Research in support of the
EU Water Initiative

« Twinning European/Third countries river basins »

Sixth Framework Programme
(2002-2006)

Assessing FloodWater Recharge of Alluvial Aquifers in Dryland Environments

WADE Project: Lessons Learnt and Achievement

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Hohenheim, Germany, December, 2006

www.wadeproject.info

The Problem Dimension of Groundwater Recharge

"Groundwater recharge, the flux of water across the water table, is arguably the most difficult component of the hydrological cycle to measure. In arid and semiarid regions the problem is exarcebated by extremely small recharge fluxes that are highly variable in space and time".

J.F. Hogan, F.M. Phillips, and B.R. Scanlon, 2004 in their Volume on "Groundwater Recharge in a Desert Environment. The Southwestern United States"

Significance of Groundwater Recharge

Accurate representation of groundwater recharge rates and mechanims in drylands is a significant challenge due to:

1.- Difficult of measuring extremely small recharge fluxes highly variable in time and space (inputs equals outputs within minimum errors).

2.- Recharge estimates often have important legal and policy implications ("*safe yield*" concept), limiting groundwater pumping to natural and artificial recharge.

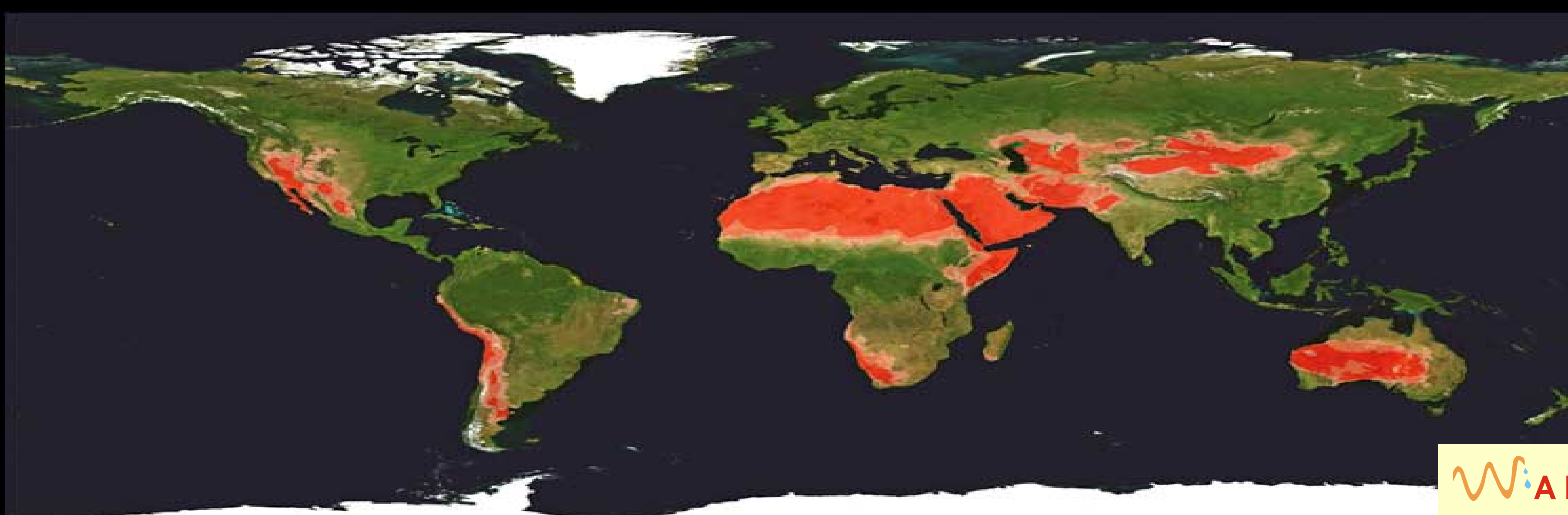
3.- Understanding of both recharge rates and mechanims is critical for development of groundwater management models, that subsequently may attempt to balance the demands for groundwater pumping while sustaining riparian ecosystems.

World-wide Dimension of Water Scarcity

- Arid and semiarid areas cover about a third of Earth surface.

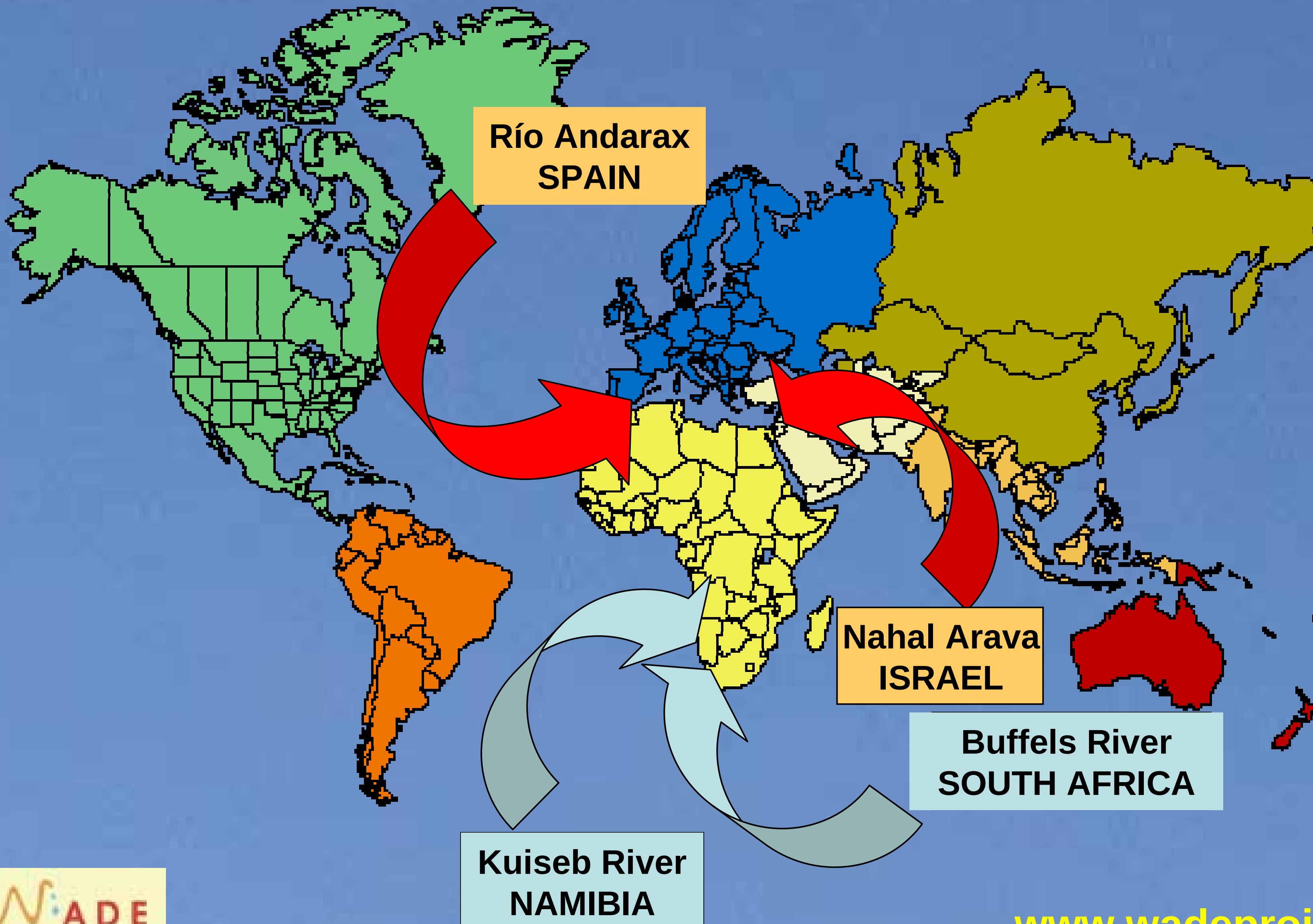
- Global water scarcity is expected to increase due to increase of population and subsequently irrigated agriculture, and global climate change.

- Planning on these regions requires information on sustainable water resources and therefore there is a need to improve long-term evaluation of groundwater availability.

