



Groundwater exploitation and recharge rate estimation of a quaternary sand aquifer in Dar-es-Salaam area, Tanzania

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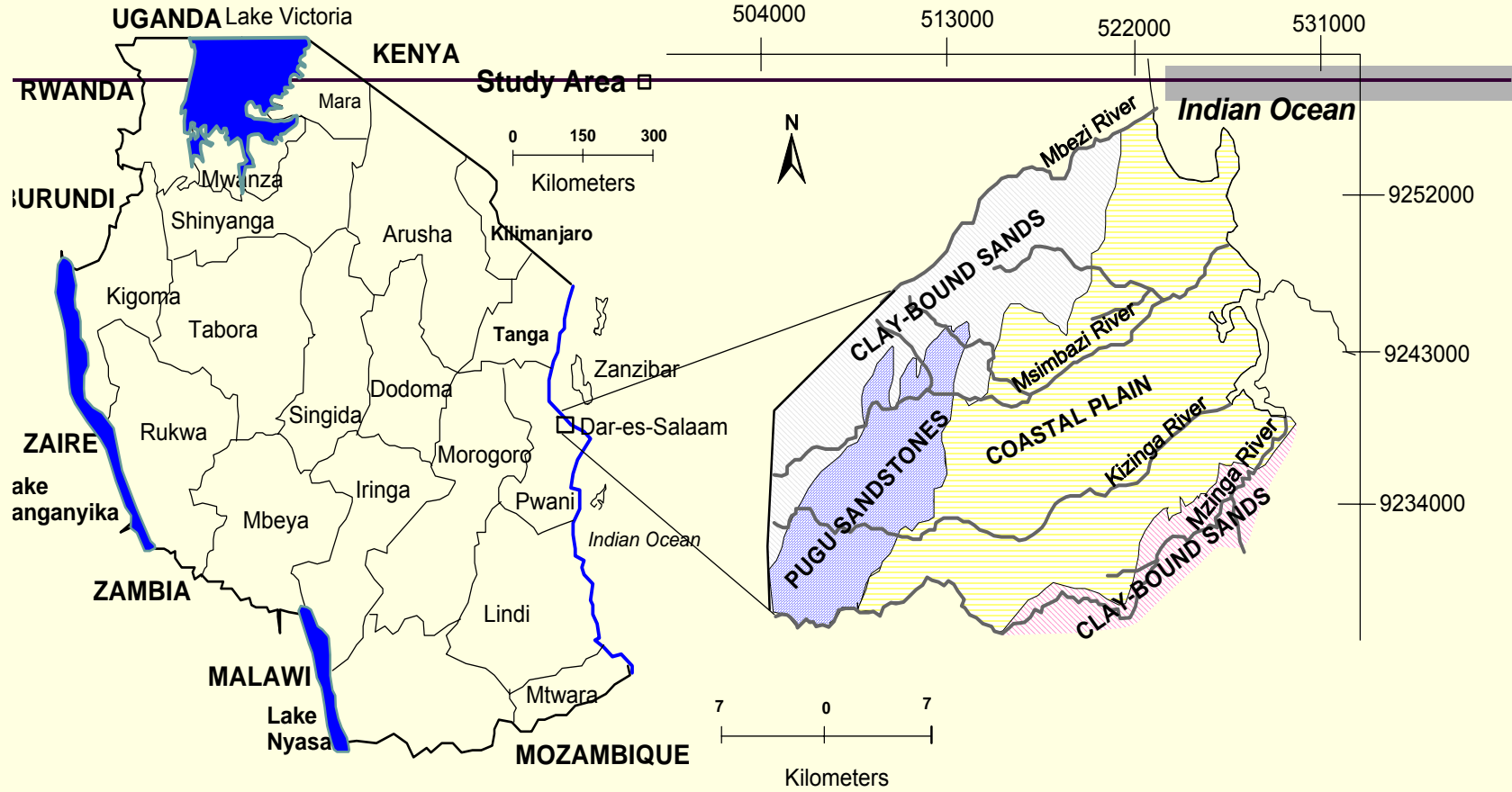
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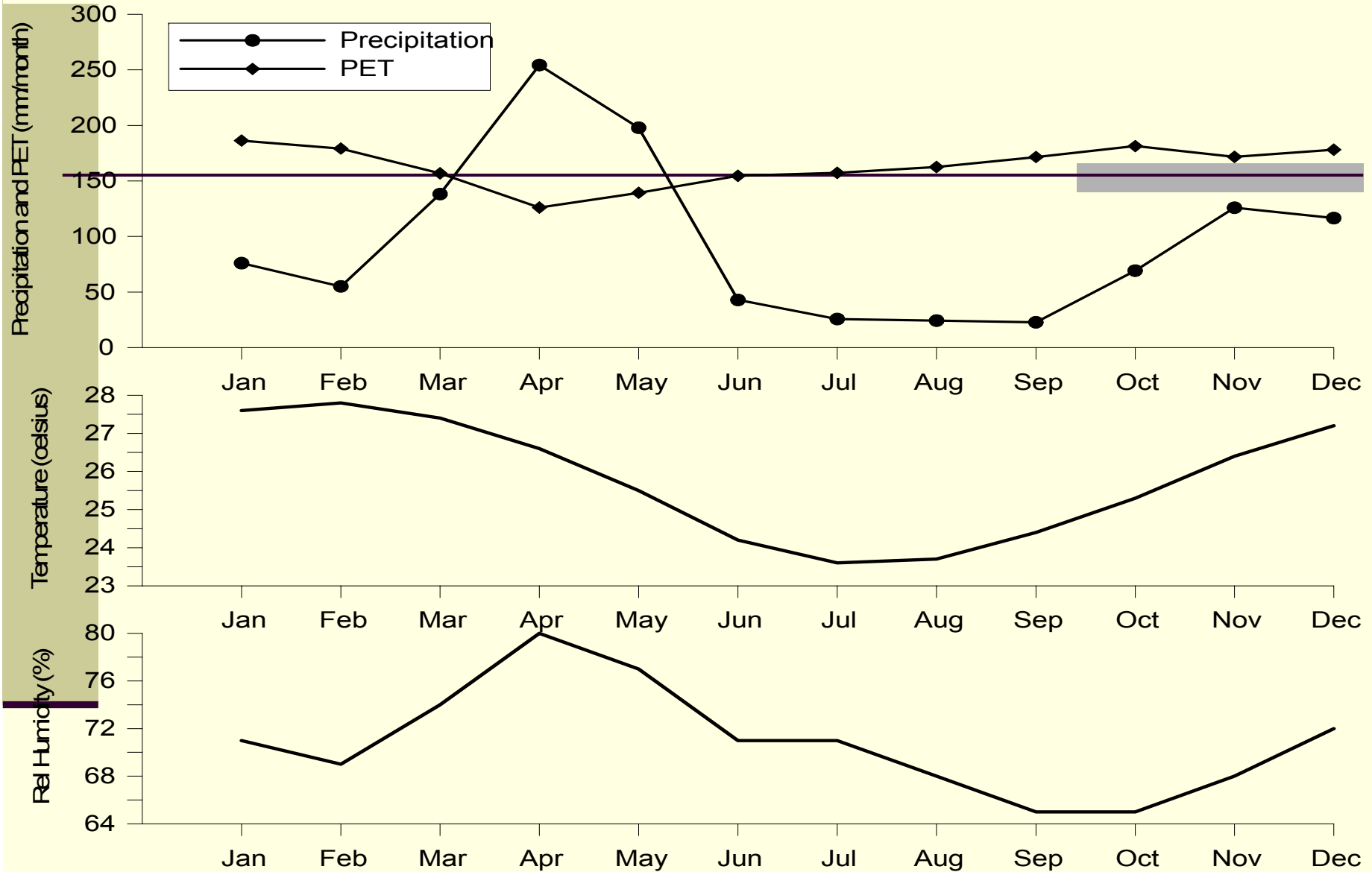
24th-28th June 2008

