Multi-sensoral remote sensing of land cover and wetland habitats on the desiccated Aral Sea bed in southern Priaralye.

International conference
Aral: Past, Present & Future
Two centuries of the Aral Sea Investigations
13. – 15. October 2009

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F. Löw

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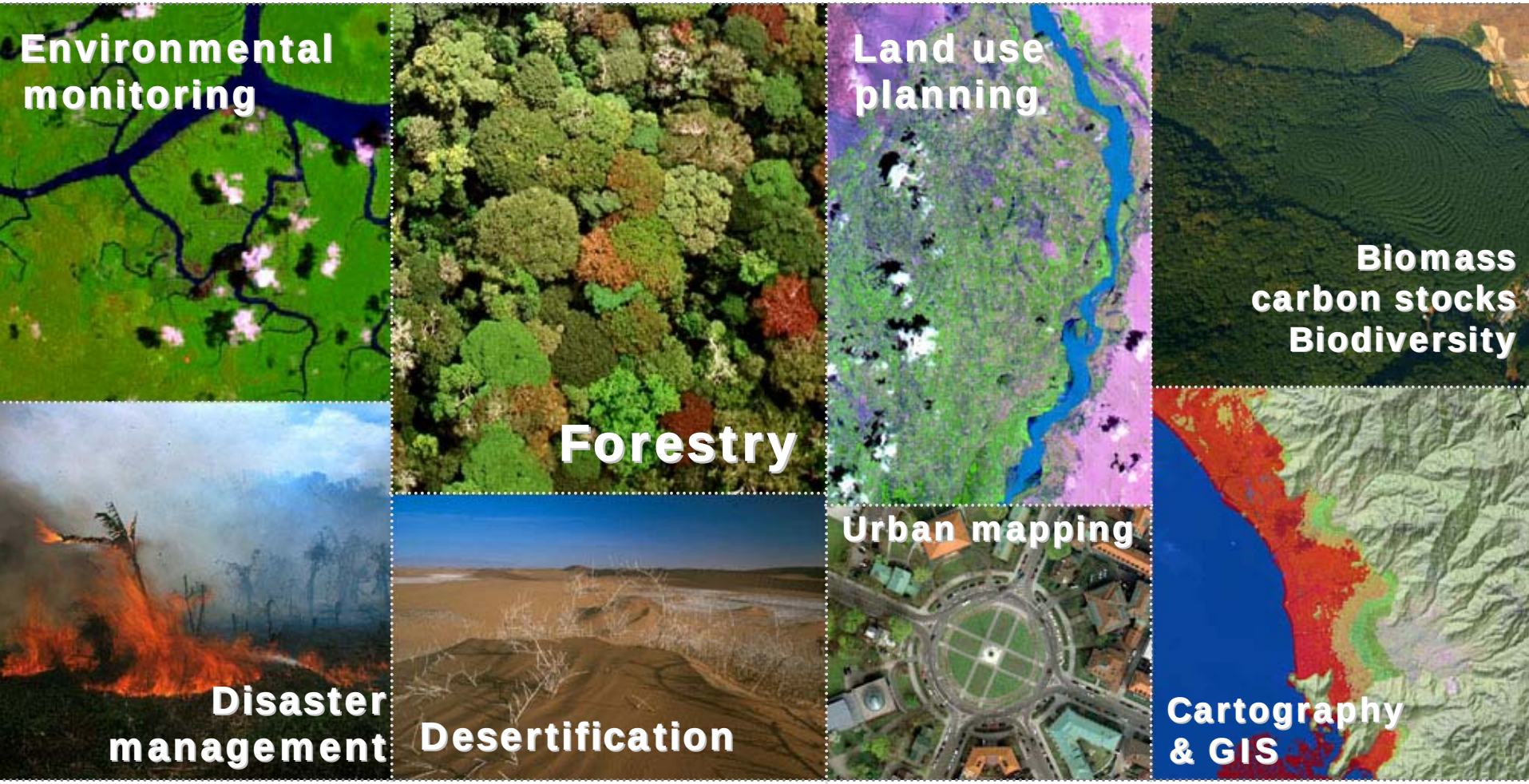
Spatial data applications