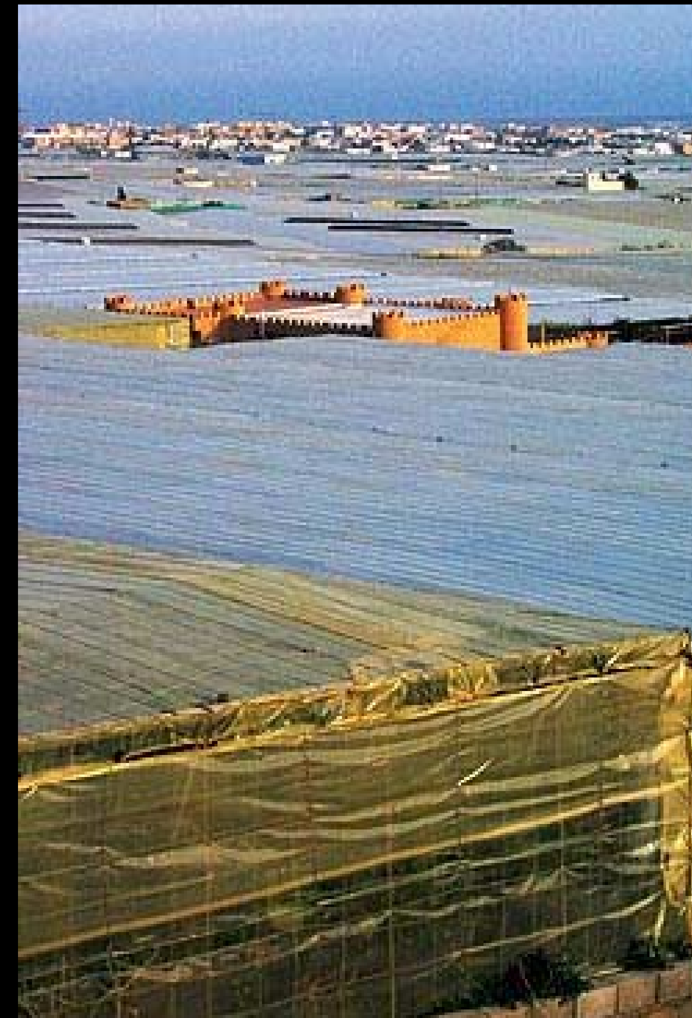


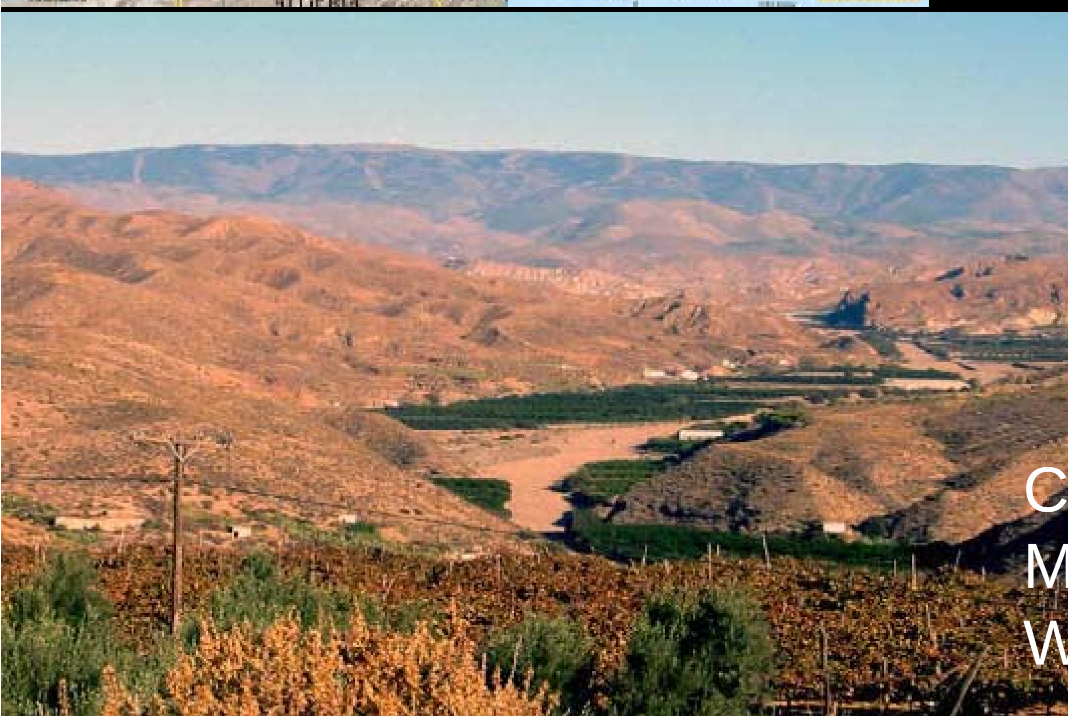
The key objective of WADE is to develop and apply a new method of investigating the occurrence of floodwater resources, in time and space, to quantify the sustainable water yield, and to propose strategies conducting to an integrated water management for their use.

Twinning River Basins…

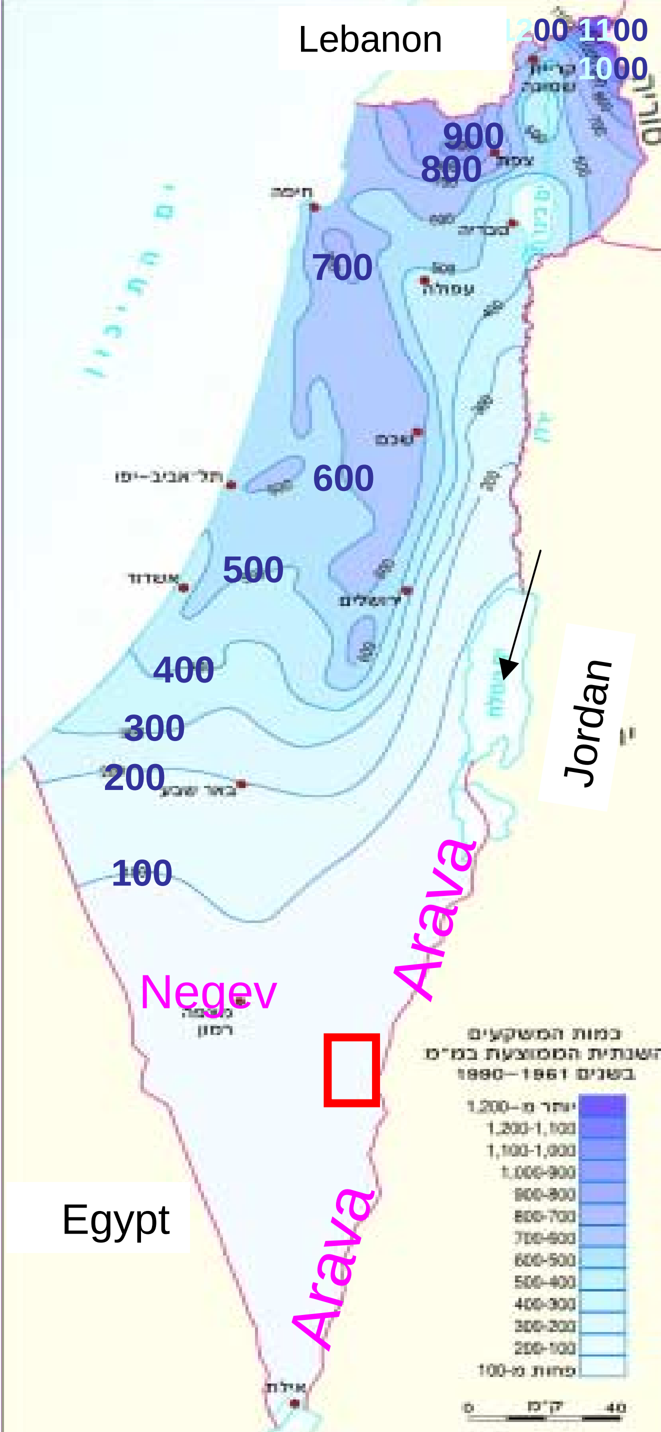


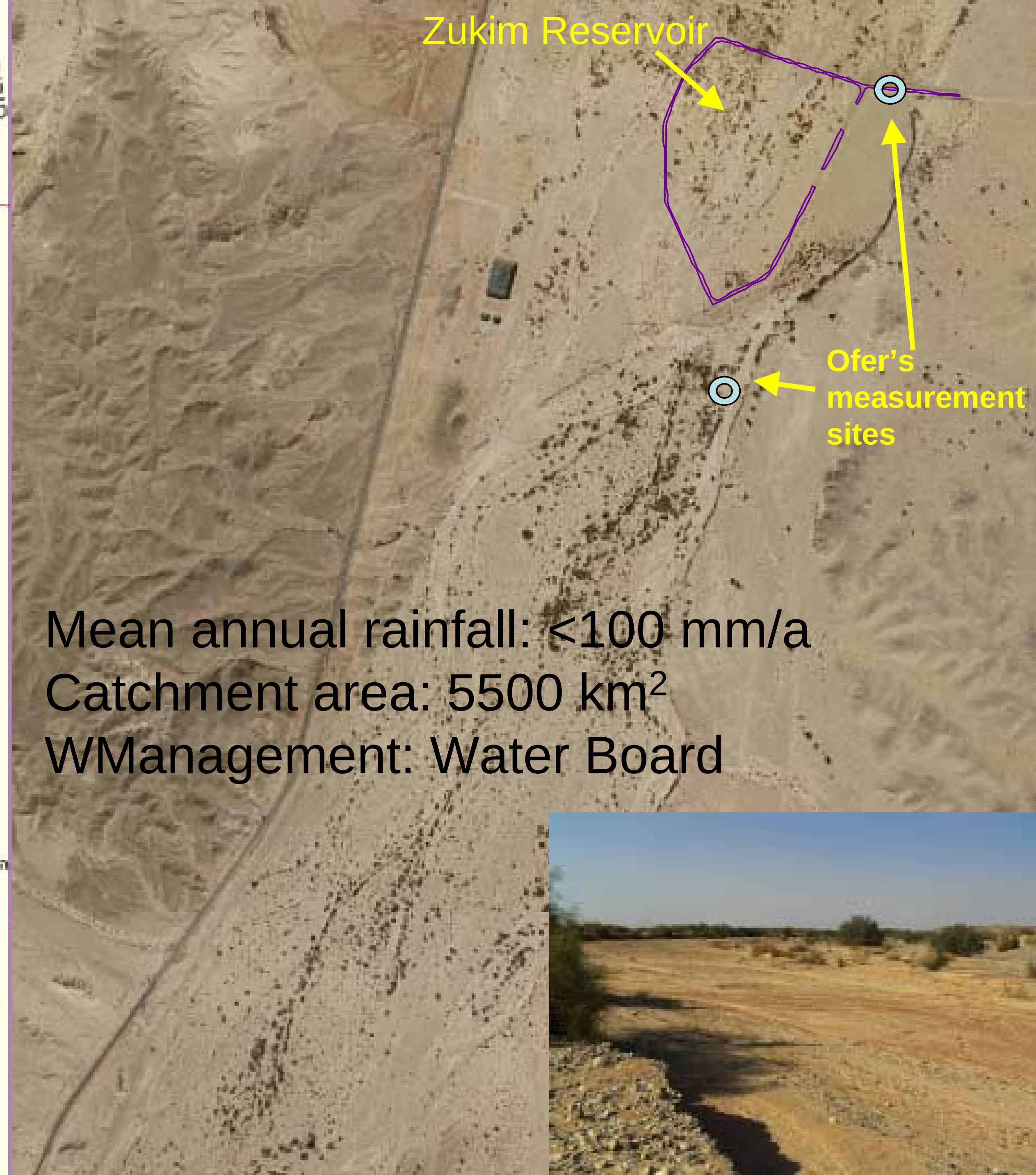
Andarax river, Spain





Catchement area: 2200 km^2
Mean annual rainfall:160 mm/a
WM: Water Board Authority





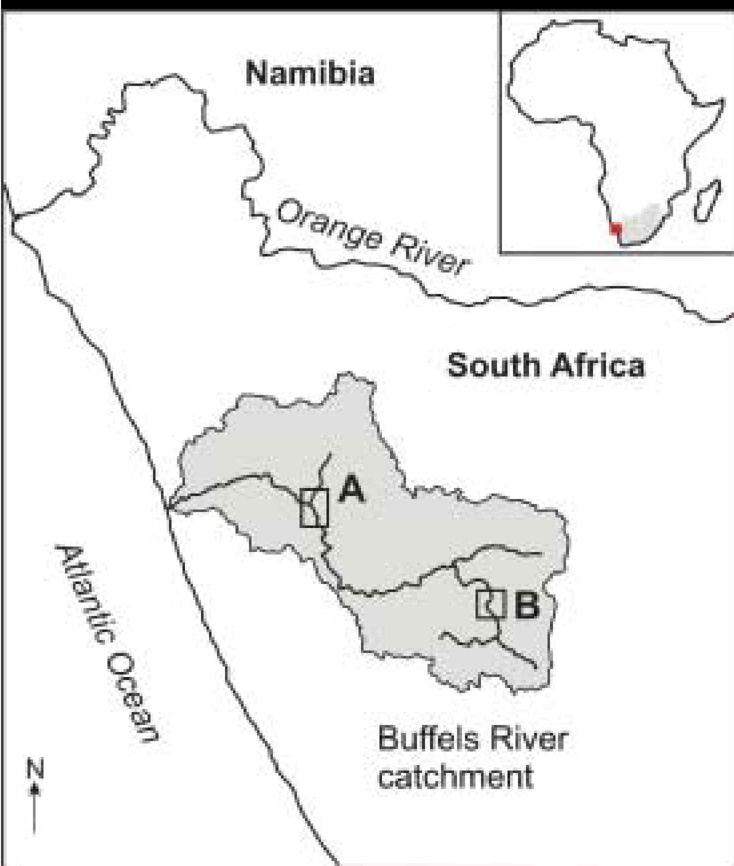
Mean annual rainfall: <100 mm/a
Catchment area: 5500 km^2
WManagement: Water Board