INTRODUCTION



Map of Tanzania showing study area (geological map)

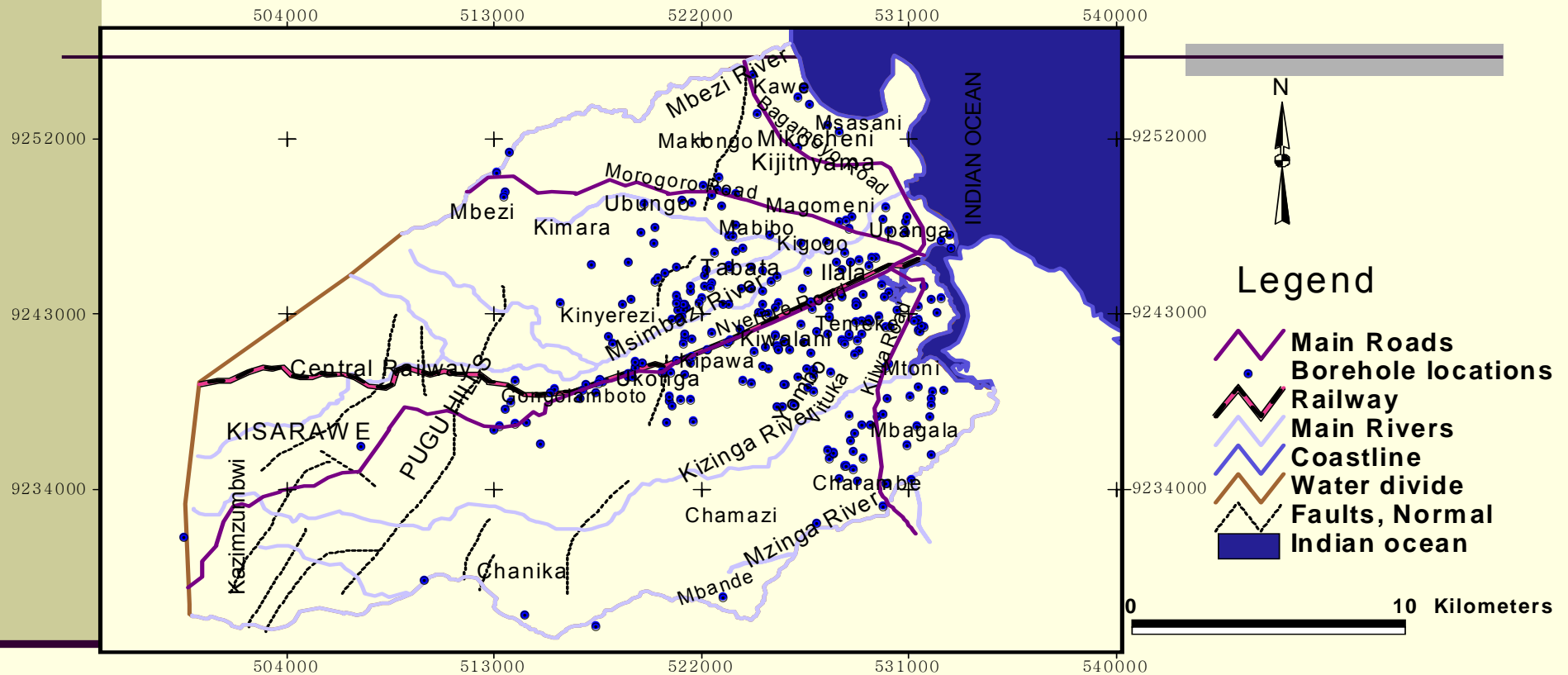
INTRODUCTION cont...



Average of monthly means of Precipitation (P), Temperature (T), Relative Humidity (RH) and Potential Evapotranspiration (PET) (1971– 2006)

METHODS

Groundwater exploitation



Groundwater abstraction (hm³/year)

