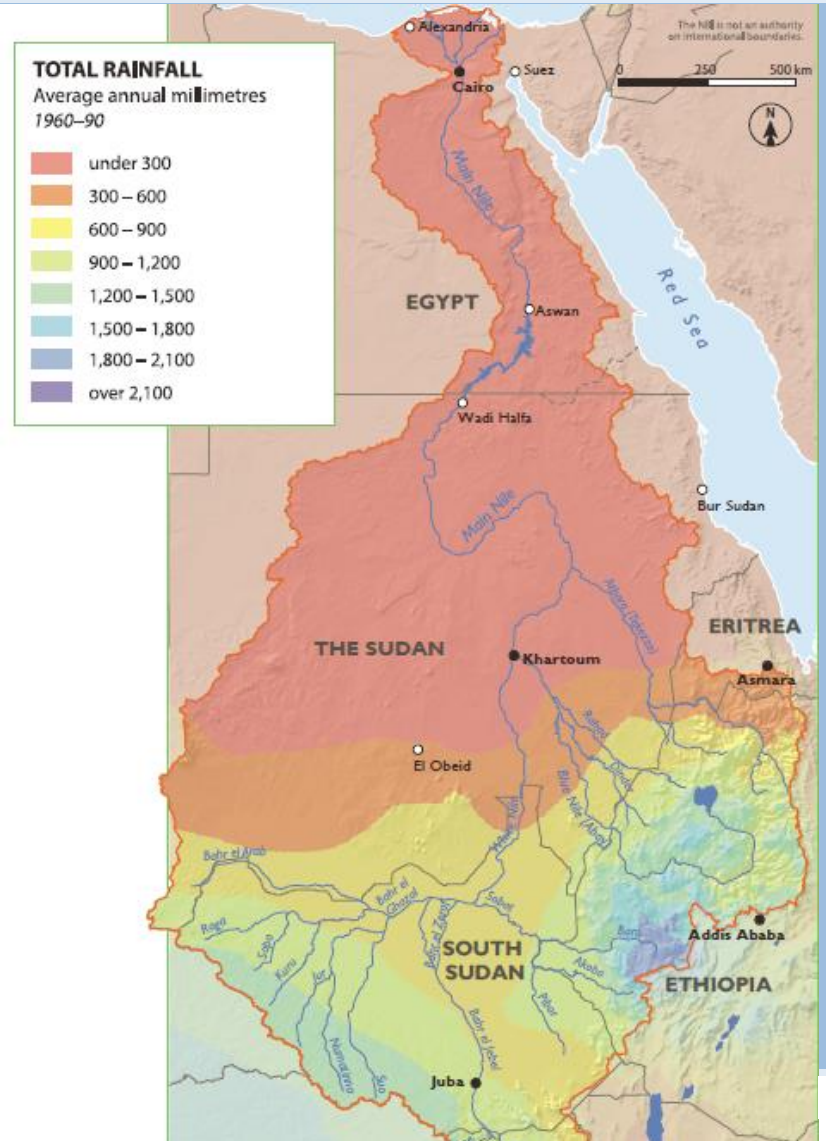
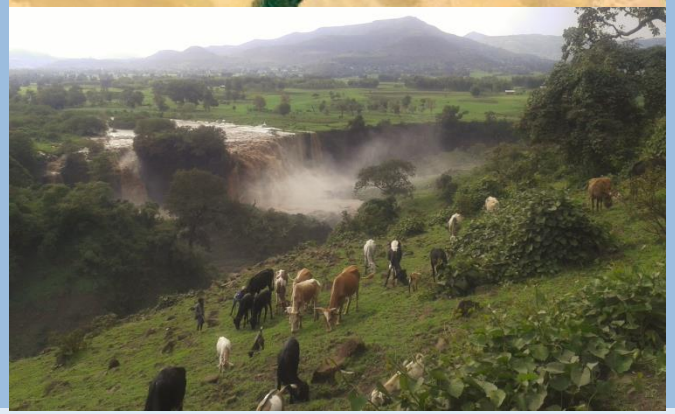
Impact of precipitation and temperature on hydrological responses in the Ethiopian Highlands

Tatenda Lemann,[1,2,3] Vincent Roth,[1,2,3] Gete Zeleke,[1,3]

[1]*Centre for Development and Environment (CDE), University of Bern, Switzerland*
[2]*Integrative Geography – Sustainable Land Management Unit, University of Bern, Switzerland*
[3]*Water and Land Resource Centre, Addis Ababa, Ethiopia*





