Ecosystem Services of Riparian Ecosystems

Report on workpackages

4.1.2 and 4.2.1 (PI Disse), 4.1.4 (PI Cyffka), and 4.2.2 (PI Thevs)

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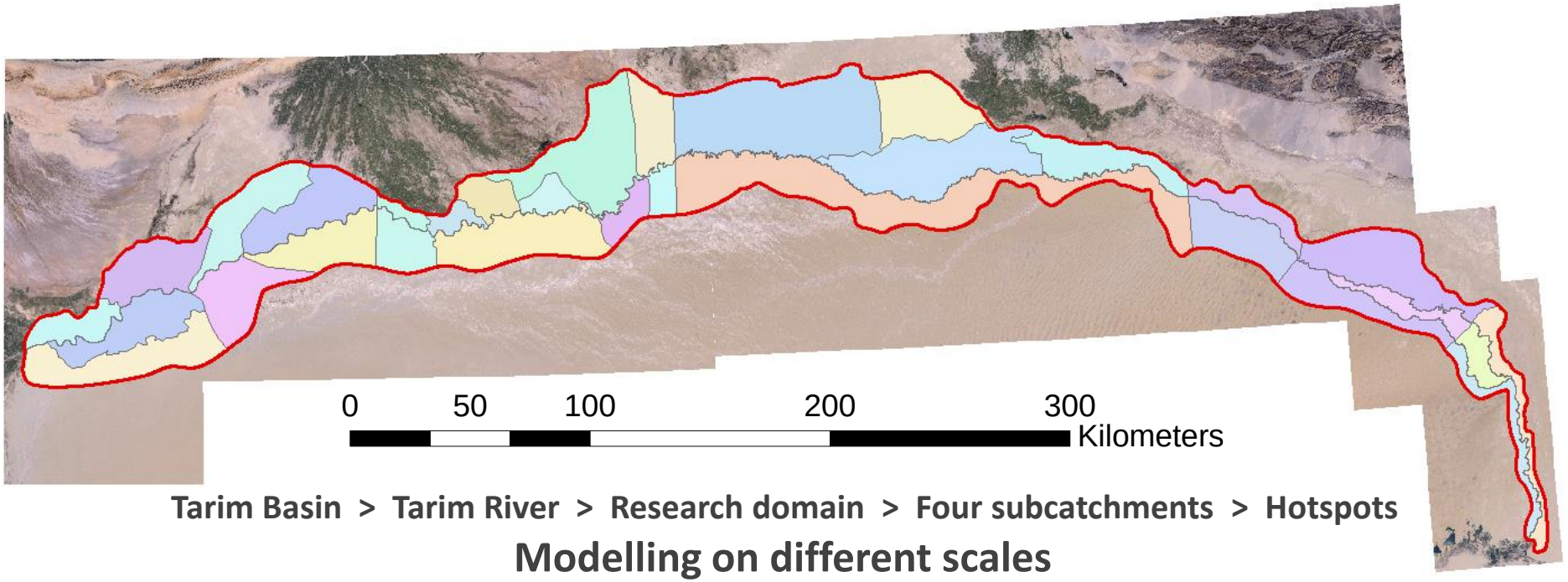
Regional water balance of riparian forests including groundwater and -salinity (4.1.2)

Water balance of extensive land use systems depending on groundwater table (4.2.2)

