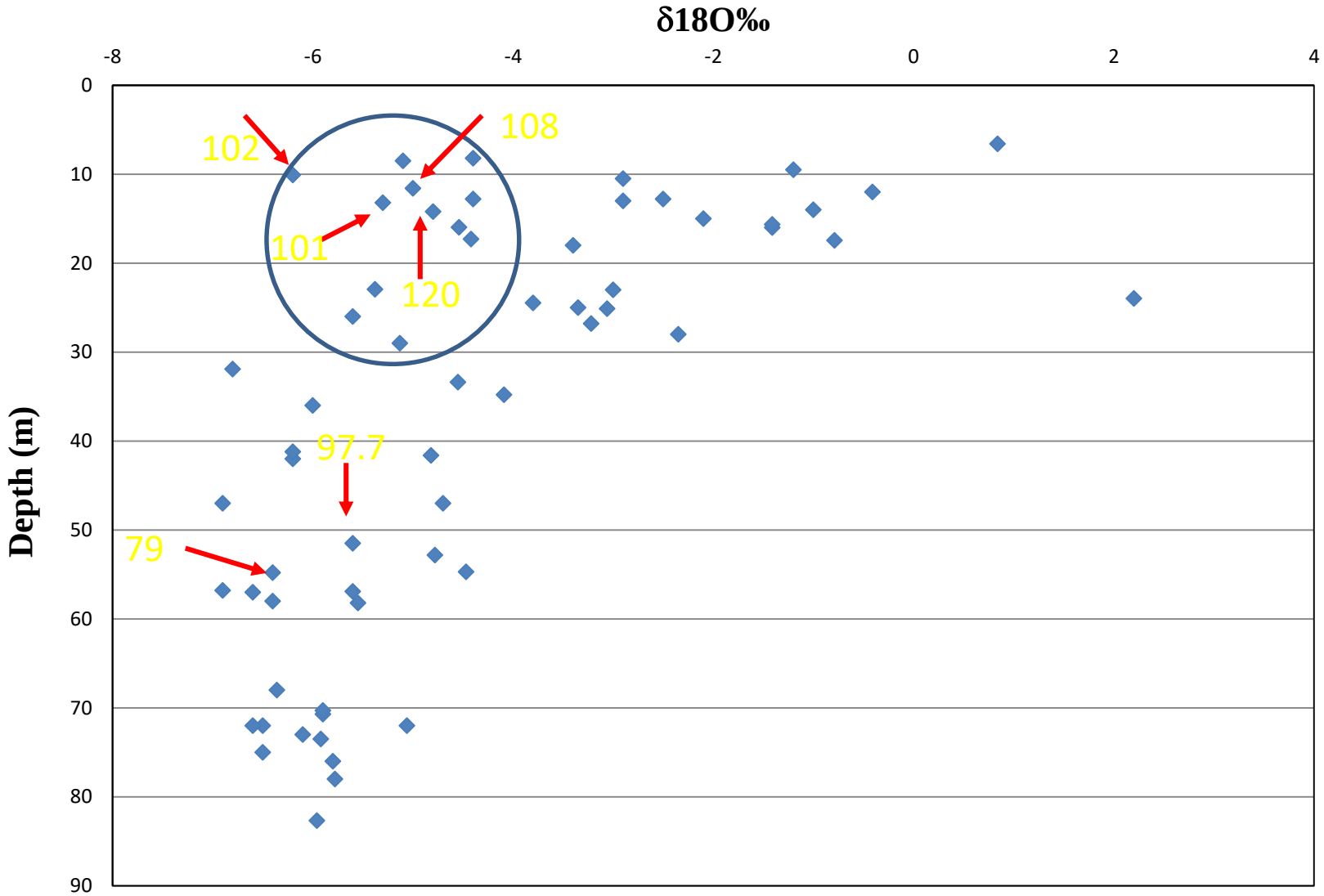
Enriched $\delta^{18}O$ in groundwater (red circle) indicating direct recharge from river channel



$\delta^{18}O$ in groundwater (yellow circle) indicates mixing zone



Depleted $\delta^{18}O$ in groundwater (blue circle) corresponds to diffuse recharge from heavy rainfall



^{14}C data showing that the depleted $\delta^{18}O$ water samples are from present day recharge

Conclusions

- Heavy rainfall with depleted stable isotope has been shown to be the dominant source of recharge to groundwater in the SW Chad basin.
- Stable isotope data have been used to demarcate preferential recharge via river channel by their enriched values
- Carbon-14 data show that the hat the depleted stable isotope water are modern with about 100 pmC
- The dominance of recharge by heavy rainfall in the region is important as the climate change predicts global change will lead to intensification of rainfall and therefore may result in increased recharge

Thank you very much for your attention