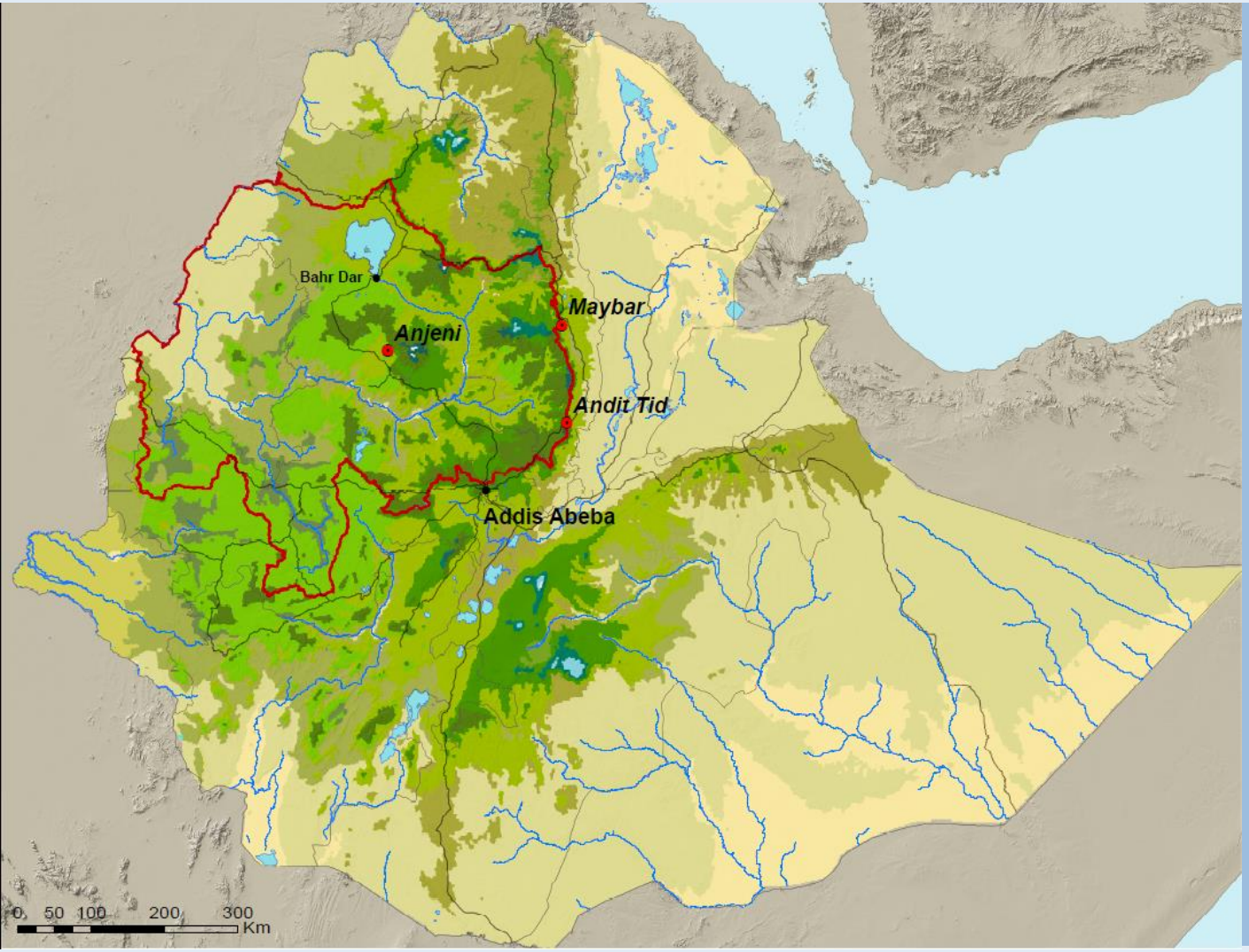
(Map prepared by the NBI; source of data: Climatic Research Unit)