Domestic = 1.76

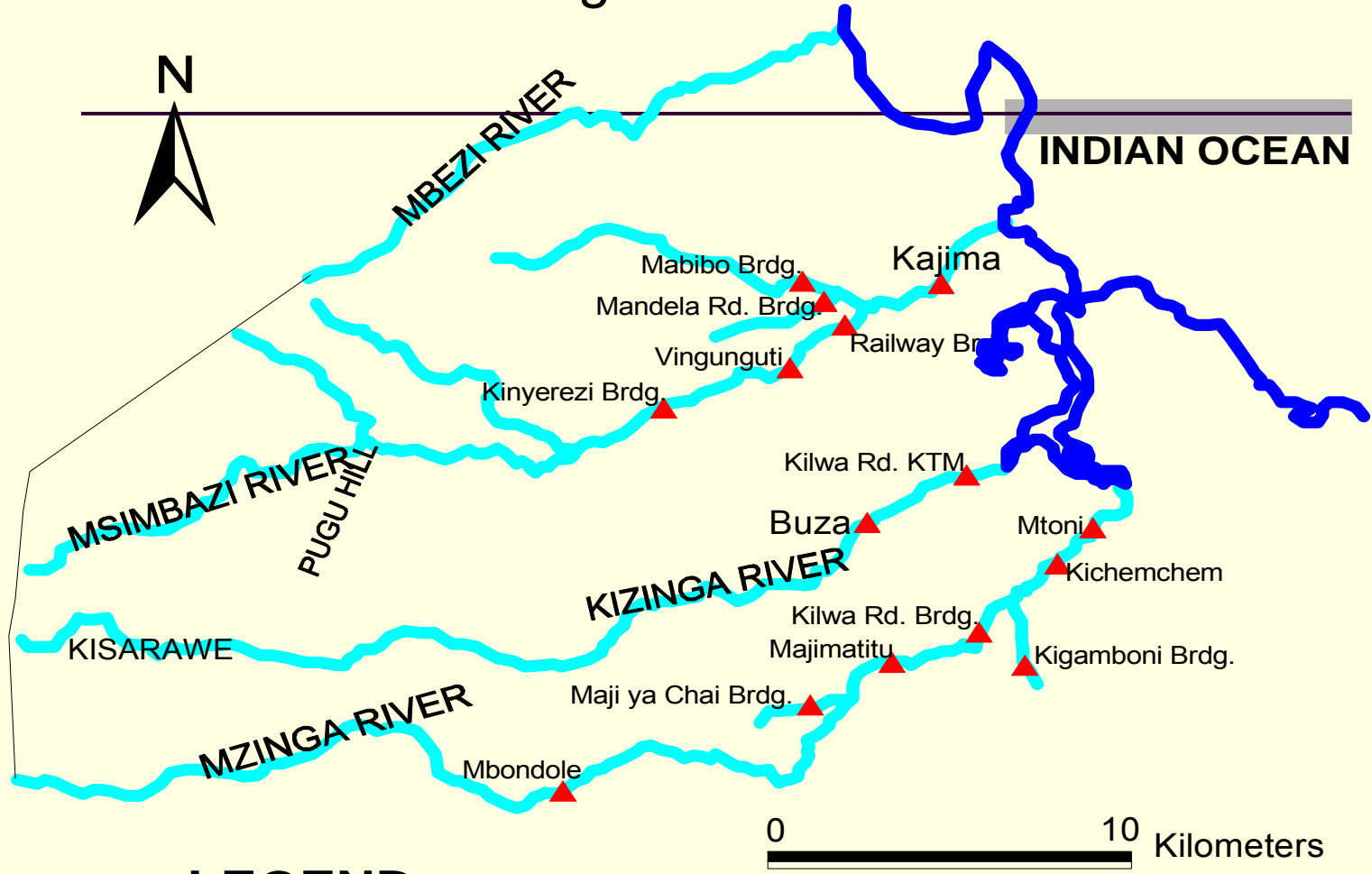
Water supply = 5.51 → total is 8.59

Industrial = 1.32

The exploitation accounts for 9.2 % of the inflowing water (Recharge)

METHODS cont...

□ Surface water discharge measurements



LEGEND: ▲ River discharge Measuring Locations

Total baseflow to rivers = 75.7 hm³/year

METHODS cont...