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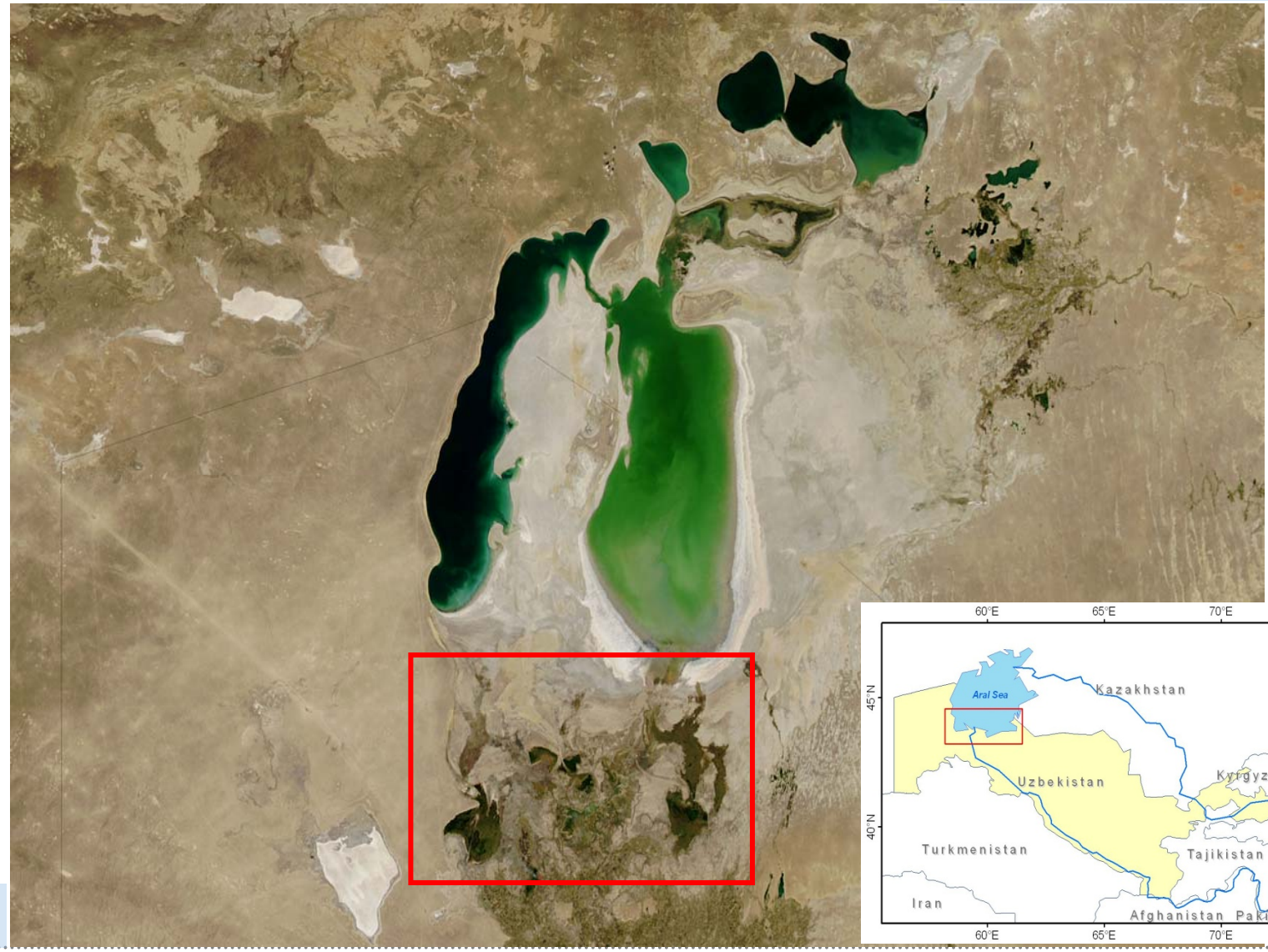
gtz

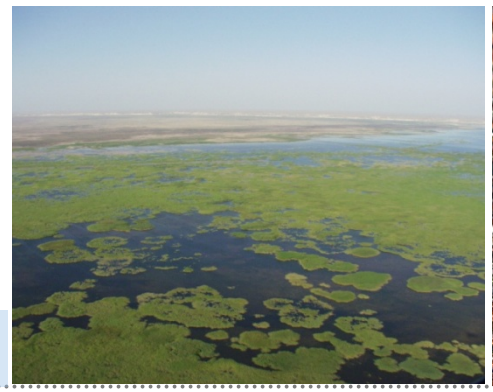
Study area: Wetlands in southern Prearalie