Context

Methodology & Data

Results & Discussion

Conclusion

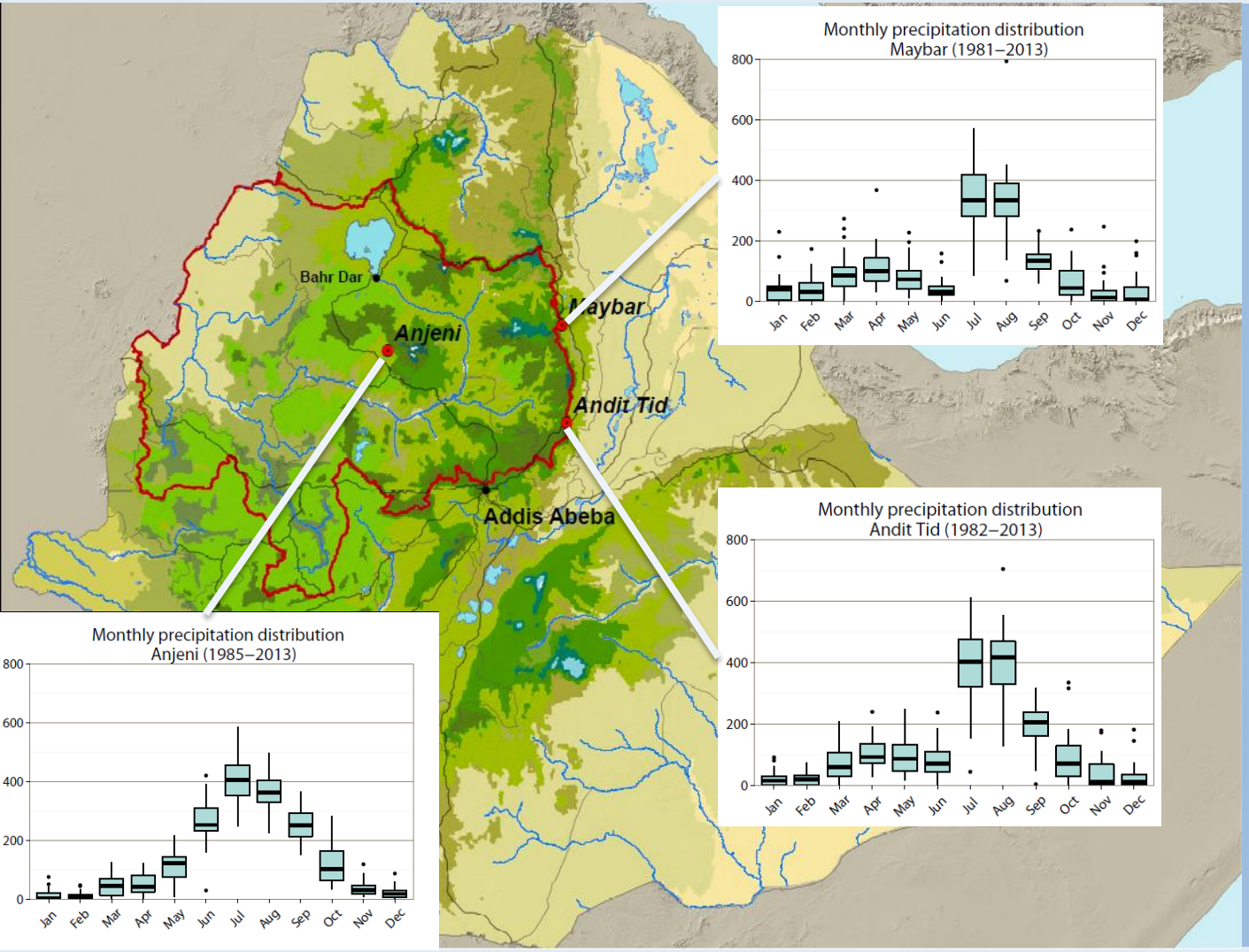


Context

Methodology & Data

Results & Discussion

Conclusion



Context

Methodology & Data

Results & Discussion

Conclusion

Andit Tid

Context

Methodology & Data

Results & Discussion

Conclusion

Context

Methodology & Data

Results & Discussion

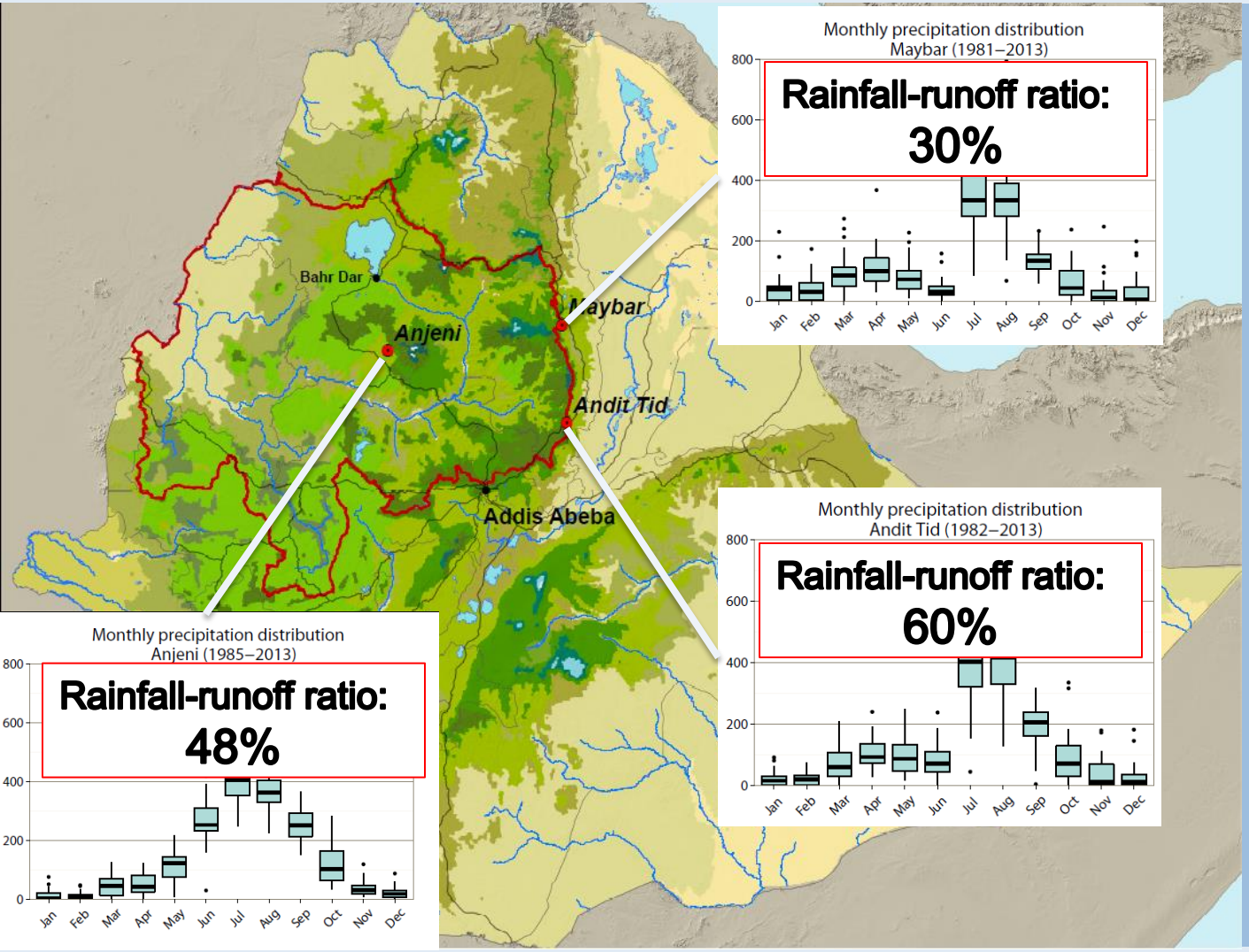
Conclusion

Context

Methodology & Data

Results & Discussion

Conclusion

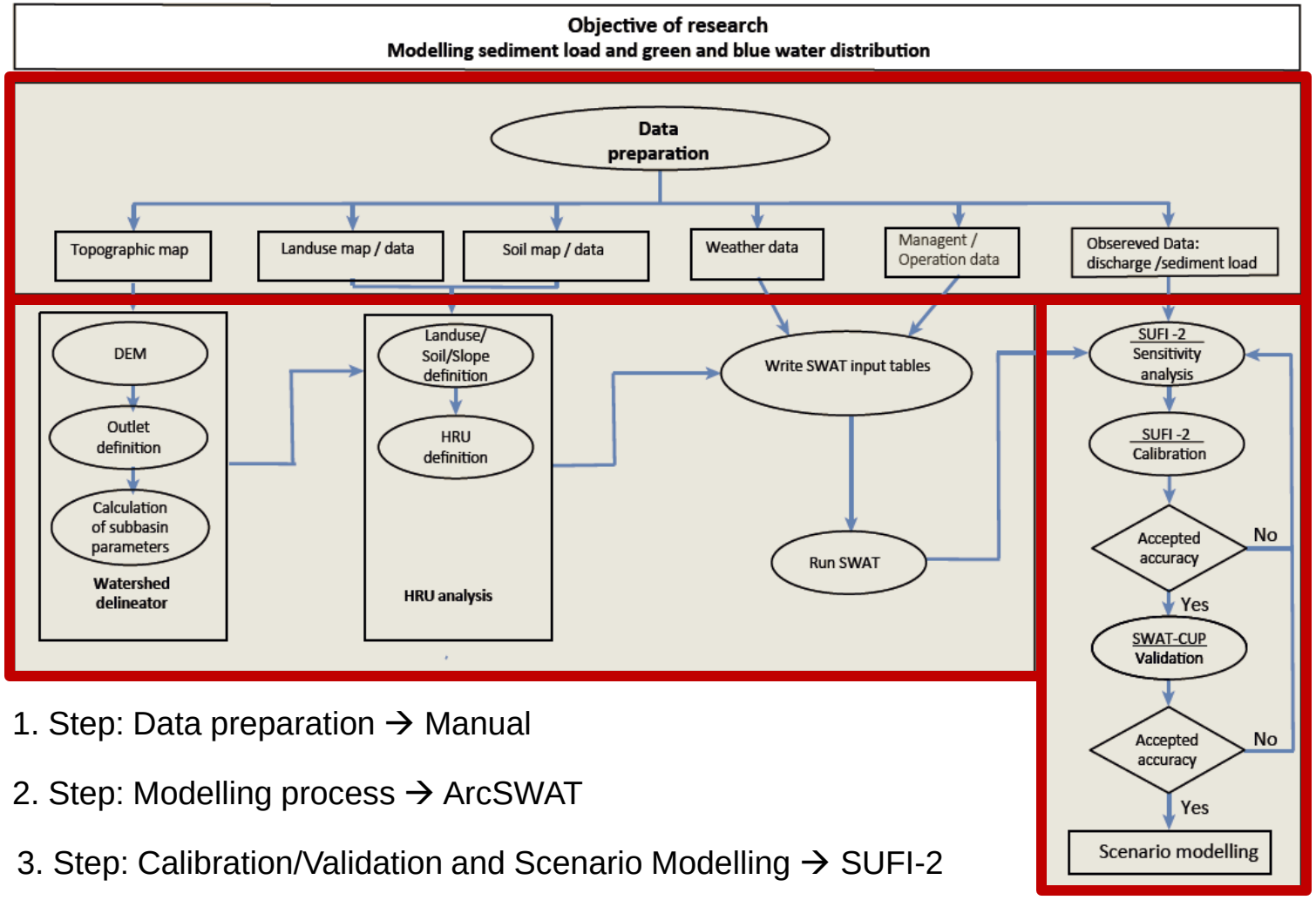


Context

Methodology & Data

Results & Discussion

Conclusion



1. Step: Data preparation → Manual

2. Step: Modelling process → ArcSWAT

3. Step: Calibration/Validation and Scenario Modelling → SUFI-2

Context

Methodology & Data