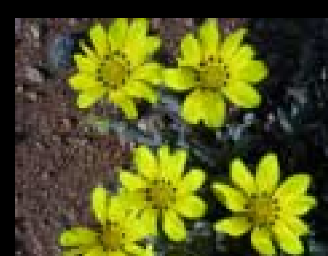
Buffels River, South Africa

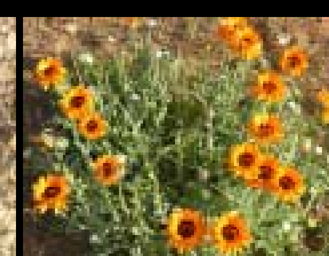
Buffels River catchment area = 9000 km^2

Mean annual rainfall: 90-300 mm/a

WMB: Not well stablished. Water Board Committee in progress (DWA, Municipality, users).







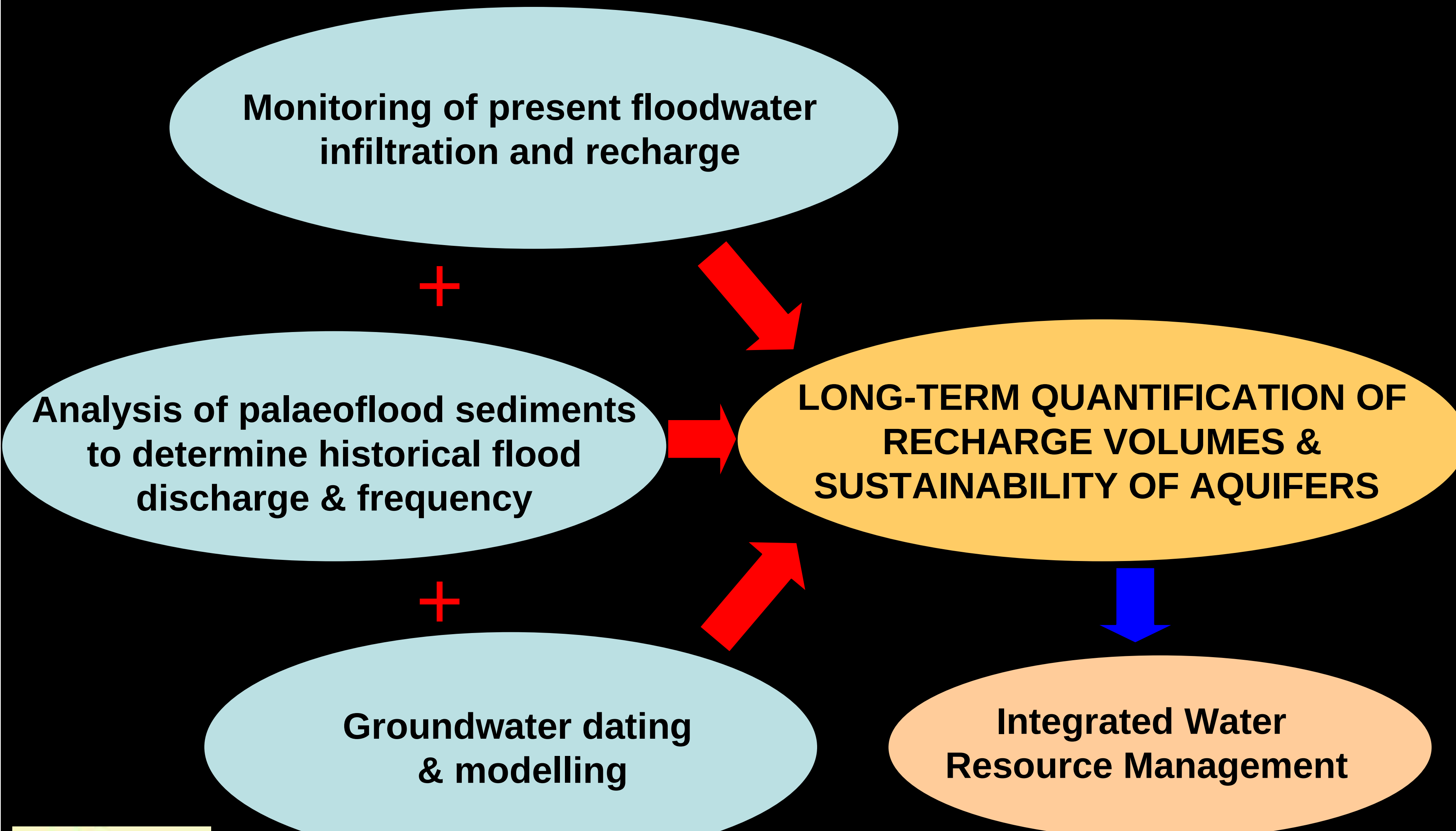
Kuiseb River, Namibia

Kuiseb River catchment area = 15,500 km^2

Mean annual rainfall: <50 mm-300 mm/a

Kuiseb Basin Management Committee (since 2001)

WADE Approach



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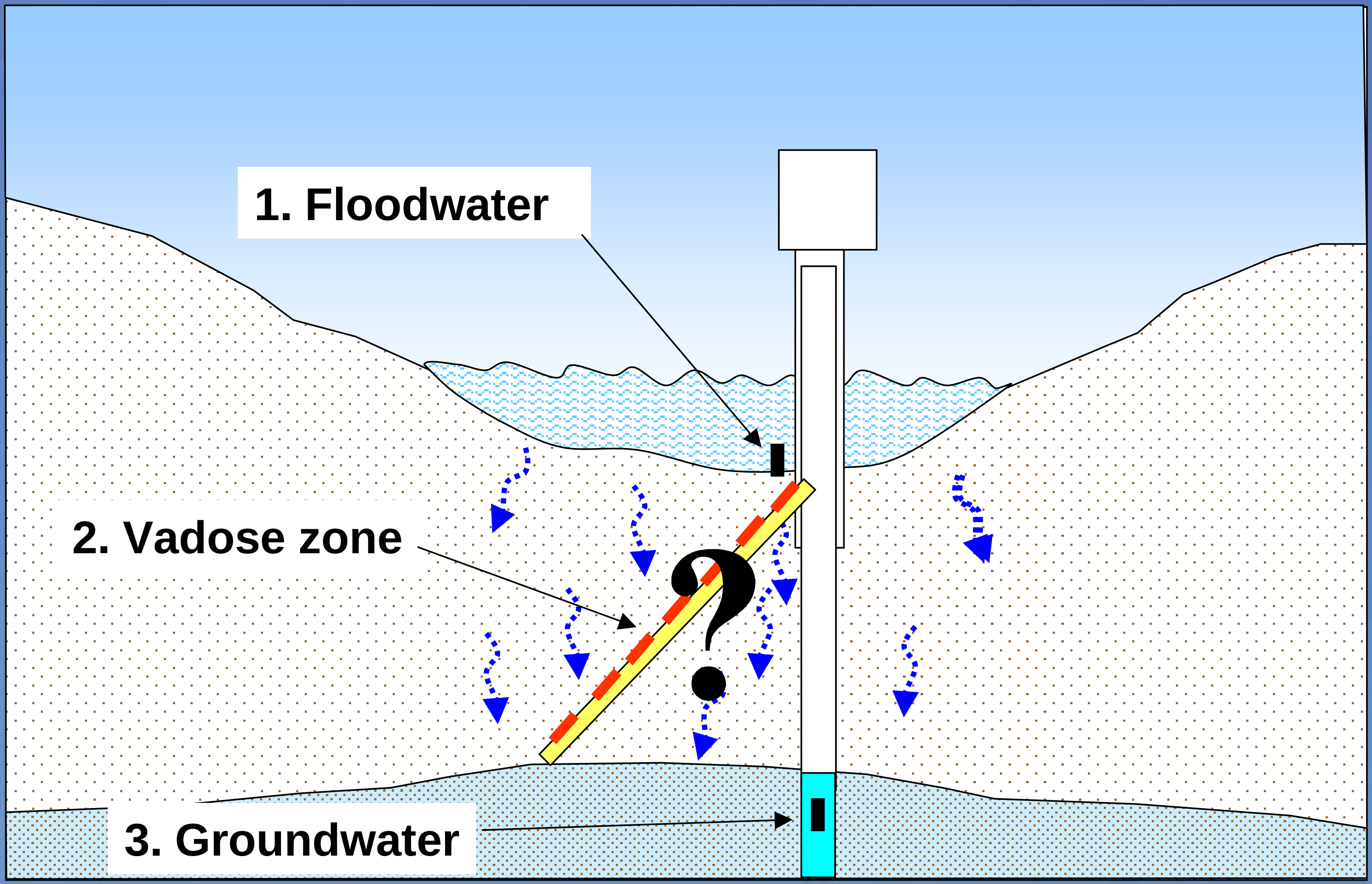
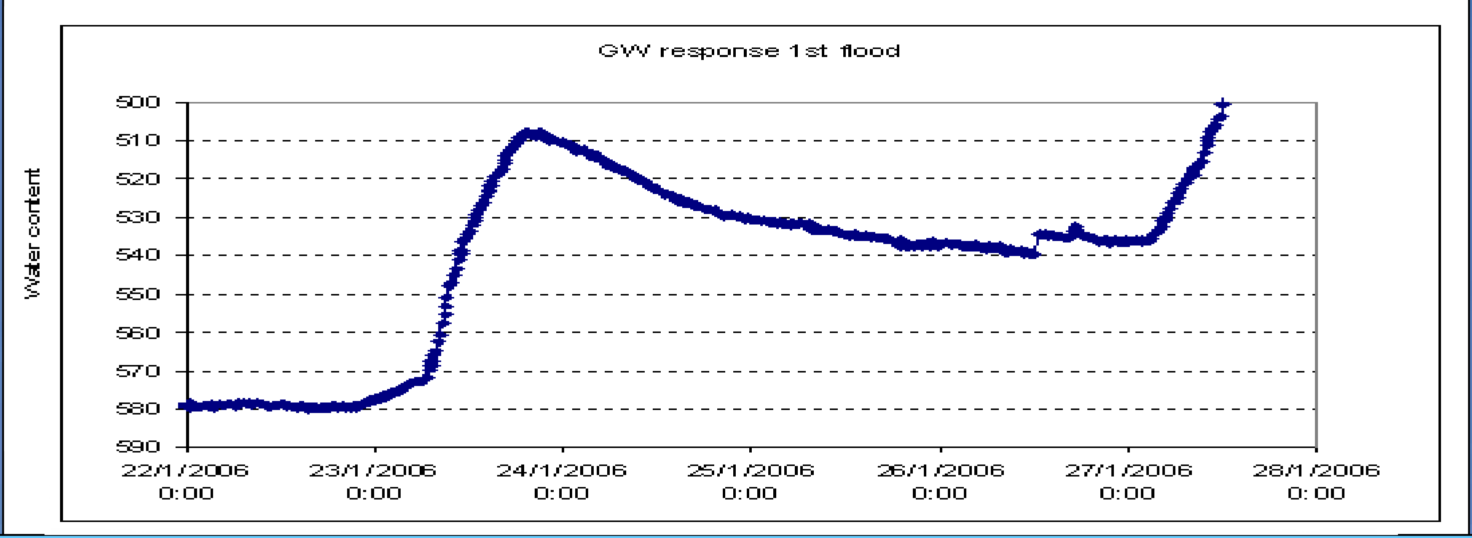
Monitoring & system components