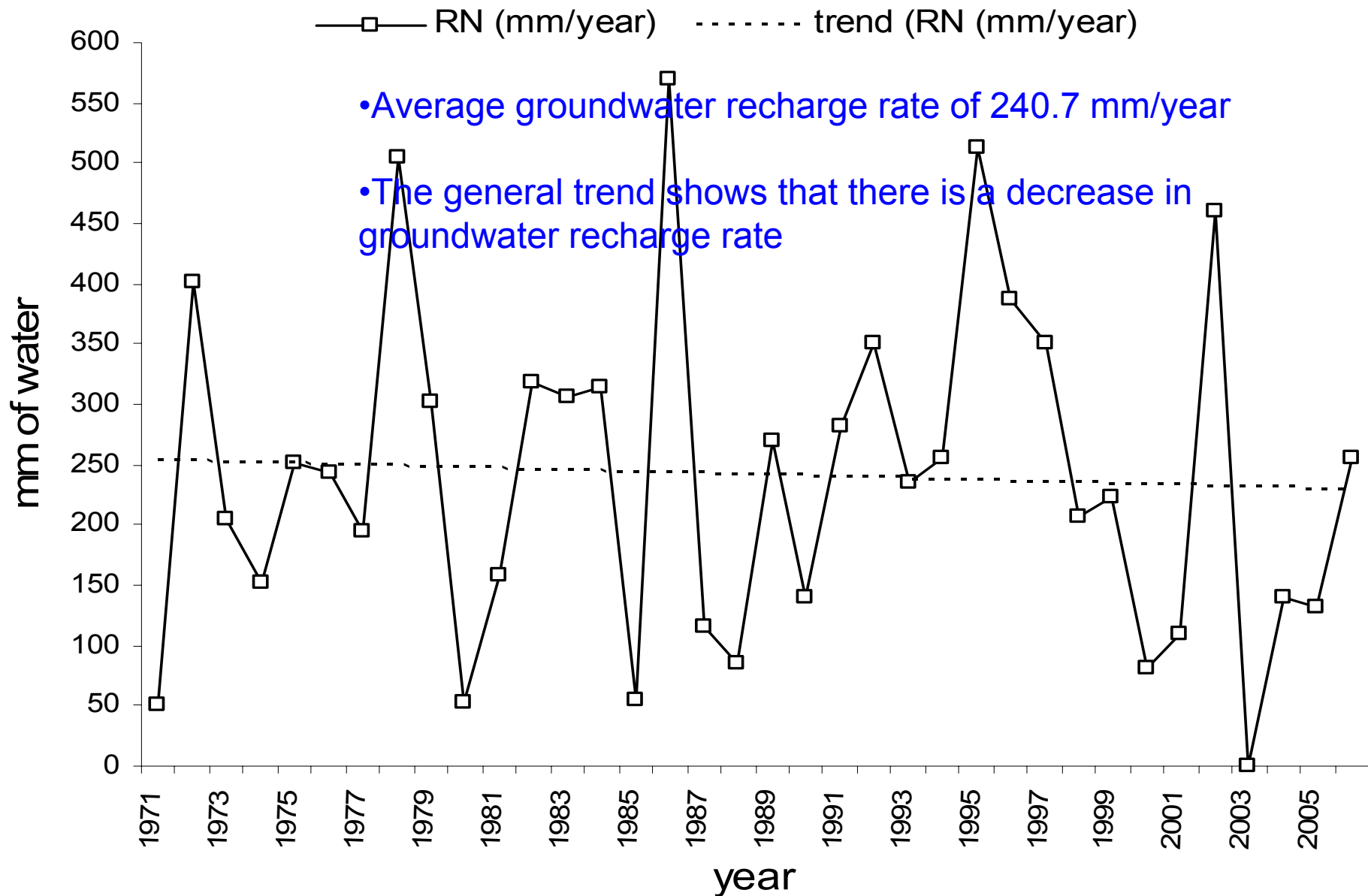
Annual soil-water budget calculations

	WET SEASON $SUR = (P-R_o) - PET > 0$			DRY SEASON $SUR = (P-R_o) - PET < 0$
	$S_B = CAP$	$S_B < CAP$		
		$(P-R_o) - PET \leq CAP - S_B$	$(P-R_o) - PET > CAP - S_B$	
S_B	CAP	$S_B + (P-R_o) - PET$	CAP	$CAP * e^{-APWL/CAP}$
R_N	$(P-R_o) - PET$	0	$(P-R_o) - PET - (CAP - S_B)$	0
AET	PET	PET	PET	$(P-R_o) + \Delta S_B$
DEF	0	0	0	PET - AET

$P-R_o$ = Precipitation - Runoff (mm)
 PET = Potential Evapotranspiration (mm)
 APWL = accumulated deficiencies (mm)
 AET = Actual Evapotranspiration (mm)
 S_B = water stored in CAP (mm)