Results & Discussion

Conclusion

Context

Methodology & Data

Results & Discussion

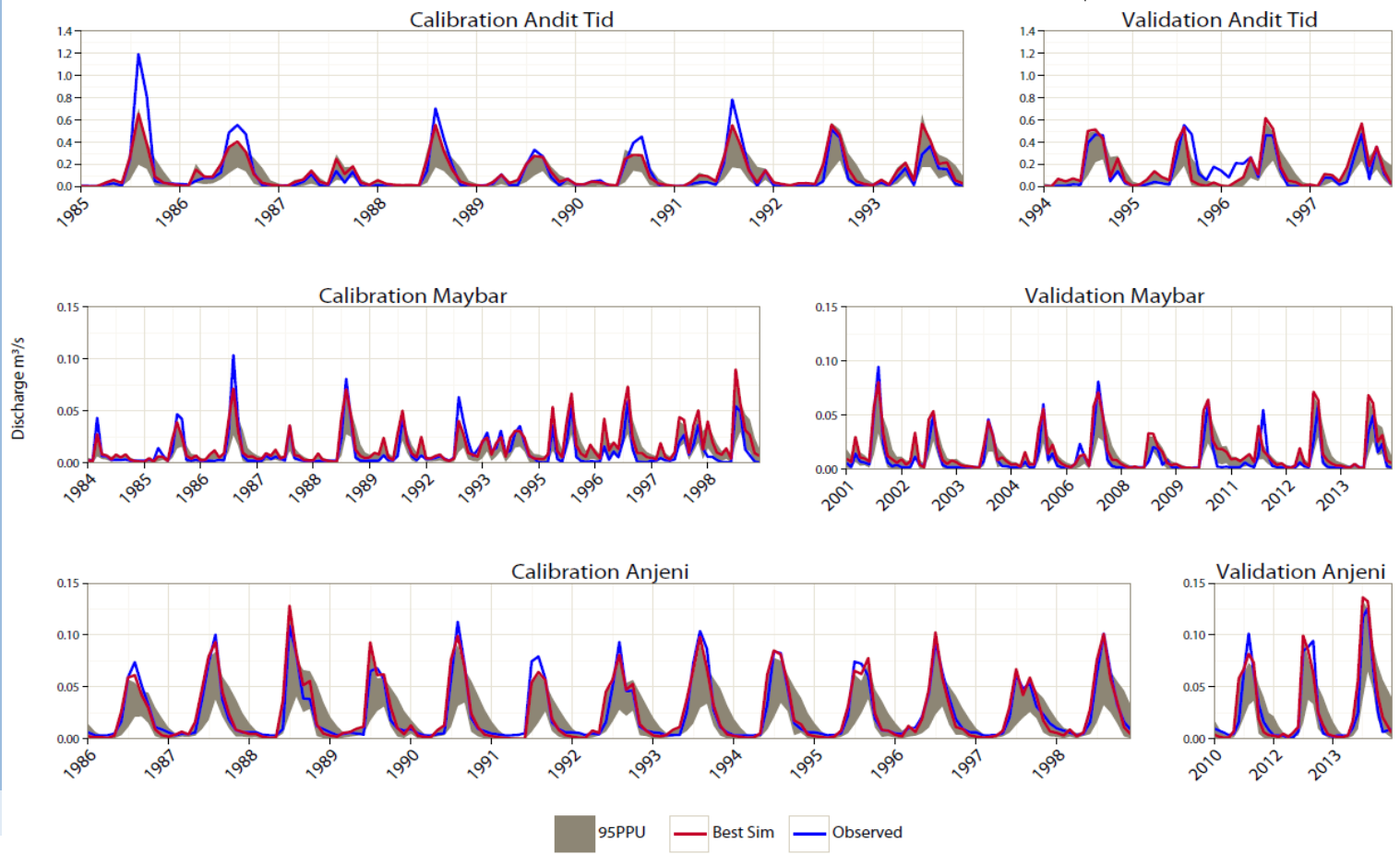
Conclusion

Calibration / Validation with SUFI-2

Name[a]	Definition	Andit Tid[b]		Maybar		Anjeni	
		min	max	min	max	min	max
a__CN2.mgt	SCS runoff curve number for moisture condition 2	-10	10	-10	10	-10	10
v__GW_DELAY.gw	Groundwater delay (days)	350	100	50	200	30	150
v__GWQMN.gw	Threshold depth of water in the shallow aquifer required for return flow to occur (mm).	0	200	0	200	50	200
v__ESCO.hru	Soil evaporation compensation factor.	0.6	1	0.7	1	0.6	0.9
v__GW_REVAP.gw	Groundwater "revap" coefficient	0.1	0.2	0.1	0.2	0.1	0.2
v__REVAPMN.gw	Threshold depth of water in the shallow aquifer for "revap" to occur (mm)	0	10	0	8	4	10
v__CH_K2.rte	Effective hydraulic conductivity in main channel alluvium	0.1	130	1	150	0.1	130
v__CH_N2.rt	Manning's "n" value for the main channel	0	0.3	0	0.3	0	0.3
V__SURLAG.bsn	Surface runoff lag time (days)	0.05	1	0.05	0.9	0.05	1
V__RCHRG_DP.gw	Deep aquifer percolation fraction	0	1	0.2	1	0	1
V__EPCO.hru	Plant uptake compensation factor	0	1	0.1	0.7	0	1
R__OV_N.hru	Manning's n value for overland flow	-0.2	0.2	-0.2	0.1	-0.1	0.2

Context
Methodology & Data
Results & Discussion
Conclusion

	P-factor		R-factor		R^2		NSE	
	Cal.	*Val.*	*Cal.*	*Val.*	*Cal.*	*Val.*	*Cal.*	*Val.*
Andit Tid	0.84	0.79	0.58	0.79	0.83	0.73	0.8	0.68
Maybar	0.75	0.83	0.77	0.79	0.74	0.78	0.65	0.66
Anjeni	0.81	0.81	0.85	0.77	0.93	0.89	0.93	0.88