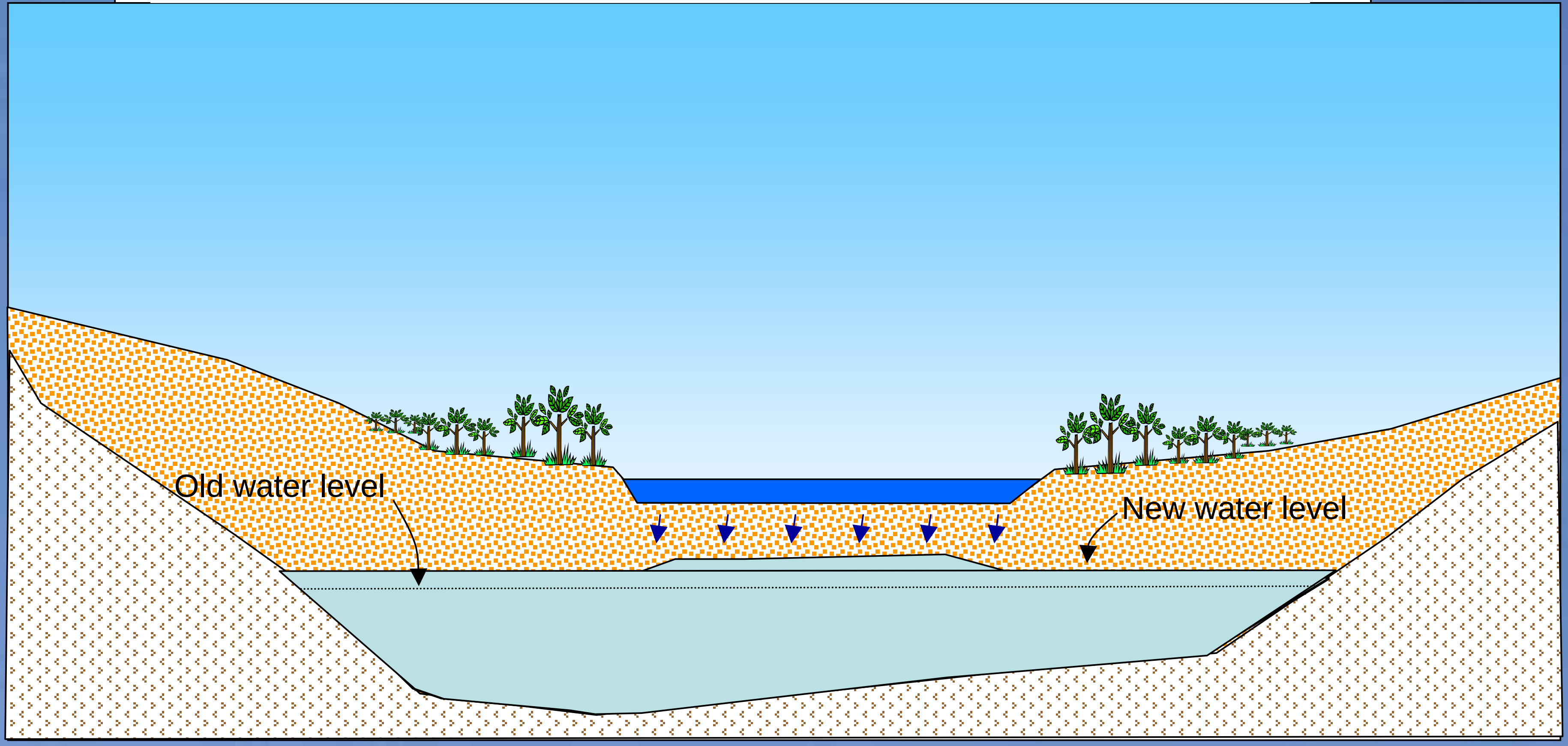


Installation of the vadose zone monitoring system in slanted boreholes

Completion of the monitoring station and protecting tower

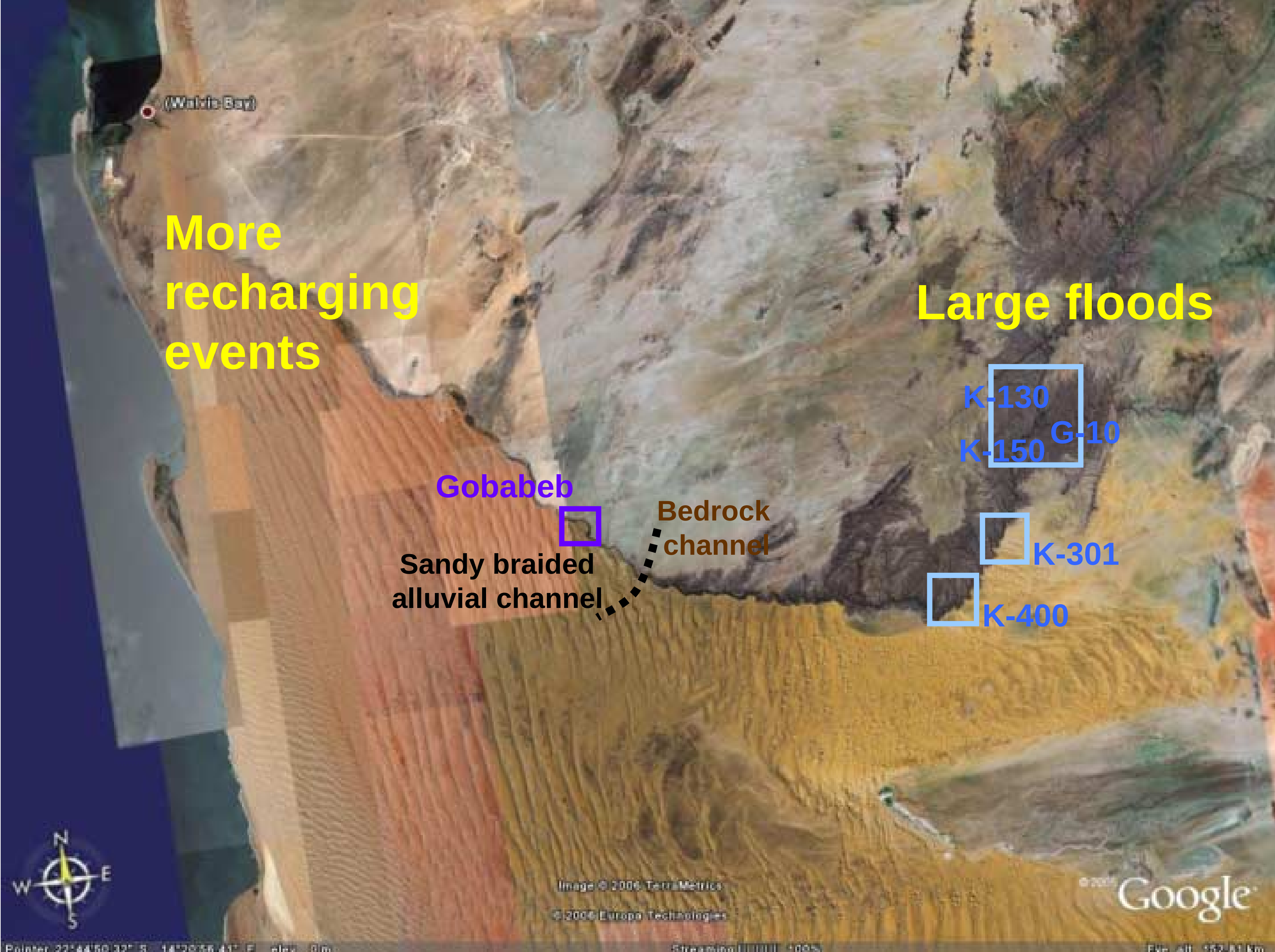

Flood3.JPG
Type: JPG File
Size: 1.66 MB
Dimension: 2592 x 1944 pixels


GW response 1st flood
Water content
500
510
520
530
540
550
560
570
580
590
22/1/2006 0:00
23/1/2006 0:00
24/1/2006 0:00
25/1/2006 0:00
26/1/2006 0:00
27/1/2006 0:00
28/1/2006 0:00


Old water level
New water level

Summary of results on Monitoring Station during 2006 flood season

Flood	Start	End	Duration	Max. stage(cm)	Flux (cm/h)	Recharge Homeb-Gobabeb	Recharge (m3)
1	20/01/2006 20:00	24/01/2006 00:00	84	150	0.75	0.75	422937.50
2	26/01/2006 16:45	31/01/2006 17:00	117	200	0.80	0.8	628281.33
3	06/02/2006 04:00*	08/02/2006 20:00	52	80	0.65	0.65	226460.00
4	11/02/2006 06:00*	13/02/2006 03:00	24	30	0.70	0.7	112560.00
5	19/02/2006 02:30*	04/03/2006 08:00	125	320	0.70	0.7	586250.00
						Total	1976488.83