Wetland habitat mapping: Background

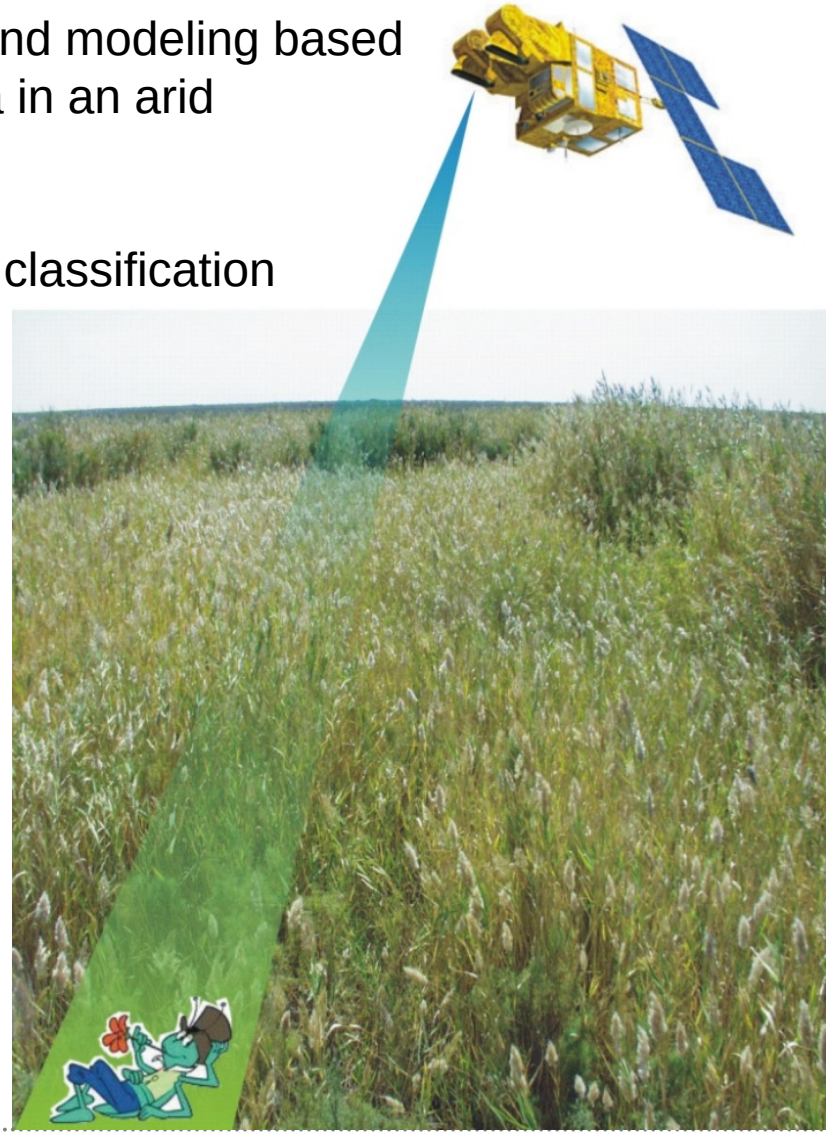
- GTZ-Project „Sustainable control of pest locusts in Central Asia“ (2002-2008)
  → Objectives: Implementation of modern, efficient and environmentally sound plant protection methods
- Large wetland areas in the Amu Darya Delta (ca. 500.000 ha)
- High intra- and interannual dynamics of the wetlands
- Optimal habitat conditions for the Asian Migratory Locust

→ **Need for a continuous Wetland-Monitoring for locust control**




Objectives

- Semi-automatic, object-based wetland modeling based on very high resolution satellite data in an arid ecosystem
- Evaluation of different object-based classification methods for wetland mapping
- Generation of habitat suitability maps for operational use by the locust control service



Used data

- Satellite data:

Acquisition date	Platform	Sensor	Mode	Processing level	Spatial resolution
16.07.2005	**SPOT-5**	**HRG**	**XS**	**2A**	**10 m**
16.07.2005	**SPOT-5**	**HRG**	**PAN**	**2A**	**2.5 m**
05.08.2006	**SPOT-5**	**HRG**	**XS**	**1A**	**10m**
23.05.2007	**SPOT-5**	**HRG**	**XS**	**1A**	**10m**

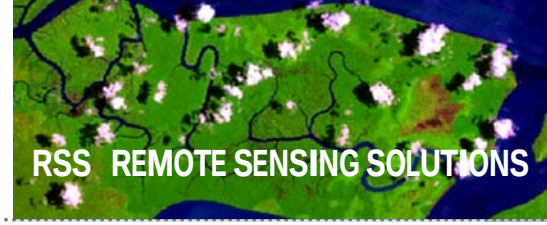
- Ground truth:

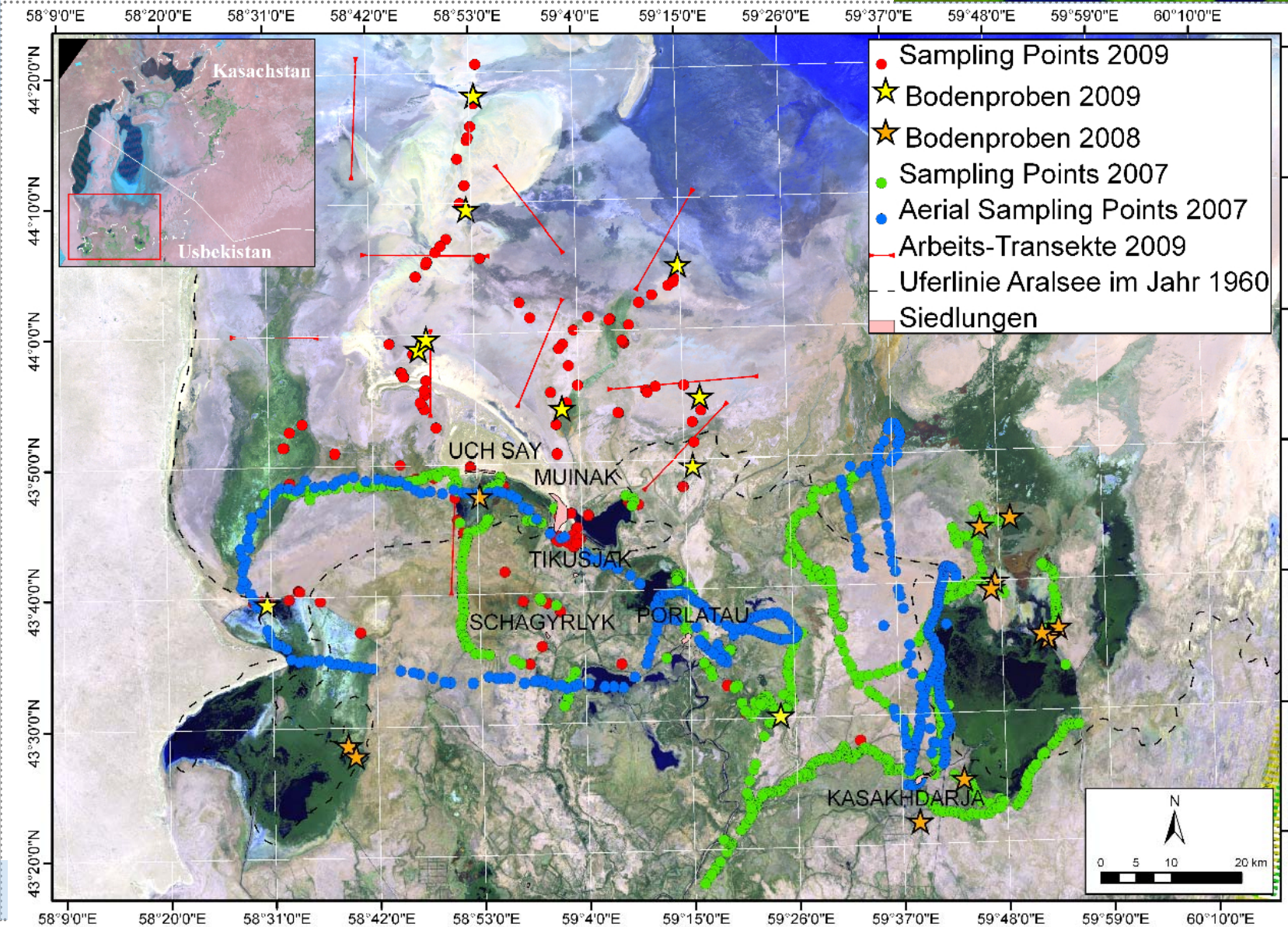
  - Vegetation mapping 2005 - 2008

  - Mapped features: Life form; dominant species; cover; growth height

  - based on FAO Land cover classification system (LCCS)