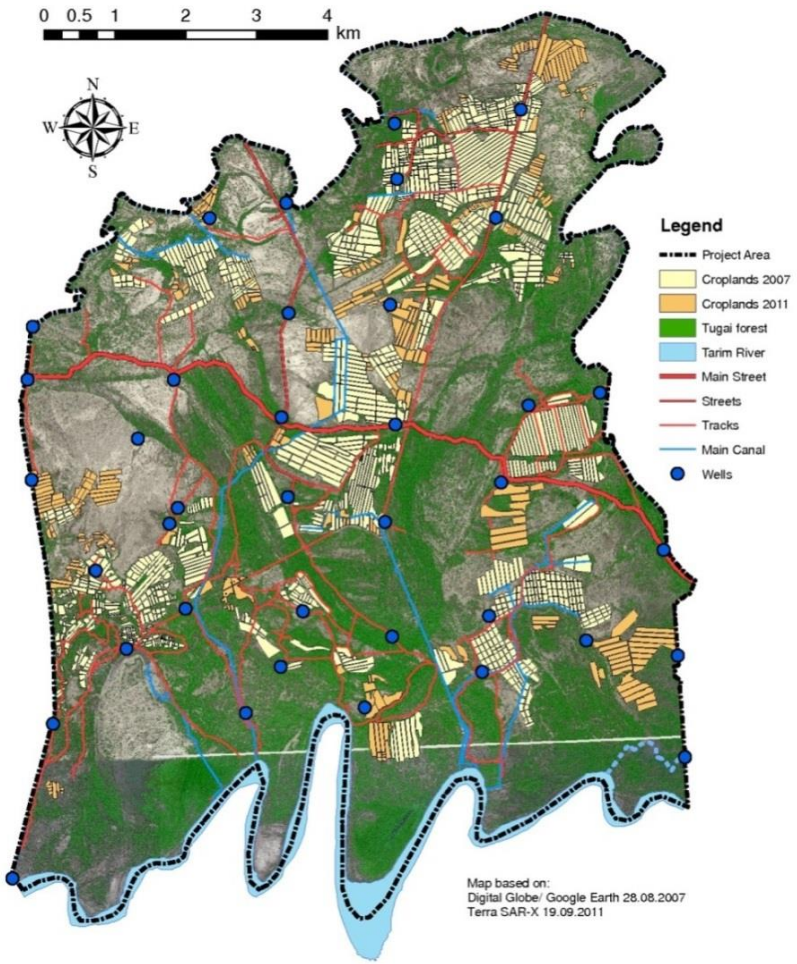
PI Prof. Dr. Markus Disse

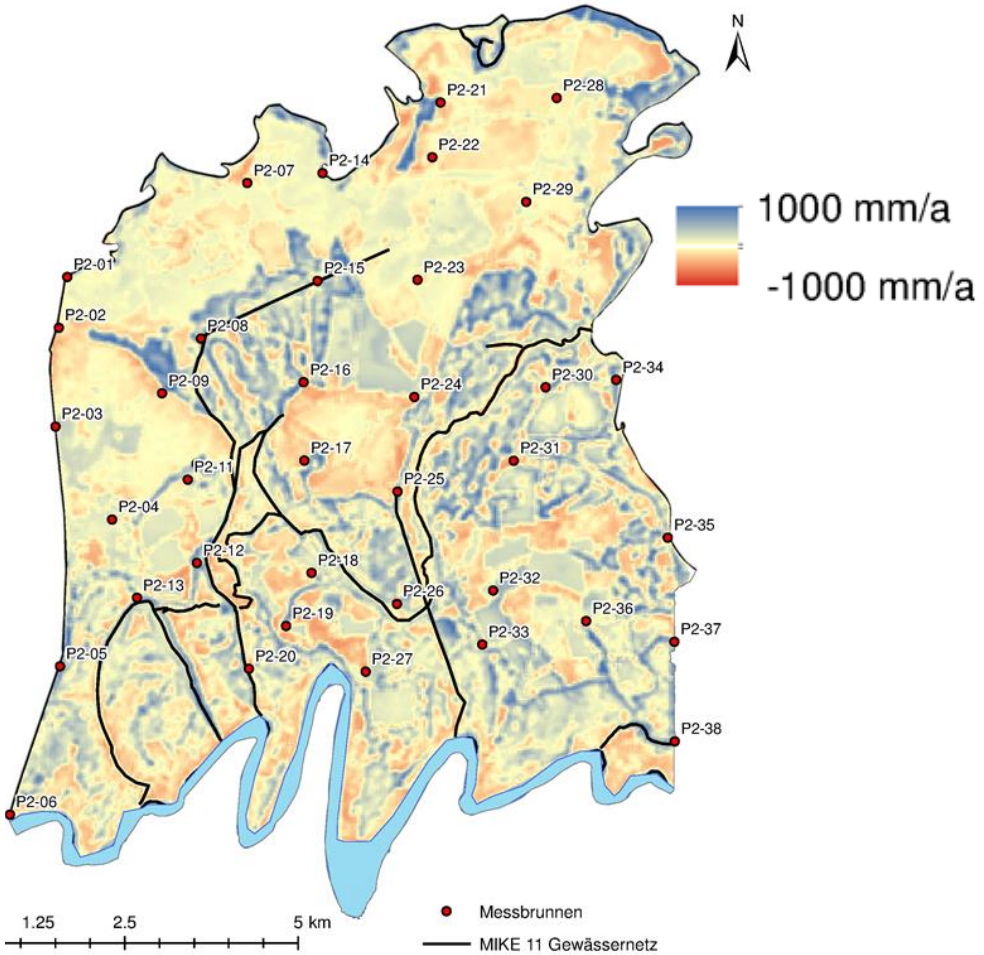


Tarim Basin > Tarim River > Research domain > Four subcatchments > Hotspots

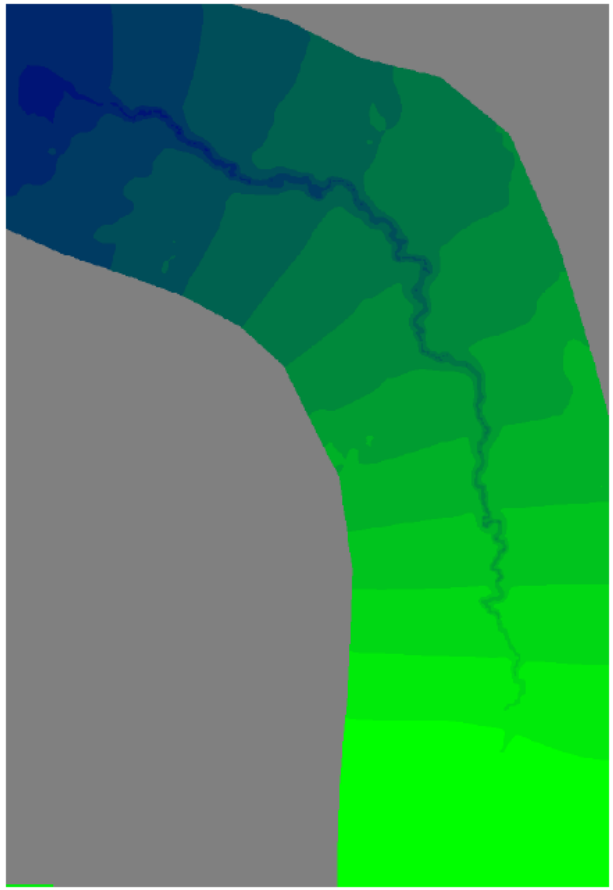
Modelling on different scales

Spatially distributed modelling of groundwater recharge and impact of land use and climate change at Yengibazar (Tarim River middle reaches)