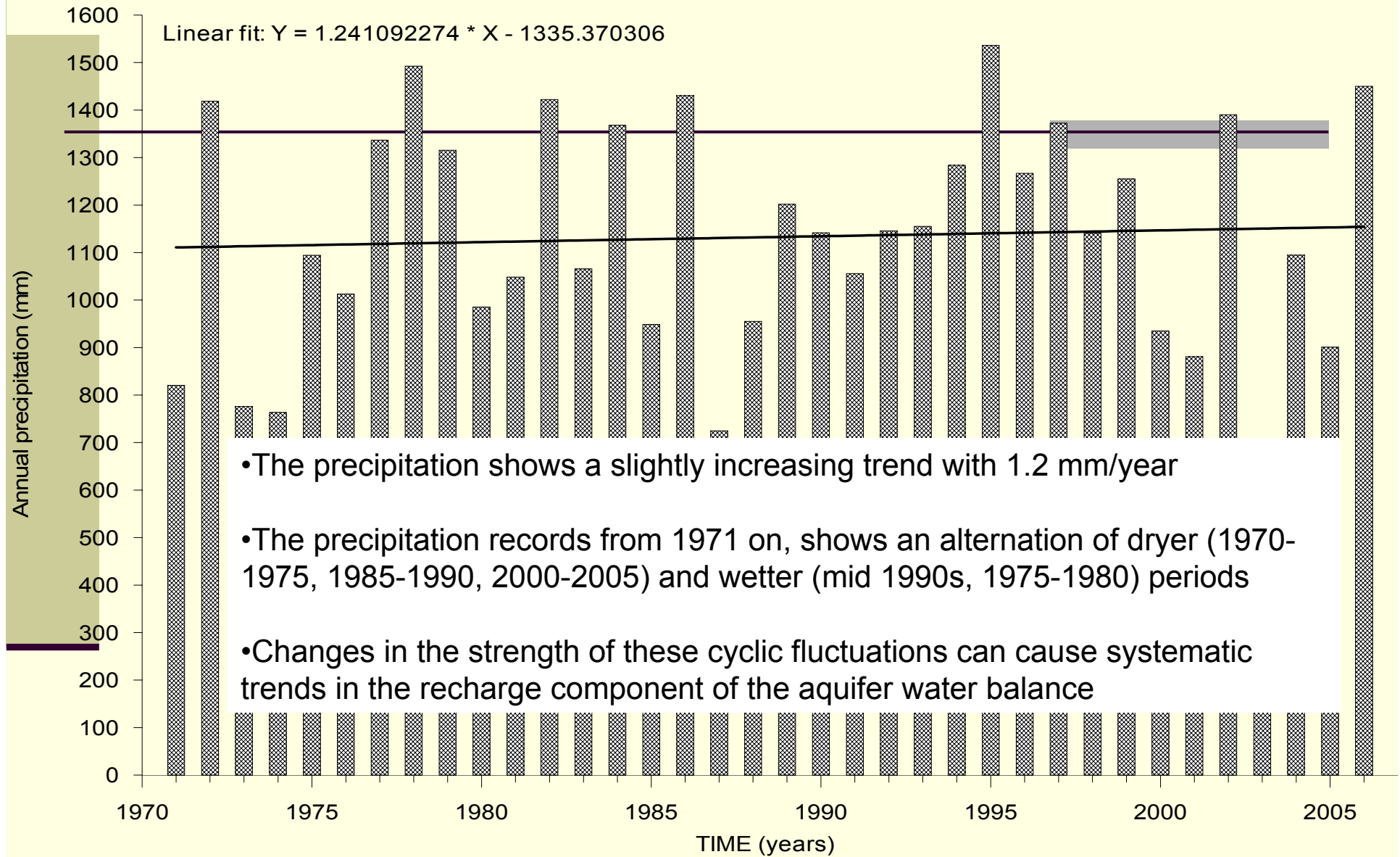
ΔS_B = Change in S_B
 DEF = Deficit (mm)
 SUR = Surplus (mm)
 CAP = Soil Capacity (mm)