Ground truth campaigns 2007 - 2009

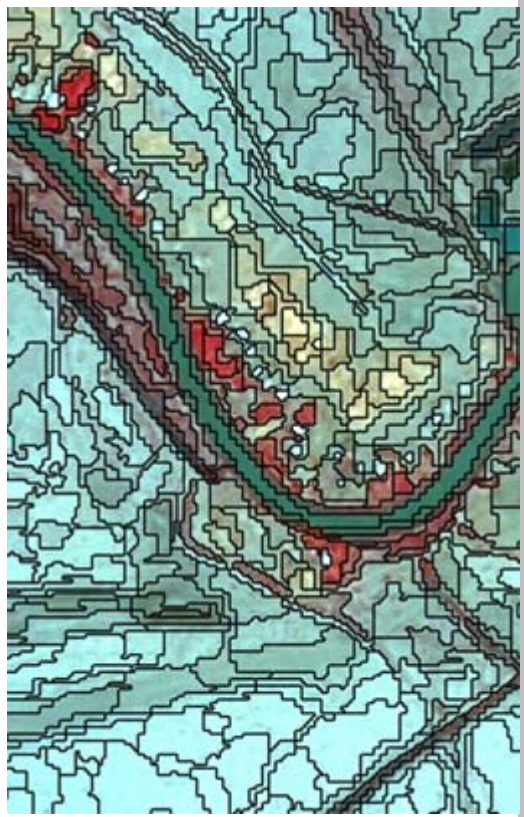




Preprocessing

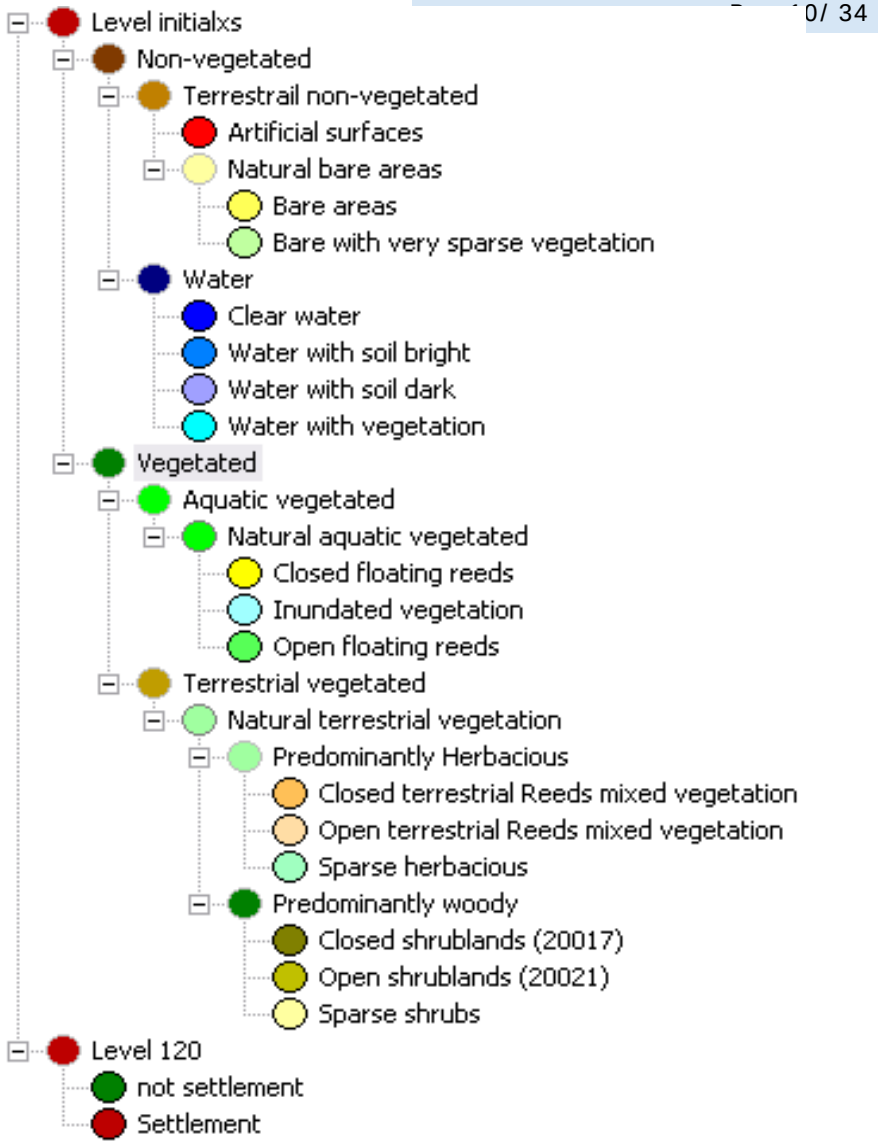
- Atmospheric & geometric correction
- NDVI
- Tasseled cap transformation
- Image segmentation

Layer	Description	Processing
Pan	Panchromatic scanner data	Atmospheric and geometric correction
green	Multispectral scanner data	
red		
nir		
swir		
Brightness	Tasseled Cap components	Tasseled Cap transformation of XS bands
Greenness		
Wetness		
NDVI	Normalized Difference Vegetation Index	Band Ratio of NIR and red bands