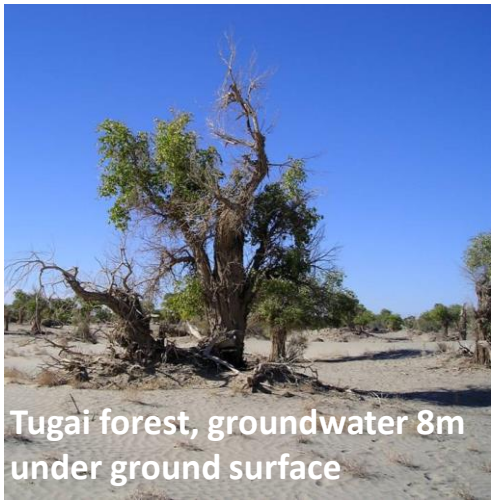




Spatially distributed modelling of groundwater recharge and impact of land use and climate change at Yengibazar (Tarim River lower reaches)



- Starting at the Daixihezi Reservoir
- Remaining land-use: Tugai forests
- Periodical ecological floodings



Tugai forest, groundwater 8m under ground surface

Tugai forest, groundwater 3.5 m under ground surface

Tugai forest, groundwater 5 m under ground surface

Protective functions and sustainable use of riparian forests (4.1.4)

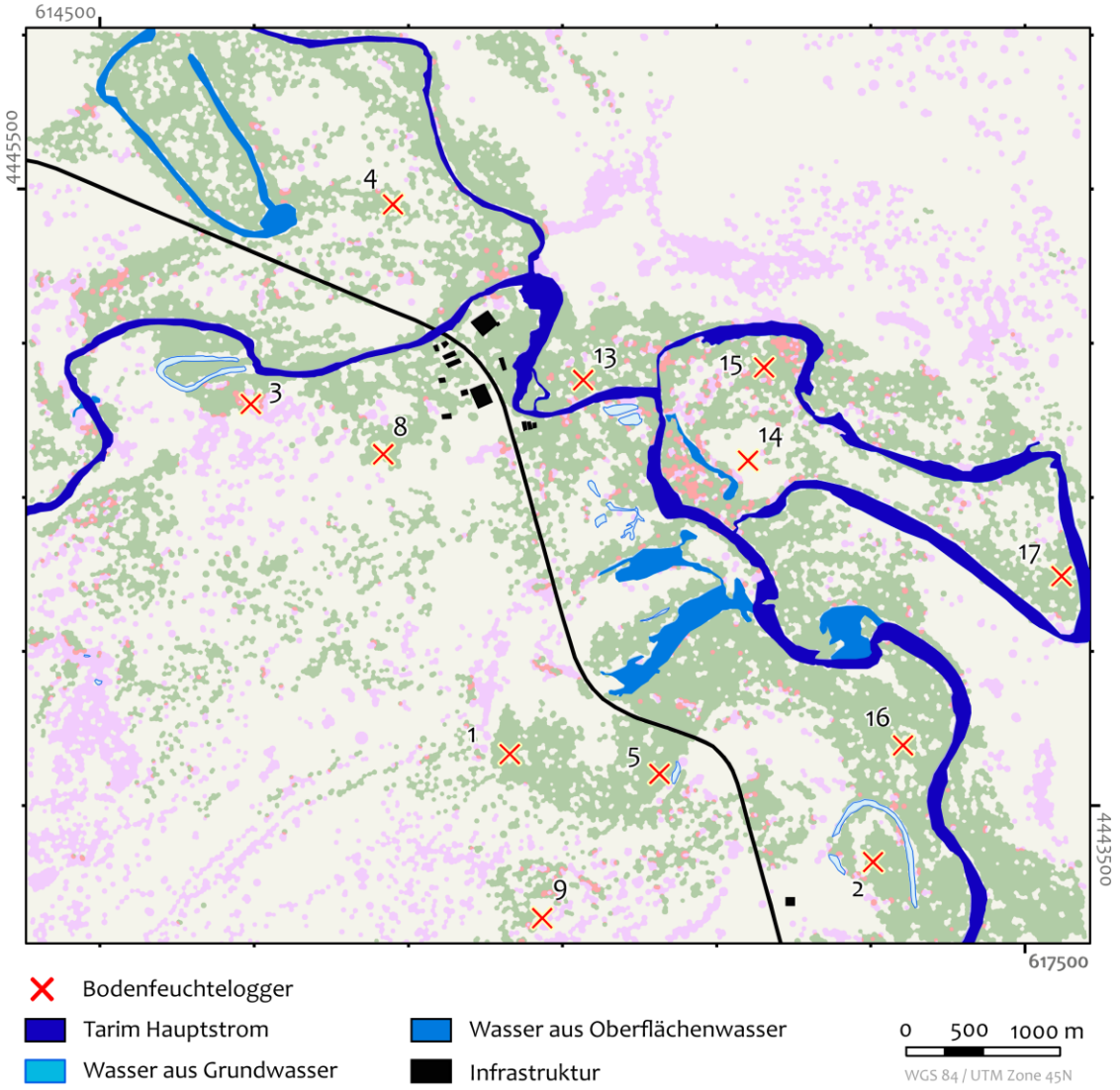
PI Prof. Dr. Bernd Cyffka

- Connection between soil moisture and vegetation condition
- Carbon storage of Tugai forest
- Sand and dust retention