(Walvis Bay)
More recharging events
Large floods
K-130
G-10
K-150
Gobabeb
Bedrock channel
K-301
Sandy braided alluvial channel
K-400
N
W
E
S
Image © 2006 TerraMetrics
© 2006 Europa Technologies
Google

Floodwater component

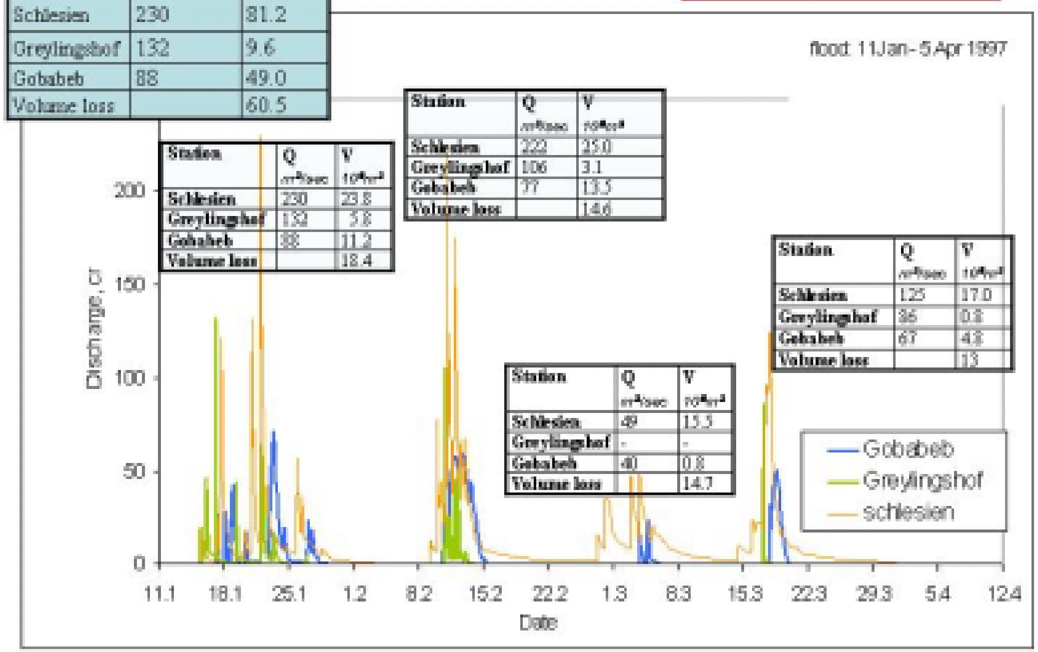
Flood characteristics

→ Palaeoflood hydrology: Long-term frequency and magnitude of lfoods

- Hydrograph- Boundary conditions for subsurface infiltration
- Transmission loss- direct infiltration to subsurface
- Chemical and isotopic characteriistics of the percolating water

Station	Discharge m^3/sec	Volume 10^6m^3
Schlesien	230	81.2
Greylingshof	132	9.6
Gobabeb	88	49.0
Volume loss		60.5

11 January – 5 April 1997



Station	Q m^3/sec	V 10^6m^3
Schlesien	230	23.8
Greylingshof	132	5.8
Gobabeb	88	11.2
Volume loss		18.4

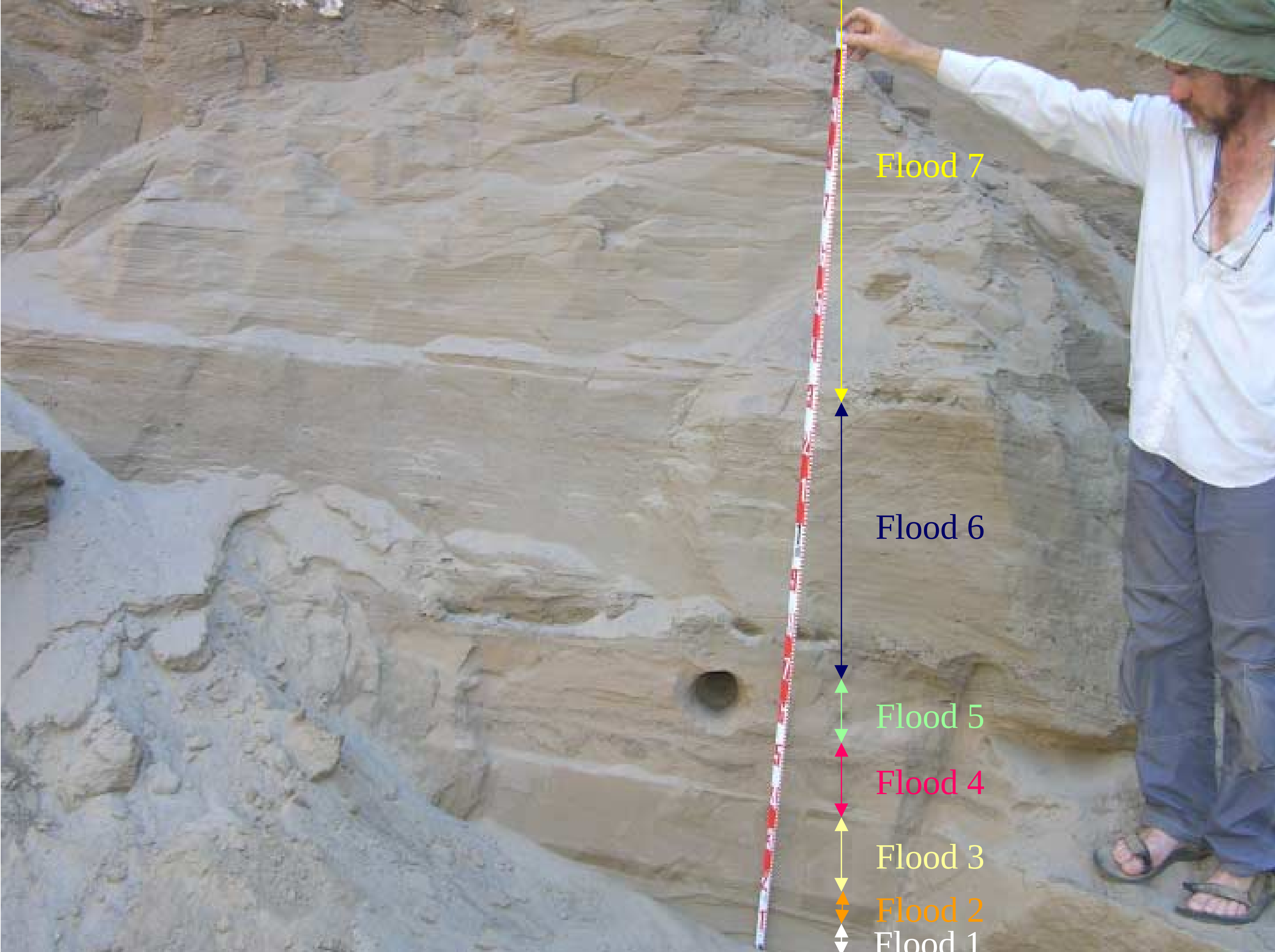
Station	Q m^3/sec	V 10^6m^3
Schlesien	222	25.0
Greylingshof	106	3.1
Gobabeb	77	13.5
Volume loss		14.6

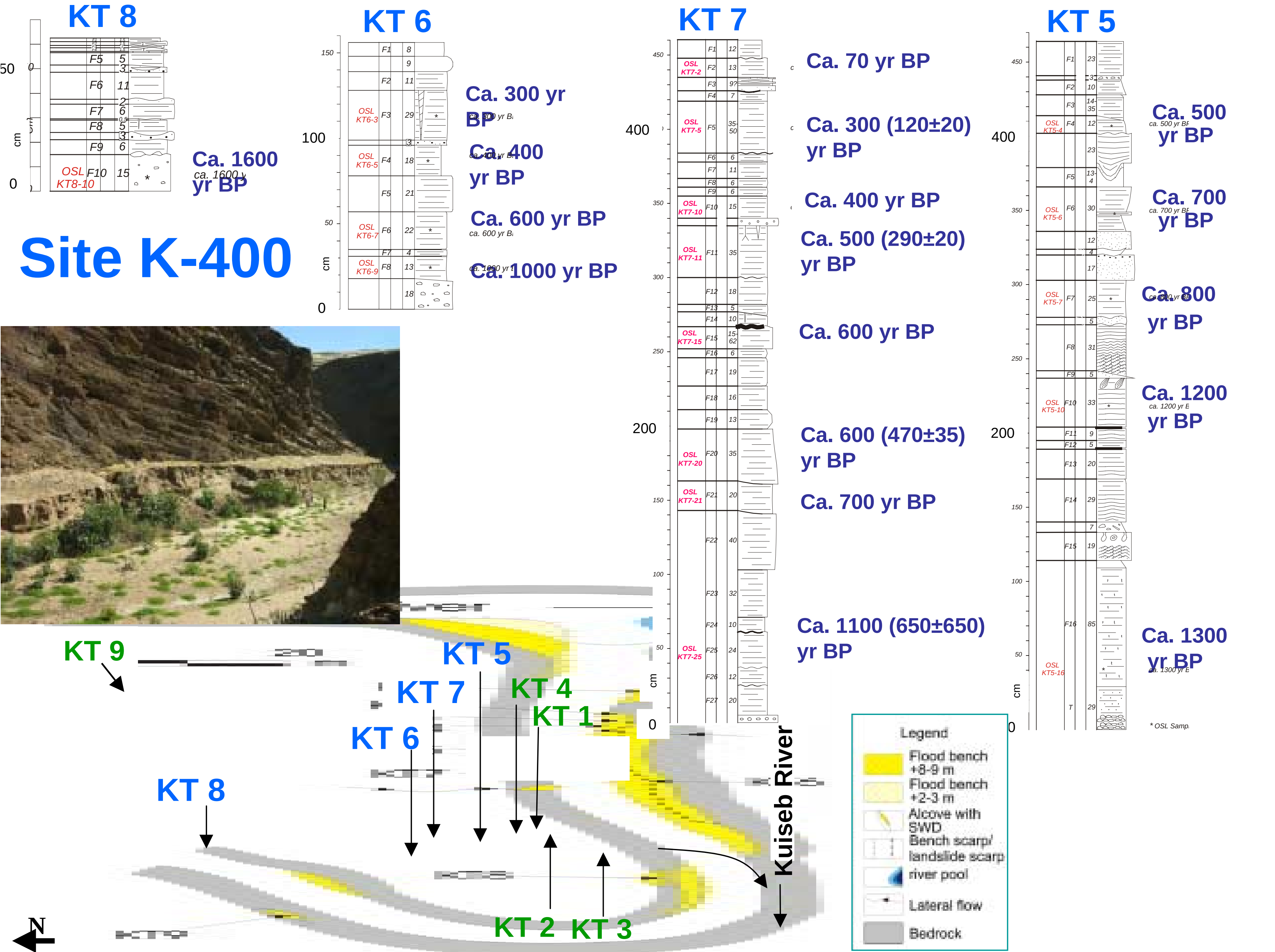
Station	Q m^3/sec	V 10^6m^3
Schlesien	49	15.5
Greylingshof	-	-
Gobabeb	40	0.8
Volume loss		14.7