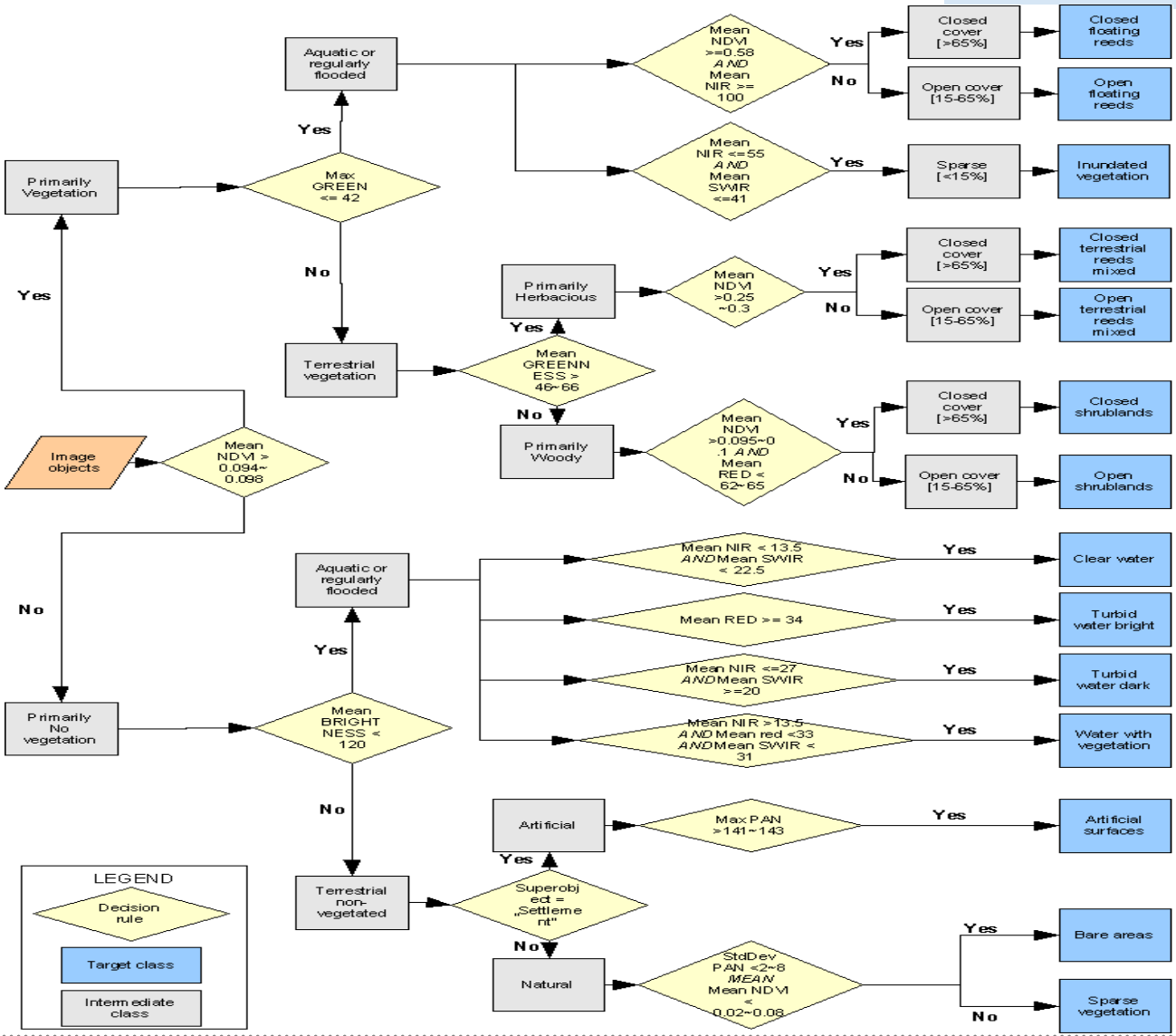


Classification appproach: Hierarchical fuzzy threshold classification (HFT)

Pre-defined class hierarchy, based on FAO LCCS:

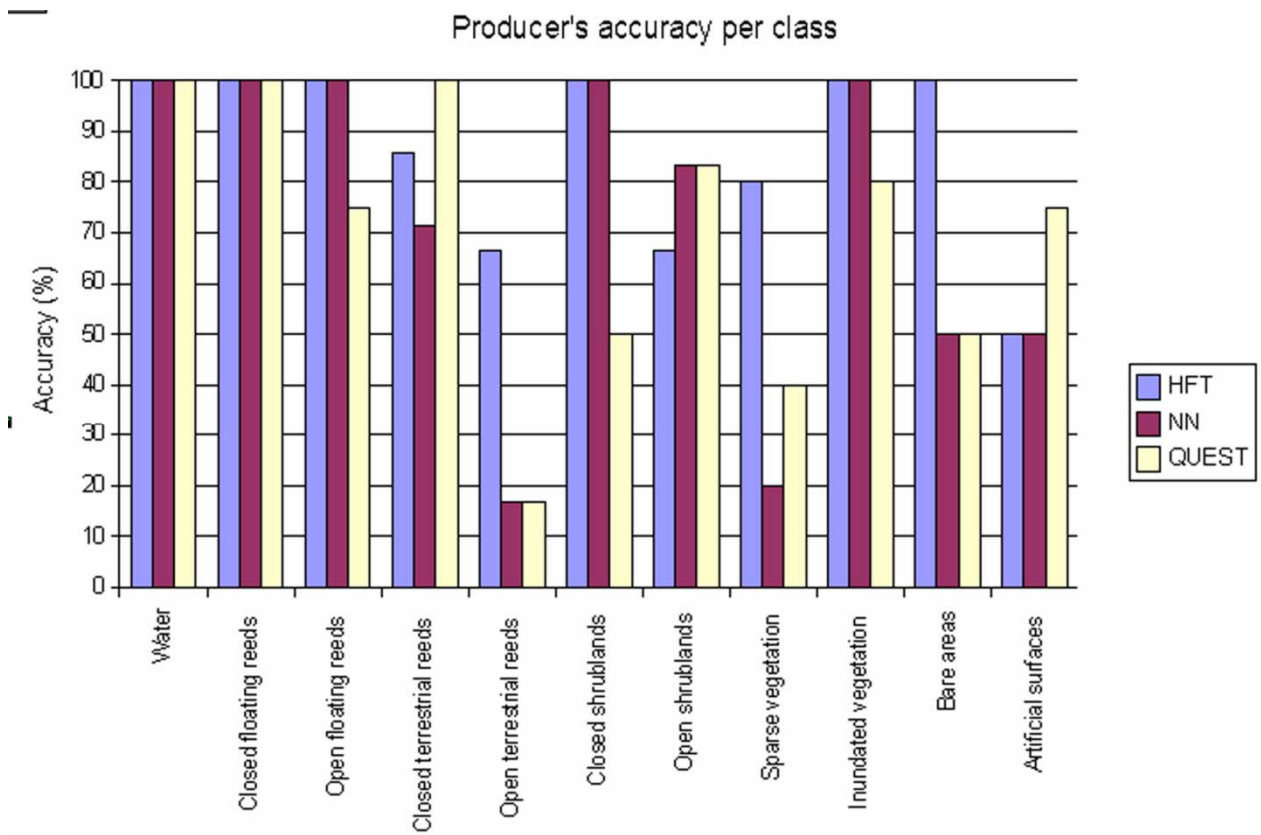


Classification appproach: Hierarchical fuzzy threshold classification (HFT)

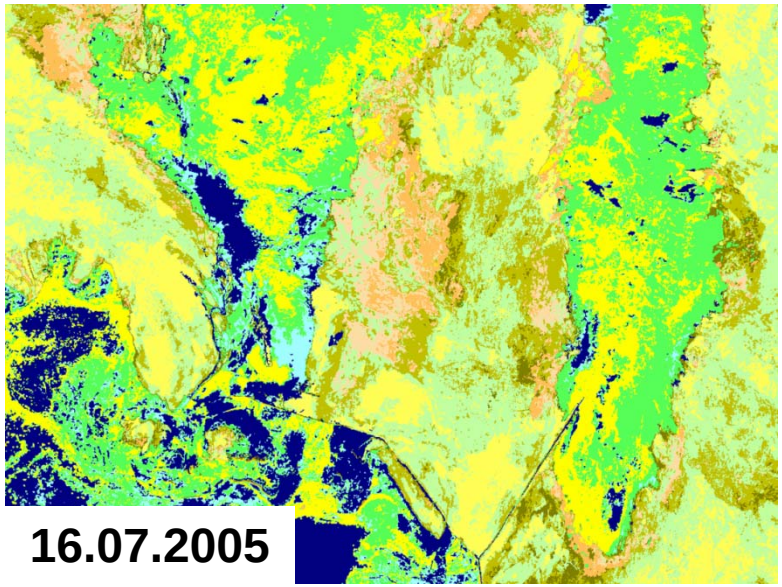


Results:
Accuracy assessment

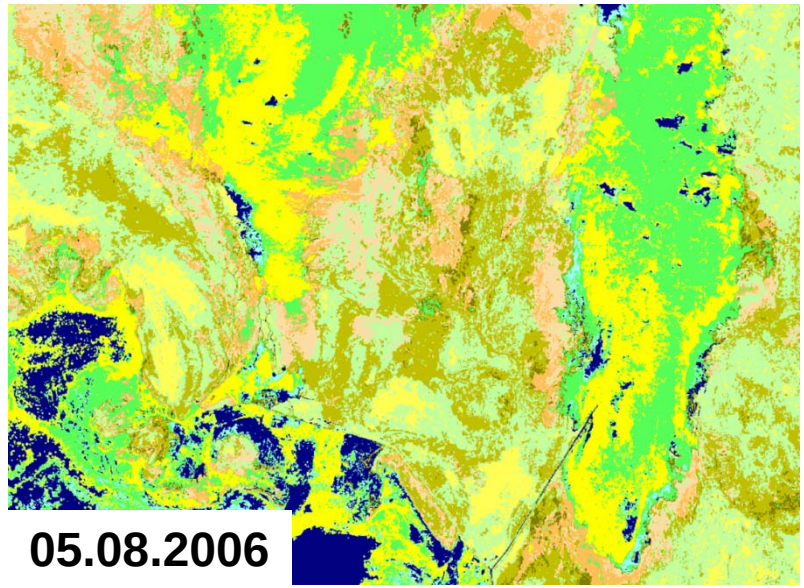
Method	Overall accuracy (%)	Kappa coefficient
Hierarchical Fuzzy Threshold (HFT)	**86.2069**	**0.8386**
Nearest Neighbour (NN)	**72.4138**	**0.6936**
QUEST	**72.4138**	**0.6930**