Connection between soil moisture and vegetation condition

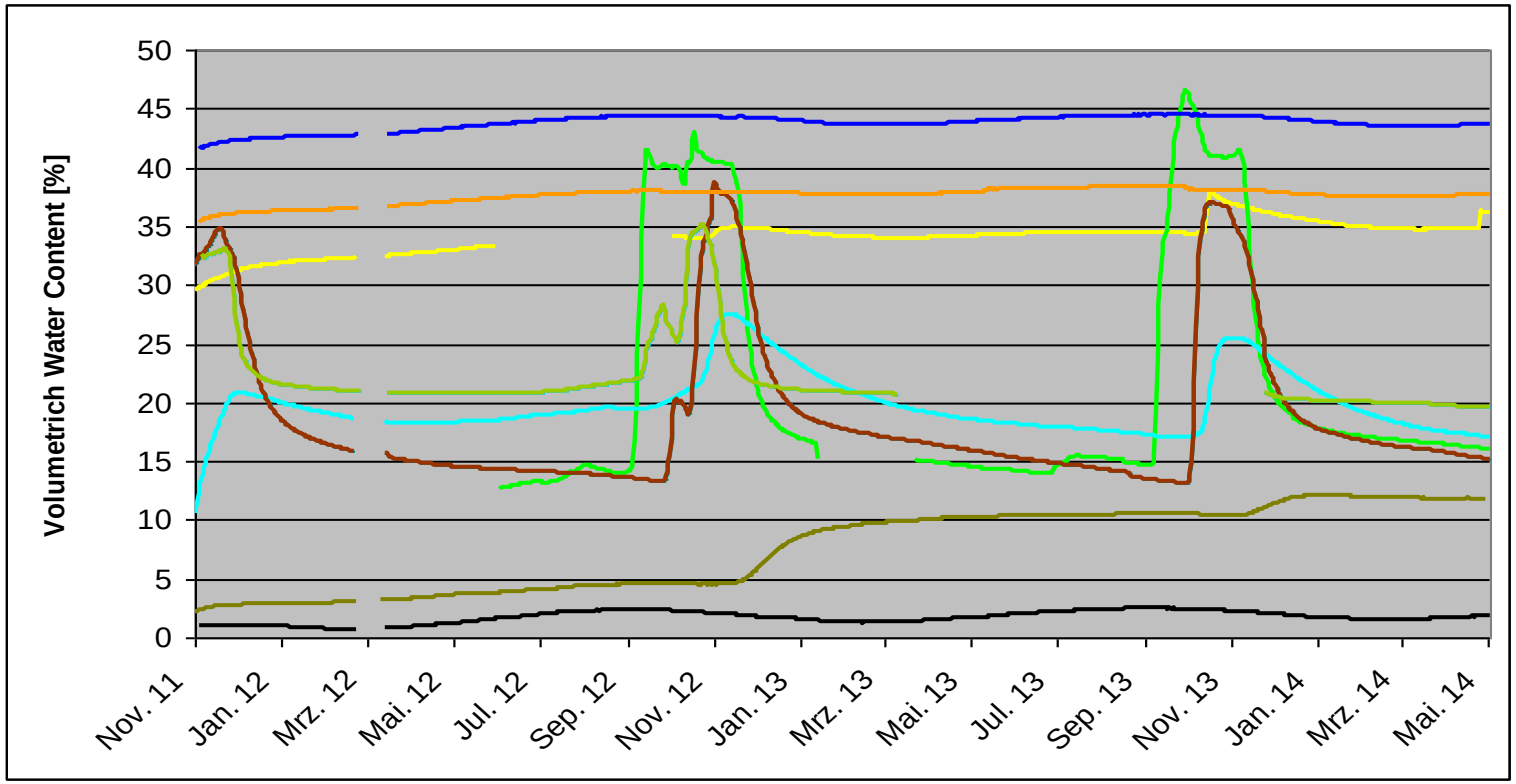
- Soil moisture:
  - 15 loggers, 3 sensors each, in different depths
- Vegetation:
  - Classification in classes of age and condition of plot scale

Result: Higher soil moisture correlates with share of young trees and share of trees in 'very good' and 'good' condition!
Co-influencing factor: distance to surface water!