Station	Q m^3/sec	V 10^6m^3
Schlesien	125	17.0
Greylingshof	36	0.8
Gobabeb	67	4.8
Volume loss		13

-Average flood duration
-Flood volume loss (upto 20 10^6 m^3 during large floods, and ~1.5 10^6 m^3 during small flood events)

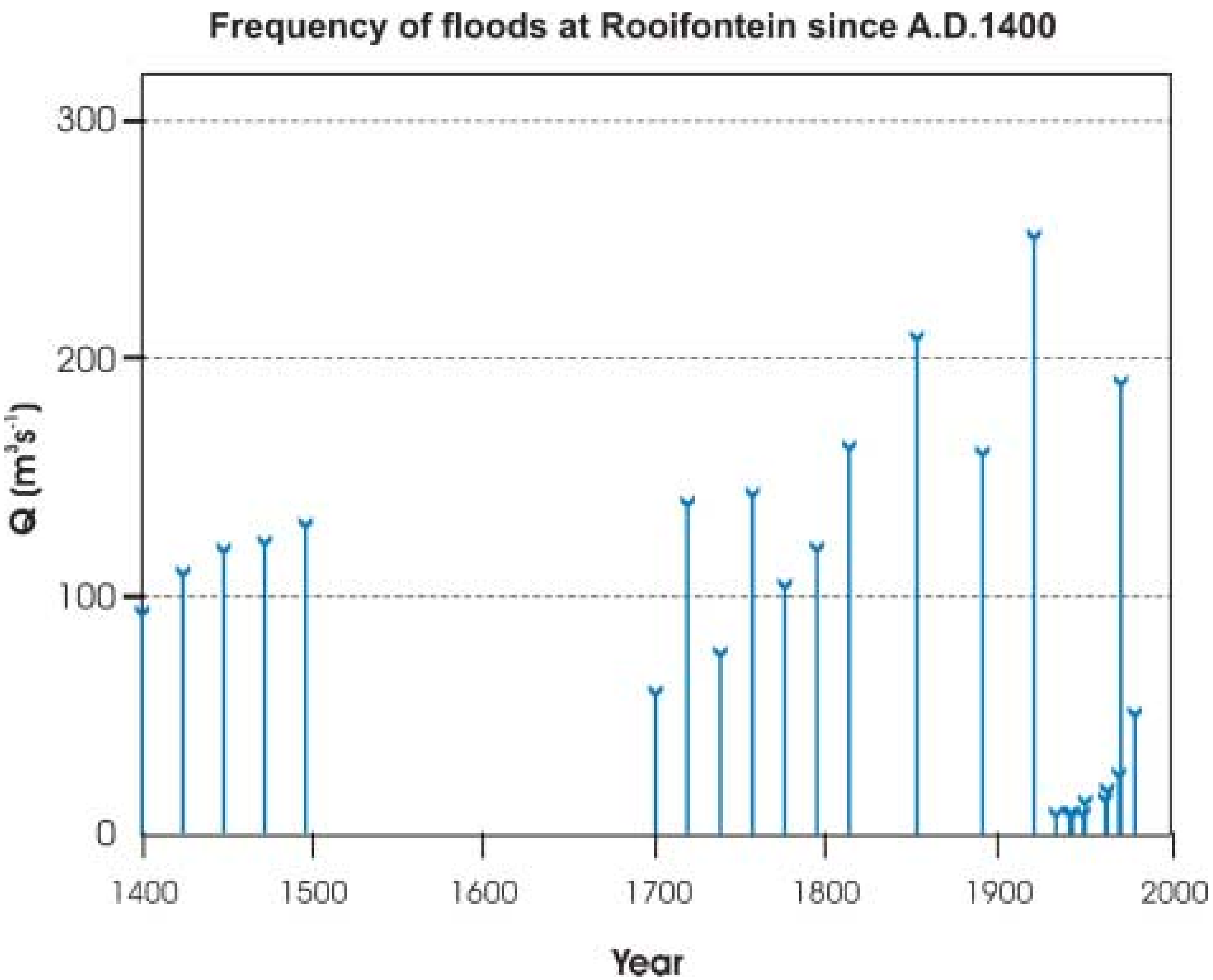

Flood level
indicators


Flood 7
Flood 6
Flood 5
Flood 4
Flood 3
Flood 2
Flood 1

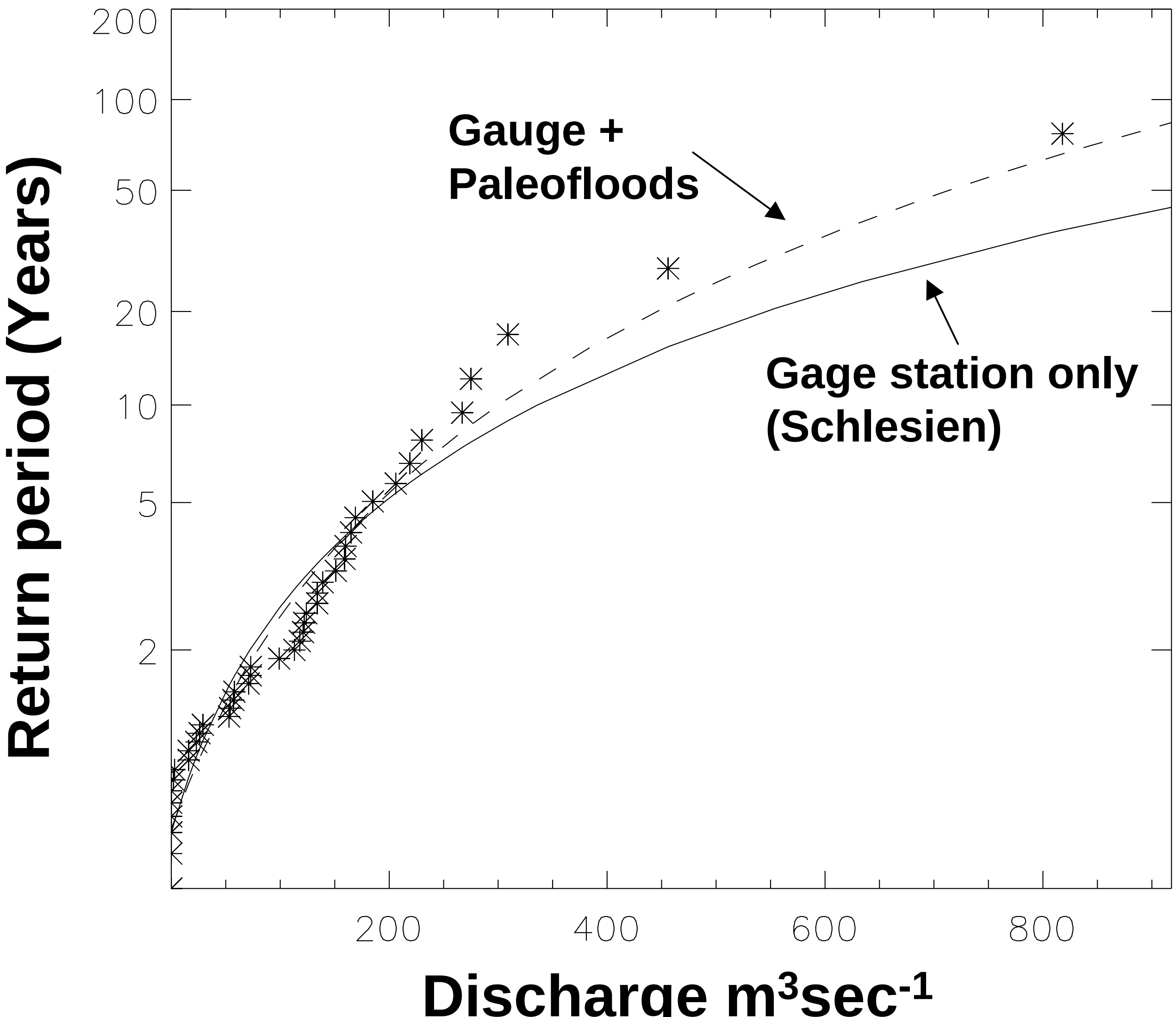


Site K-400
KT 8
Ca. 1600 yr BP
KT 6
Ca. 300 yr BP
Ca. 400 yr BP
Ca. 600 yr BP
Ca. 1000 yr BP
KT 7
Ca. 70 yr BP
Ca. 300 (120±20) yr BP
Ca. 400 yr BP
Ca. 500 (290±20) yr BP
Ca. 600 yr BP
Ca. 600 (470±35) yr BP
Ca. 700 yr BP
Ca. 1100 (650±650) yr BP
KT 5
Ca. 500 yr BP
Ca. 700 yr BP
Ca. 800 yr BP
Ca. 1200 yr BP
Ca. 1300 yr BP
* OSL Samp
KT 9
KT 5
KT 7
KT 4
KT 1
KT 6
KT 8
KT 2
KT 3
Kuiseb River
N
Legend
Flood bench +8-9 m
Flood bench +2-3 m
Alcove with SWD
Bench scarp/ landslide scarp
river pool
Lateral flow
Bedrock