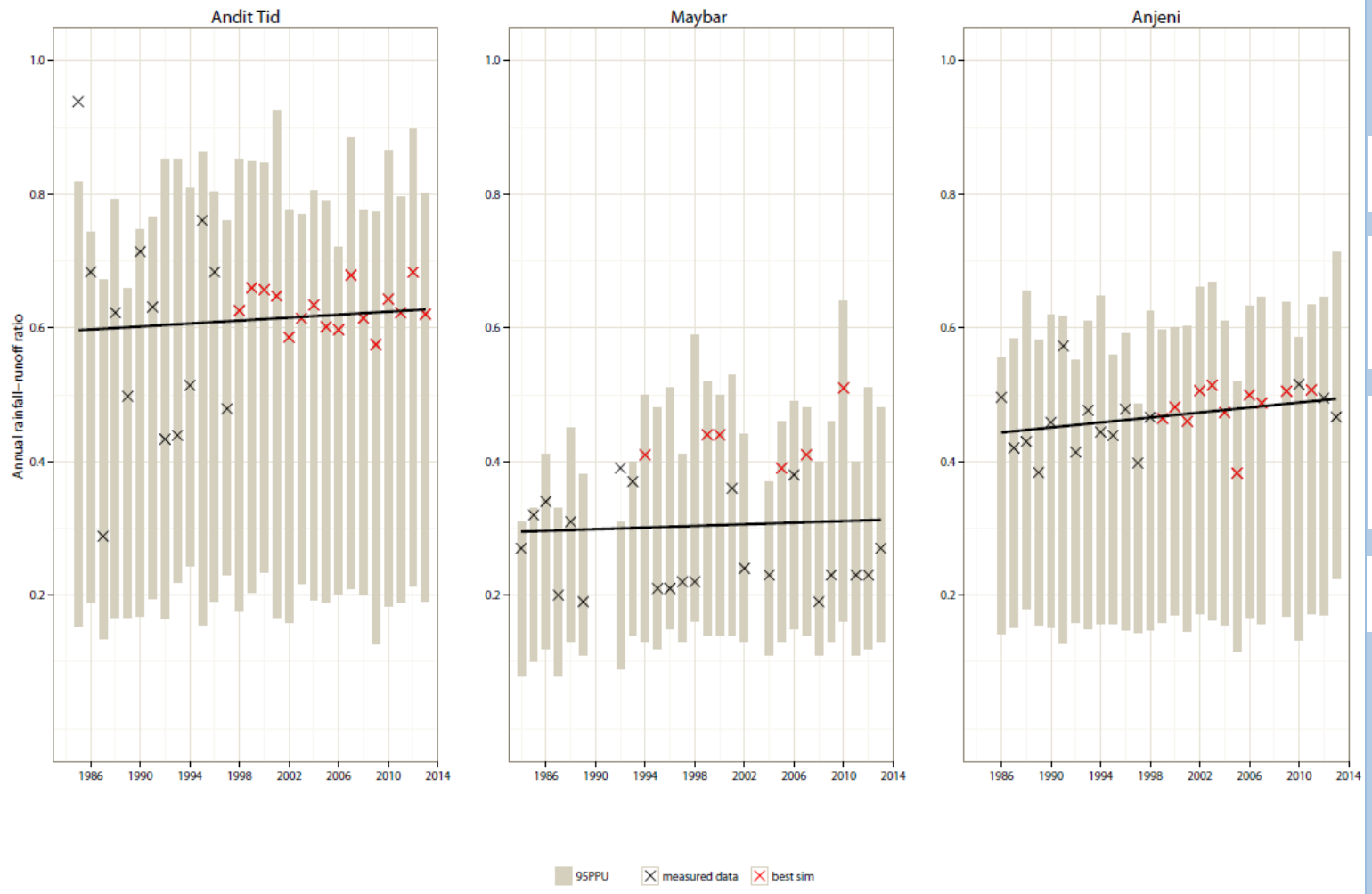


Context

Methodology & Data

Results & Discussion

Conclusion



Context

Methodology & Data

Results & Discussion

Conclusion

Scenario Modelling with SUFI-2

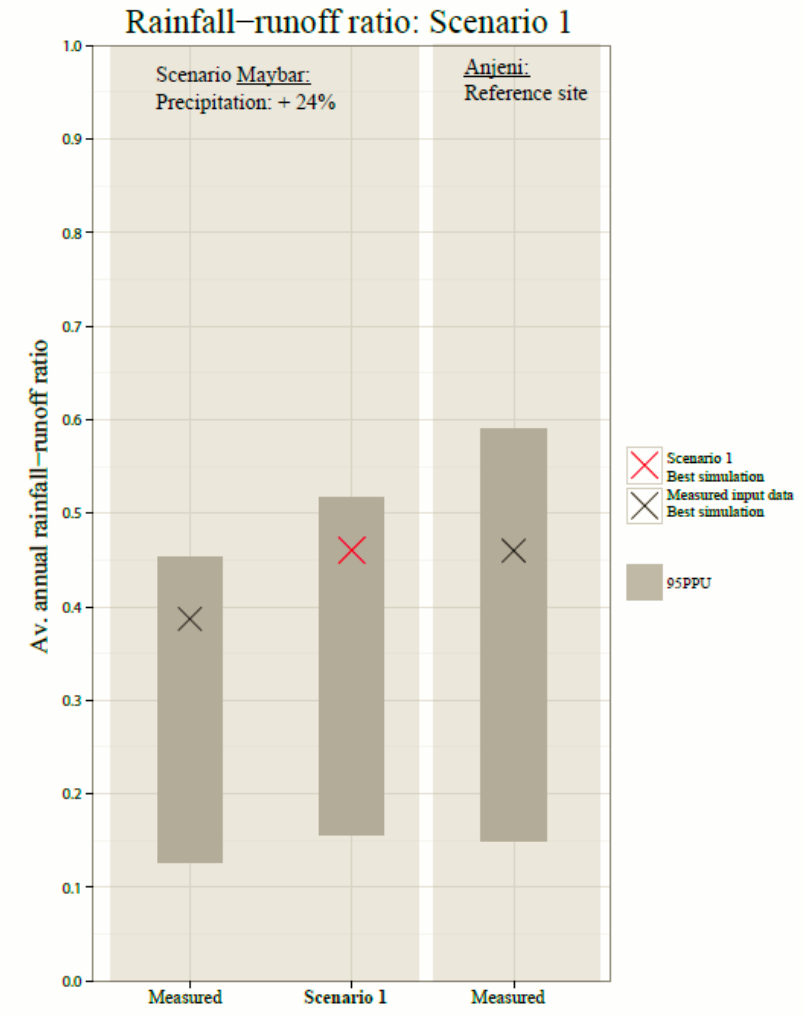
Name[a]	Definition	Maybar		Andit Tid	
		Scenario 1	Scenario 3	Scenario 2	Scenario 3
r__Precipitation.pcp	Amount of precipitation falling during the day (mm)	0.24	**0.24**	---	**0.1**
r__PCPMM.wgn	Average or mean total monthly precipitation (mm)	0.24	**0.24**	---	**0.1**
r__RAINHHMX.wgn	Maximum 0.5 hour rainfall in entire period of record for month (mm)	0.24	**0.24**	---	**0.1**
r__PCPSTD.wgn	Standard deviation for daily precipitation in month (mm/day)	0.24	**0.24**	---	**0.1**
r__TMPMX.wgn	Average daily max. air temperature for month (ºC).	---	**0.07**	0.42	**0.42**
r__TMPMN.wgn	Average daily min. air temperature for month (ºC).	---	**-0.21**	0.05	**0.05**
r__MAXTEMP.tmp	Daily maximum temperature (ºC)	---	**0.07**	0.42	**0.42**
r__MINTEMP.tmp	Daily minimum temperature (ºC)	---	**-0.21**	0.05	**0.05**
r_TMPSTDMX.wgn	Standard deviation for daily max. air temperature in month (ºC)	---	**0.07**	0.42	**0.42**