Connection between soil moisture and vegetation condition

Indifferent reaction of soil moisture on ecological flooding

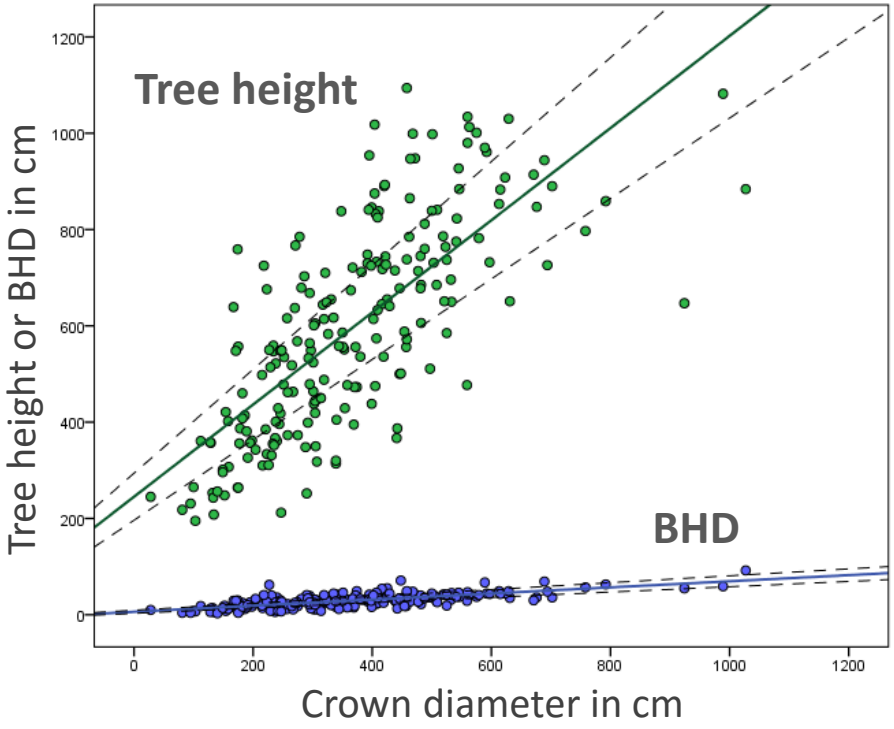


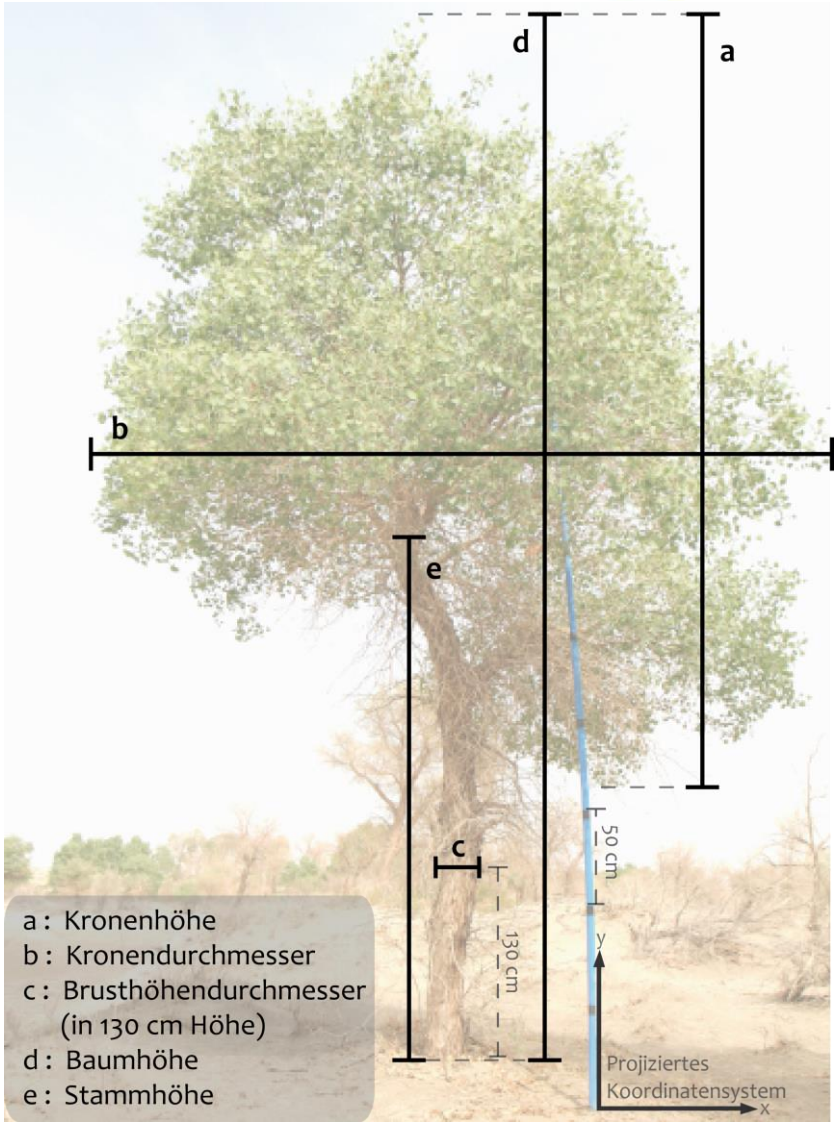
Key:
Colors represent different soil moisture sensors at 150 cm depth

- **Very high variations between the plots**
- **Some with high response to ecological flooding, others not**