RESULTS AND DISCUSION



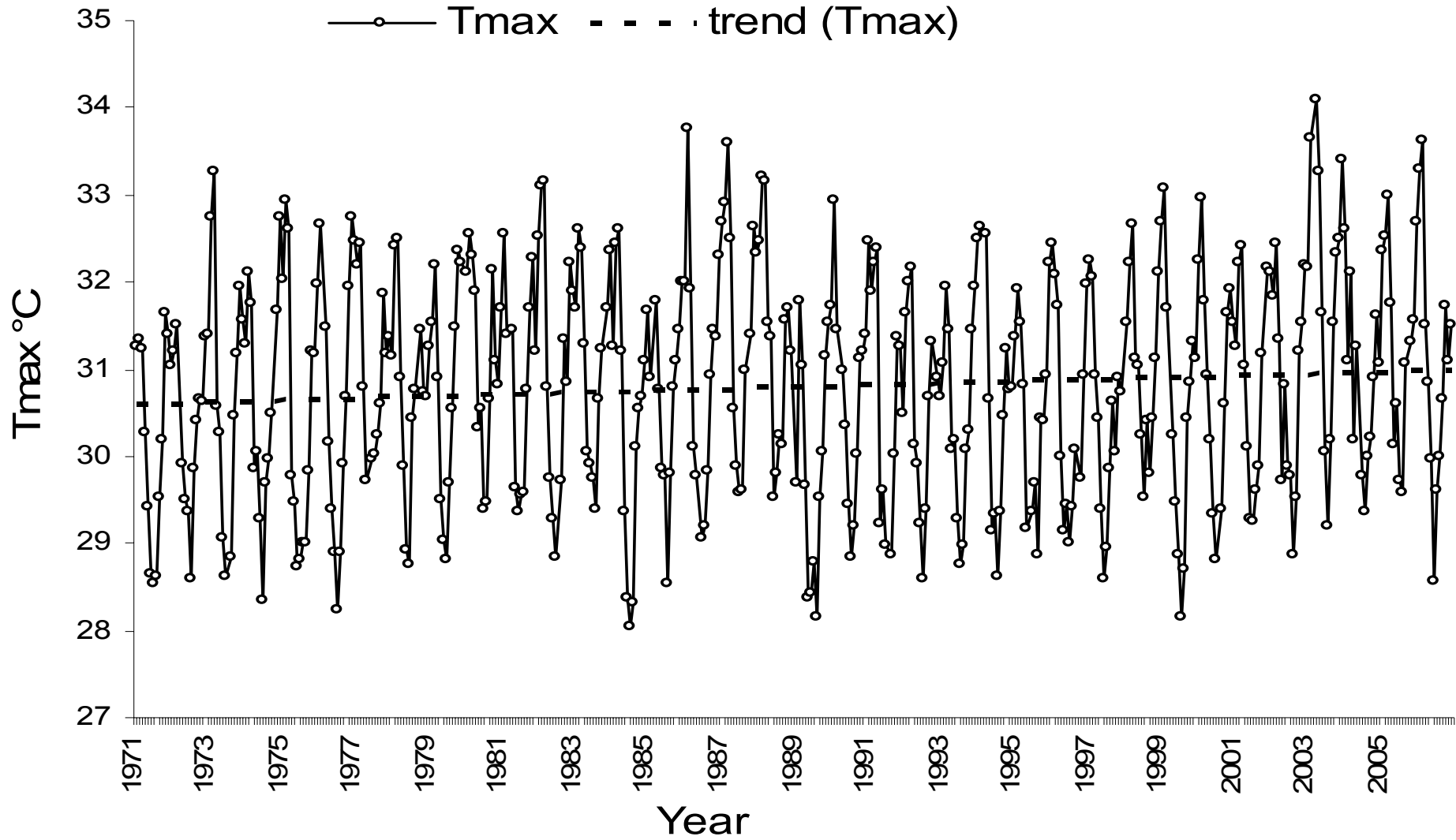
Annual groundwater recharge rate variation for 36 years (1971-2006)

RESULTS AND DISCUSSION Cont...



Total yearly precipitation (in mm) in the period 1971-2006

RESULTS AND DISCUSION Cont...



Mean monthly maximum temperature (Tmax) variation for 1971-2006)

RESULTS AND DISCUSION Cont...

Integrated water balance of the Dar-es-Salaam aquifer

Water balance component	Amount (hm ³ /year) (+ = inflow/- = outflow)	Fraction of total recharge (%)
Recharge	+93.4	
Pumping	-8.59	9.2
River baseflow	-75.7	81.0
Discharge to sea	-9.11	9.8

CONCLUSIONS

- ❑ The estimated groundwater abstraction of 8.59 hm³/year accounts for 9.2 % of the inflowing water (i.e. recharge)
- ❑ Three main rivers (and some tributaries) drain the aquifer basin and the total baseflow was calculated at 75.7 hm³/year (81%)
- ❑ Rainfall is the main source of aquifer recharge and the Dar-es-Salaam region has two distinct rainy seasons; March to May, April being the wettest month with an average rainfall of 254 mm and the second shorter rainy season is in November and December.
- ❑ For the period 1971 till 2006 the average aquifer recharge is sized at 240.7 mm/year.
- ❑ As precipitation shows a rather slightly increasing trend with 1.2 mm/year, it may be assumed that the impact of increasing temperatures on decreasing groundwater recharge rates is more important.

THANK YOU