Context

Methodology & Data

Results & Discussion

Conclusion

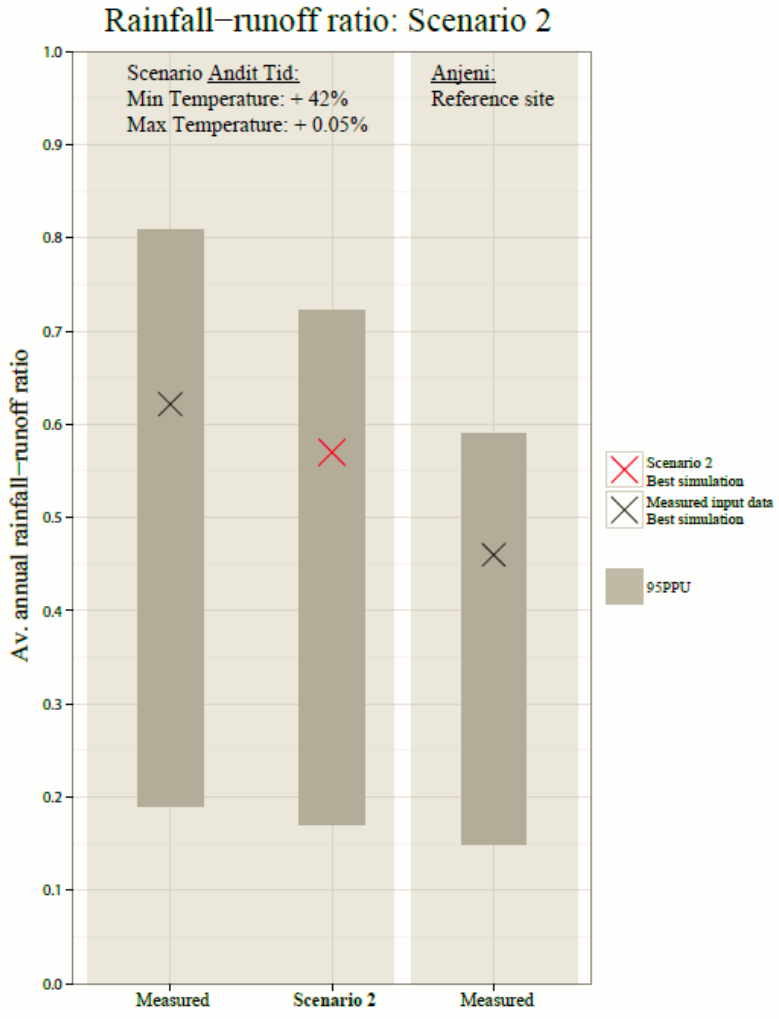


Scenario 1 for Maybar

+ 24% precipitation
Same av. annual precipitation as Anjeni

+ ~50% more discharge
+ ~20% higher drainage ratio
infiltration-excess processes

Context
Methodology & Data
Results & Discussion
Conclusion



Scenario 2 for Andit Tid

+ 42% (6.8°C) Min Temperature
Same av. annual temperature as Anjeni

+ ~ 60% potential Evapotranspiration
from 1,099 to 1,608 mm

- ~10% discharge

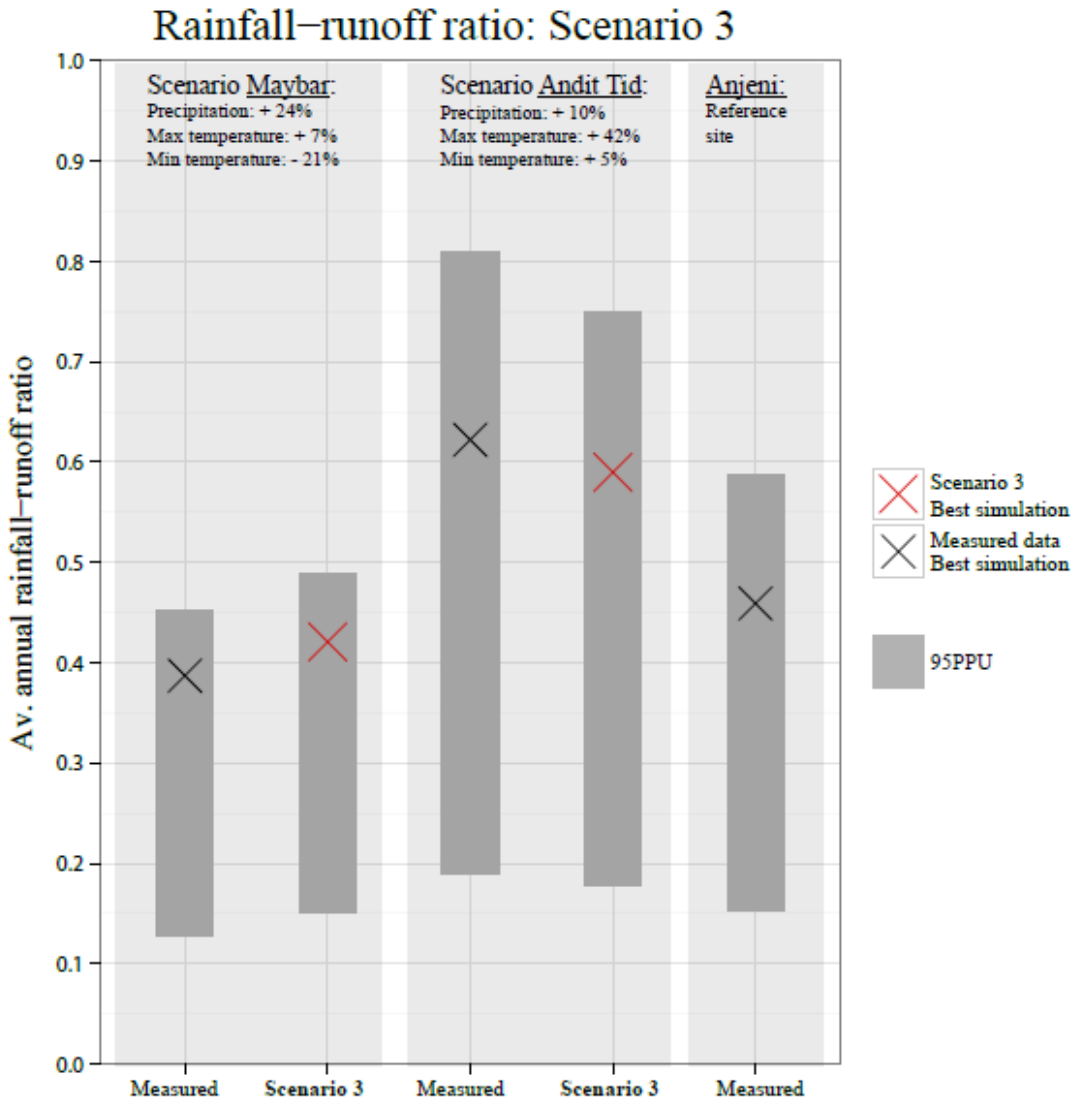
- ~ 10% drainage ratio

Context

Methodology & Data

Results & Discussion

Conclusion



Context

Methodology & Data

Results & Discussion

Conclusion

Increasing temperature → Decreasing rainfall-runoff ratio

Increasing precipitation → Increasing rainfall-runoff ratio

Differences of rainfall-runoff ratio in small scale catchments are largely caused by temperature and precipitation

Changes in temperature or precipitation (e.g. climate change) have far-reaching consequences for blue and green water distribution

Context
Methodology & Data
Results & Discussion
Conclusion

Context

Methodology & Data

Results & Discussion

Conclusion

Thank you!

Questions?

tatenda.lemann@cde.unibe.ch