Carbon storage of Tugai forest

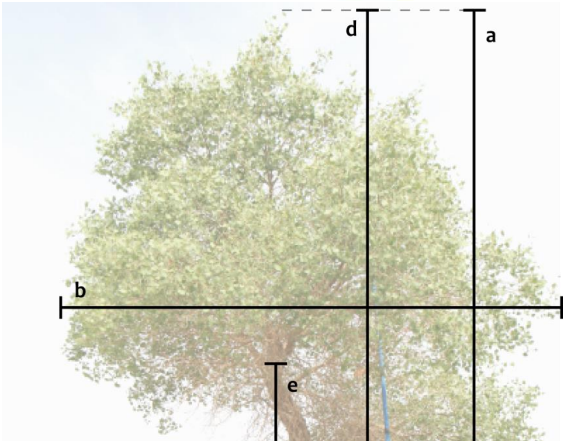
- Set-up of regression between crown diameter and biomass
- Photogrammetric data of 209 trees in study area





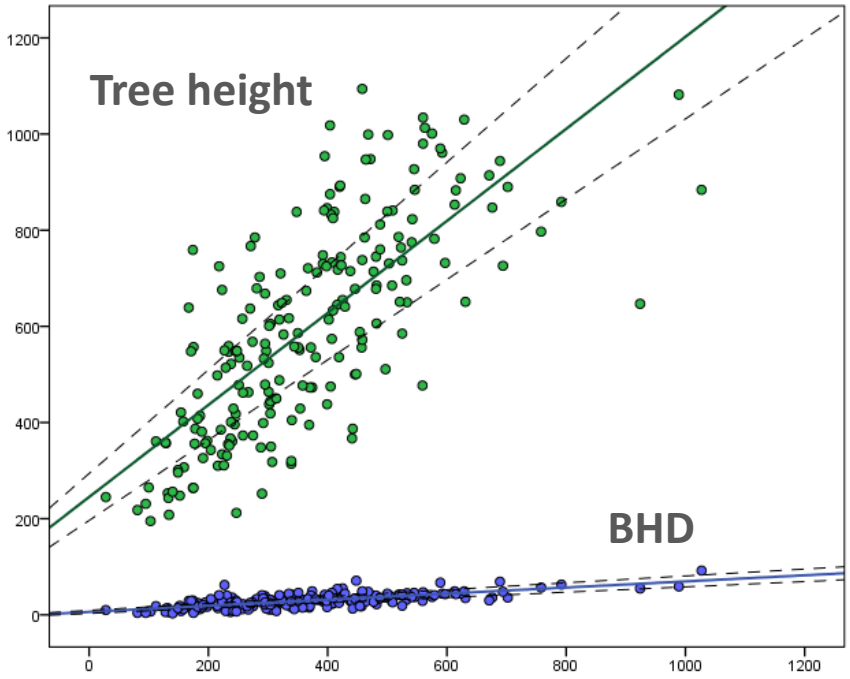
Carbon storage of Tugai forest

- Set-up of regression between crown diameter and biomass
- Photogrammetric data of 209 trees in study area
- Mapping and measuring of crown diameter of ALL trees from satellite imagery



➢ Calculation of carbon stored in study area and upscaling to the lower reaches

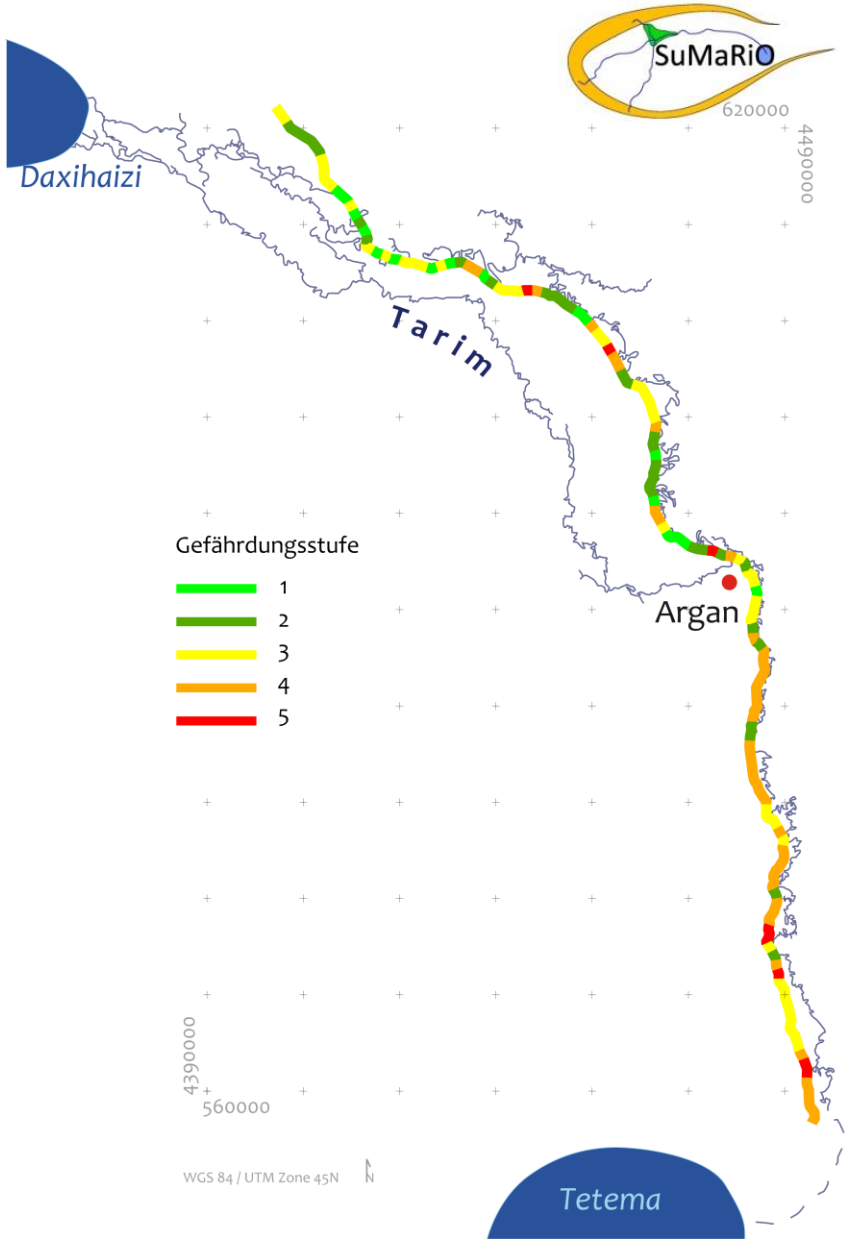
➢ **Monetary value of ESS: 16,000,000 €**