Buffels River: Flood Frequency

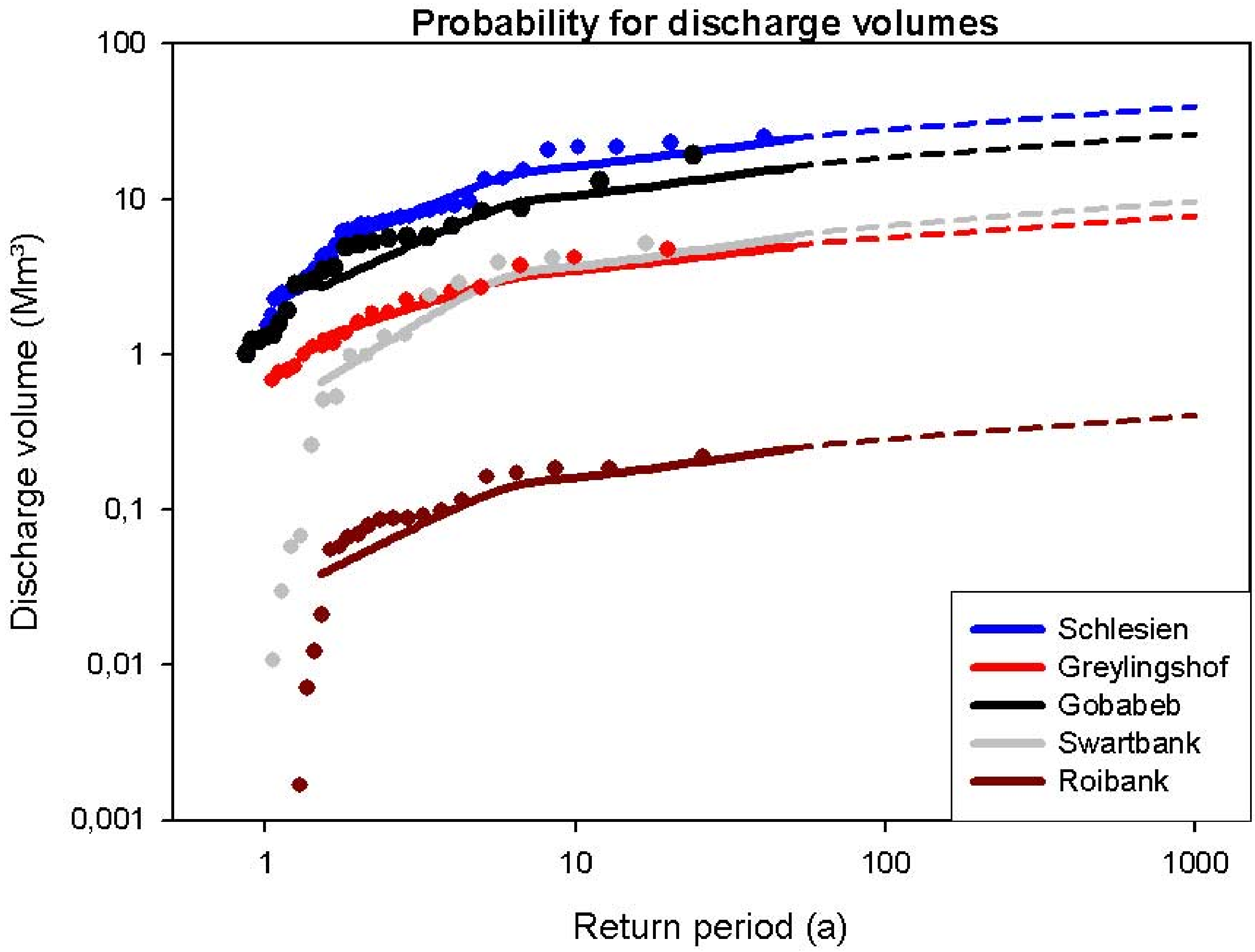


GEV Distribution fitting palaeoflood data from the Kuiseb river

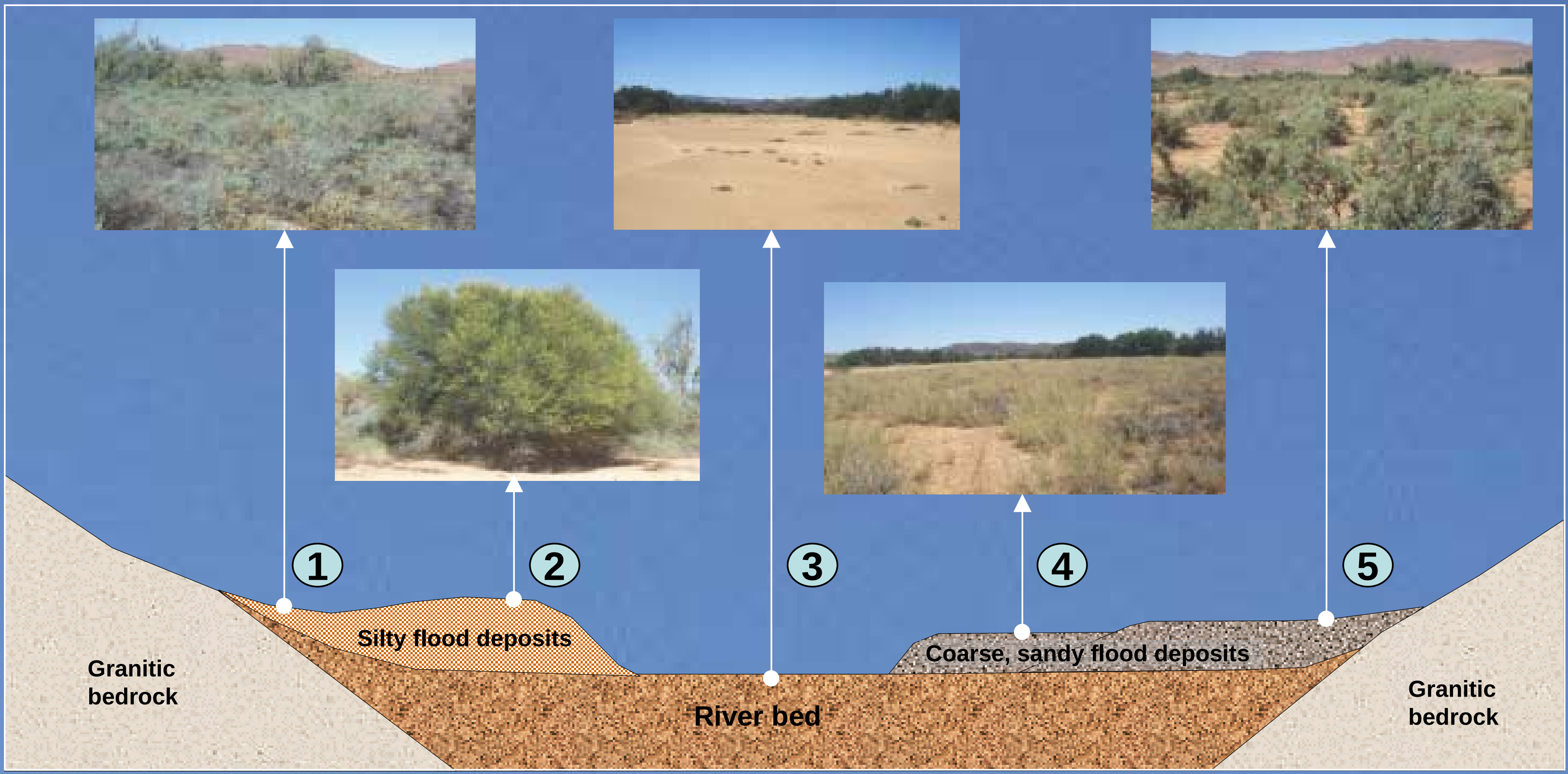


	all data m^3s^{-1}	Gauge only m^3s^{-1}
Q5	195	190
Q10	335	300
Q50	990	710
Q100	1530	1000
Q500	4000	2100