Sand and dust retention

- Calculation of costs avoided for road maintenance
- Set-up of a wind-erosion-model for study area (main influencing factors: grain size and vegetation density)
- Mapping of hazard potential for entire highway N218 (lower reaches)

➢ **Avoids costs for this ESS: approx. 240,000 € per year**



Ecology, productivity, and ecosystem services of Phragmites and Apocynum (4.2.2)

PI Dr. Niels Thevs

Periodical water shortage along the Tarim River, e.g. 2007-2009 led to unreliable water supply for downstream region of Tarim River

Soil salinization due to insufficient irrigation management makes it necessary that alternatives that yield income on saline land under irregular water supply are needed

Plant species of the natural vegetation that yield income under unreliable water supply and their ESS

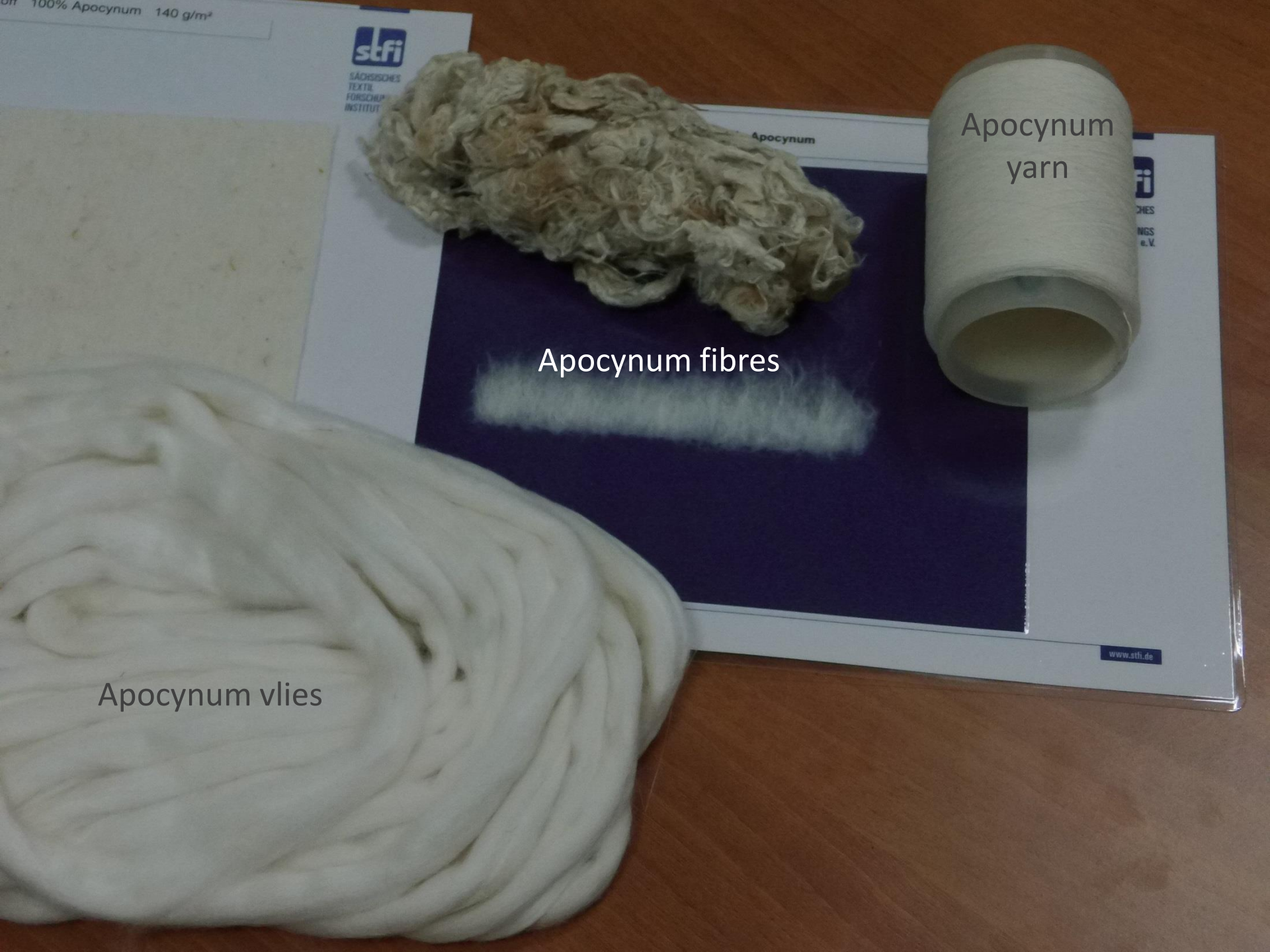



Plant species ESS	*Phragmites australis*	*Apocynum* spec.	*Glycyrrhiza* spec.	*Alhagi* spec.
Fodder	■	■	■	■
Medicinal products		■	■	■
Fibres, textiles		■		
Raw material	■			

Knowledge about *Apocynum* from former Soviet Union

- Traditional utilization as fibre for centuries
- Systematic utilization started in 1927
- 65,000 ha under *Apocynum* in today's Turkmenistan before 1960s
- Fibre yields up to 780-900 kg/ha
- Industrial textile utilization started in 1930
- Propagation through root pieces or seed germination in a nursary
- In 1960s cotton was promoted over other fibres and planted in large scale in the Aral Sea Basin

- Fibre properties are similar to cotton
- Processing with standard textile machinery is possible
- Yarn is similar to flax (linnen)
- Fibres have good aeration properties
- *Apocynum* usually is blended: 70% cotton, 30% *Apocynum*


100% Apocynum 140 g/m²
stfi
Apocynum
Apocynum yarn
Apocynum fibres
Apocynum vlies
www.stfi.de

Site conditions and stem biomass yields from *Apocynum*

Site: Qongaral (Q) Xayar (X)	Ground-water [m]	EC at ground-water [mS/cm]	EC of topsoil 0-5 cm [mS/cm]	Stem biomass July 2011 [t/ha]	Stem biomass Oct. 2011 [t/ha]
Q1	5.2	1.57	18.7	0.34	1.23
Q2	4.3	1.86	16.5	0.49	-
X1	1.7	0.88	8.8	1.14	1.4
X2	1.3	1.36	10.5	0.65	0.56

- Sites were partly grazed. Plot with no grazing – 2.4 t/ha stem biomass (X1). Interviews revealed stem yields of 3 t/ha (≈ 300 kg fibres/ha).
- Topsoil salinity is higher than threshold for cotton (7.7 mS/cm*).

*Maas , E., Hoffman, G. (1977). Crop salt tolerance, current assessment. *Journal of Irrigation Drainage Engineering. Div. ASCE* 103, 115-134.

Water consumption of cotton, *Apocynum*, and *Zyzyohus* (newly promoted fruit tree)

Month	May	June	July	August	October	Total growing season
Crop						
Cotton						
ET_0 [mm]		7.3	8.1	7.9	2.5	
ET_c [mm]		**0.6**	**4.1**	**6.3**	**1.3**	**524.7**
K_c		0.09	0.51	0.79	0.52	
A. pictum						
ET_0 [mm]	6.2	7.8	7.3	6.3	3.2	
ET_c [mm]	**1.5**	**1**	**1.8**	**1**	**0.3**	**217.2**
K_c	0.24	0.13	0.26	0.16	0.1	
Z. jujuba						
ET_0 [mm]		3.5	2.9	2.8		
ET_c [mm]		**2.4**	**2.7**	**2.4**		**339**
K_c		0.67	0.91	0.85		

Carbon and phosphorus footprint of *Apocynum* and cotton

	Cotton	*Apocynum*
Carbon footprint		
Climate footprint (emissions) [CO2e / kg fibre]	4.82	4.03
Energy footprint [MJ / kg fibre]	33.58	45.98
Phosphorus footprint [g P / kg fibre]	110.05	11.26

- **Energy footprint of *Apocynum* is higher than cotton due to assumption of chemical fibre extraction. Retting would reduce energy footprint considerably.**
- **Phosphorus footprint of *Apocynum* extremely low; *Apocynum* saves phosphorus, which is a limited fossil resource**

Conclusions and further research

- Water productivity (fibres per m^3 of water) of cotton 3-4 times higher than *Apocynum*
- *Apocynum* has potential to offer income opportunities (fibres and medicinal tea) on saline lands that cannot be used for cotton or other crops, e.g. Tarim lower reaches, Aral Sea region of Uzbekistan and Kazakhstan

Major research needs

- **Planting techniques**
- **Improvement of cultivars (breeding of *Apocynum*)**
- **Harvest technology and fibre extraction: retting or manual processing with chemical fibre extraction**

Now: Kendir goes west!

Building up experimental plots and approach partners in textile industry in Kyrgyzstan and Germany (www.kendir.org)