Distribution fitting discharge volumes for Kuiseb river

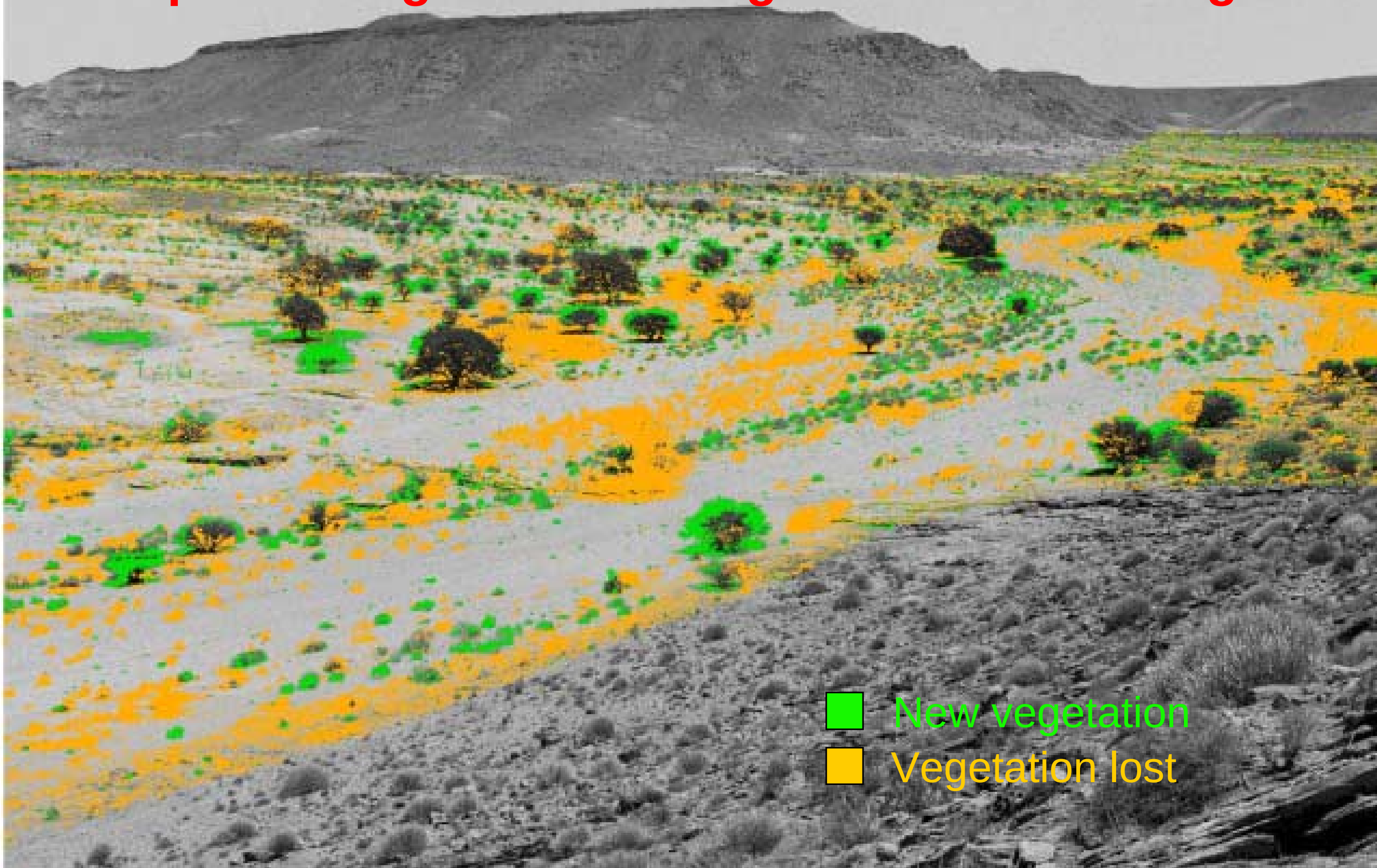


Role of riparian vegetation on floodwater infiltration and water consumption



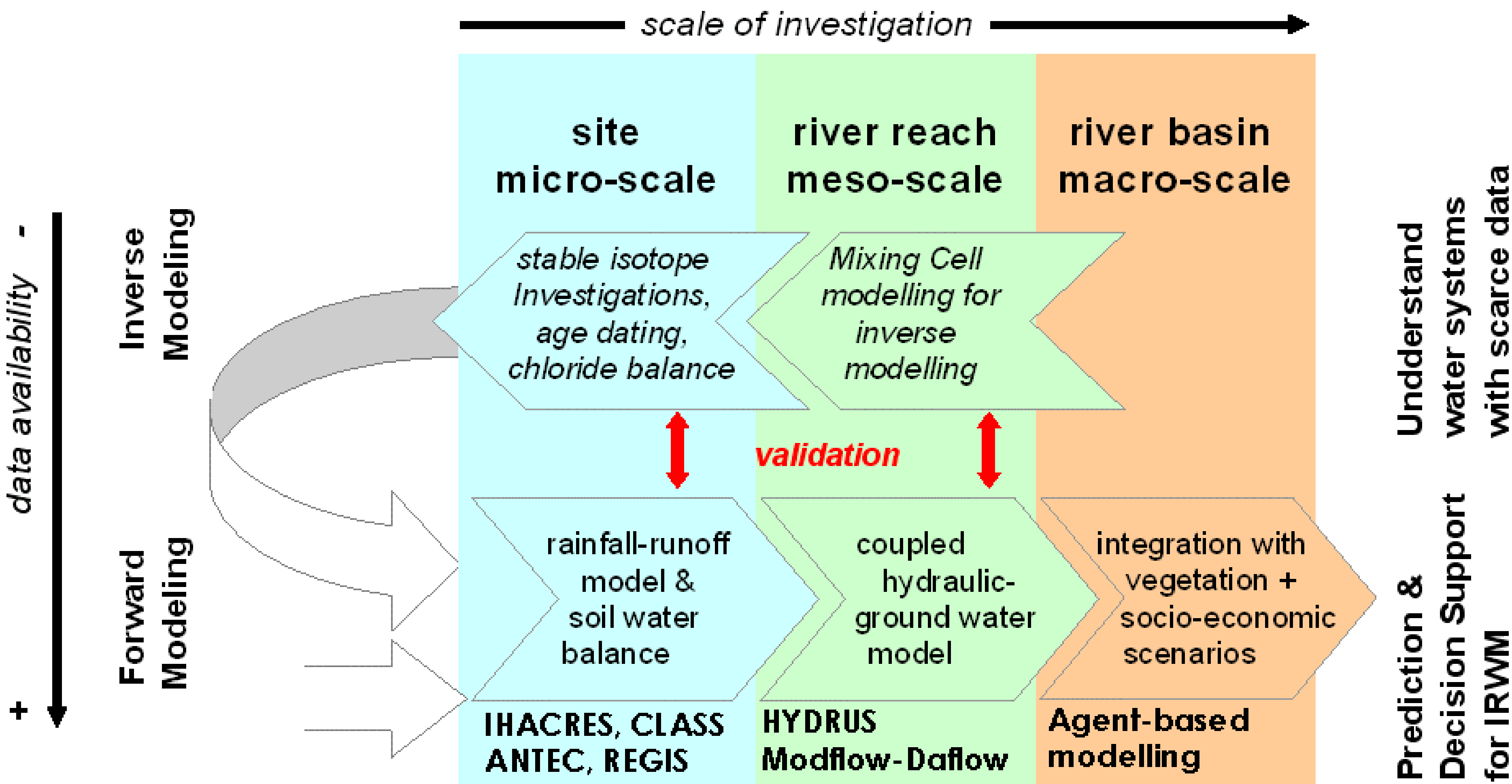
Plant communities of the Buffels River are strongly controlled by edaphic (environmental) factors. The above communities represent the dominant plant communities of the Buffels River. Only Communities, 1, 2 and 5 are important from a hydrological perspective.

Environmental History:
Riparian Vegetation Changes & Global Change

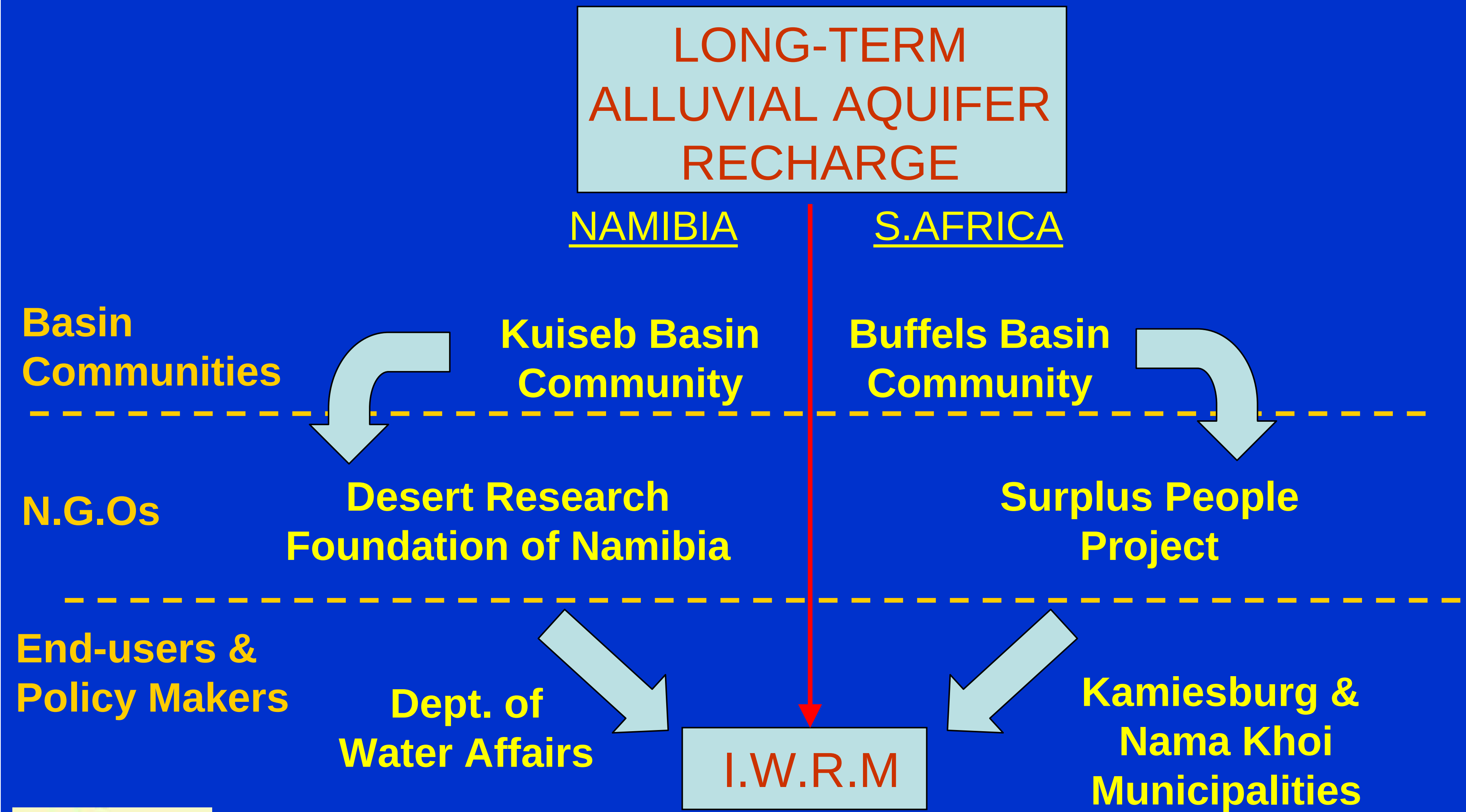


2005

Integrated modeling approach for WADE, adapted to dryland research and IWRM



Community Participation & Integrated Water Resource Management



Scientific Achievements of the WADE project (1)

- The monitoring system allowed accurate and detailed understanding of the infiltration process.

- The infiltration rate and final groundwater recharge is dependent on the flood duration and stream channel width.

- WADE results shows that floodwater recharge is predictable in ephemeral channel systems.

- Palaeoflood data allowed the reconstruction of flood magnitude and frequency of extreme events over the last 600 years at the study areas. Flood patterns were influenced by climate variability, and a similar behaviour is expected for the future.

- Active groundwater recharge sections were identified as well as its average long-term recharge sources and rates.
- A model coupling process-based vadose zone to groundwater recharge is being formulated, which will become an important input to the IWRM in dryland areas.
- The role of riparian vegetation on groundwater recharge and demands has been quantified. Overdraft impacts on environment are being evaluated.
- Local awareness of the water resource potential has been increased through active community participation and regular public information.
- Wade provides scientific bases and reliable data to be incorporated by water management decisions. A report on IWRM is being draft.
- Active participation of WADE end-users (DWA, Municipalities, NGOs..) and local scientists are being critical on project results exploitation and dissemination.

Contribution to water resource management

- Evaluation of groundwater resources at the different studied catchments, current recharge, and future recharge perspectives (evaluation of sustainable yields).

- Public information on “good practices” for the exploitation and conservation of groundwater resources.

- Evaluating the human dimension of the water resource scarcity and quality problems in relation of poverty and gender issues, which can be used to reduce these problems in future policy.

Leasons learnt

- Field data collection (monitoring, sampling,..) is the bases for understanding recharge rates and processes.
- Models are used for regionalisation of on-site field data, and gain credibility after calibration and validation with field data collected specifically for purpose of the study.
- Need for multidiscliplinary/transdisciplinary studies, linking scientific results with ground problems.
- Water managers expect reliable and robust data on water resources and recommendations on how to improve water management practices.
- Encourage active involvement on EU projects of local scientists which are the seed for further dissemination of results and knowledge beyond the project duration.

WADE Participants

Consejo Superior de Investigaciones Cientificas
CSIC

Hebrew University of Jerusalem
HUJI

HYDROISOTP gmbh
HY

Desert Research Foundation of Namibia
DRFN

University of Edinburgh
UEDIN

University of Cape Town
IPC

Institut National de la Recherche Scientifique
INRS

Ben Gurion University
BGU

Ministry of Agriculture, Water & Rural Development, Namibia
MAWRD

Surplus People Project
SPP

Kamiesberg (KM) and Nama Khoi Municipality (NKM)


Thanks for your attention!!
WADE
www.wadeproject.info

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