Results:
Transferability of the classification method onto new datasets



16.07.2005



05.08.2006

- Closed floating reeds
- Open floating reeds
- Closed terrestrial Reeds mixed vegetation
- Open terrestrial Reeds mixed vegetation
- Closed shrublands (20017)
- Open shrublands (20021)
- Bare areas
- Bare with very sparse vegetation
- Artificial surfaces
- Inundated vegetation
- Water

Rule-set threshold adjustments:
mean NDVI: +0.02
mean greenness: + 6

Reasons:

- minor differences in atmospheric calibration
- seasonal differences

Conclusions wetland monitoring

SPOT-5 data and object-based classification proved viable for monitoring wetlands and surrounding areas on the dry Aral Sea bed

- Accurate and robust classifications
- inter-annual transferability of the rule-set possible with minor adjustments
- Methodology suitable for a landscape monitoring system!

Impact assessment of afforestation measures on the dry Aral Sea bed

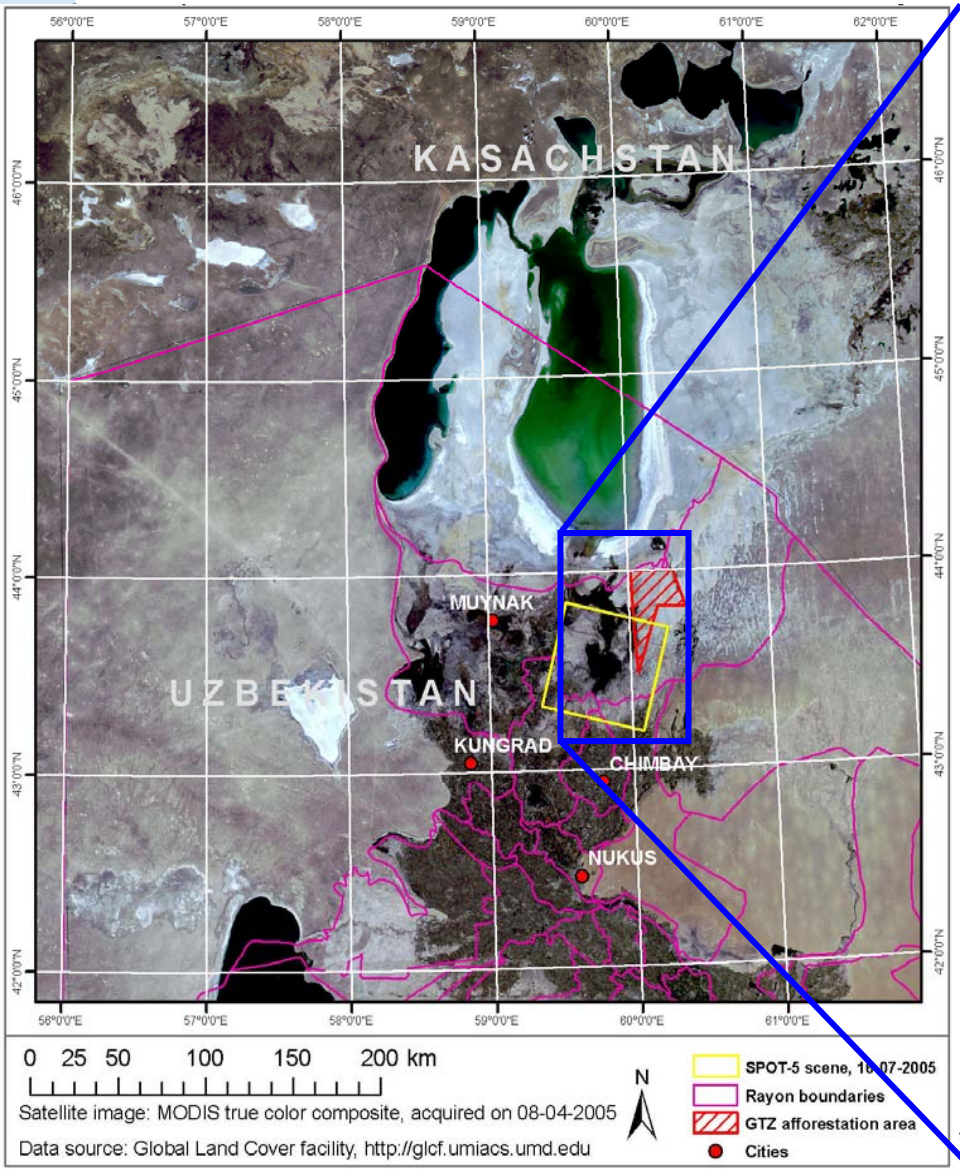
Framework: GTZ-project: “Stabilization of the desiccated Aral Sea bottom in Central Asia” (2000-2007)

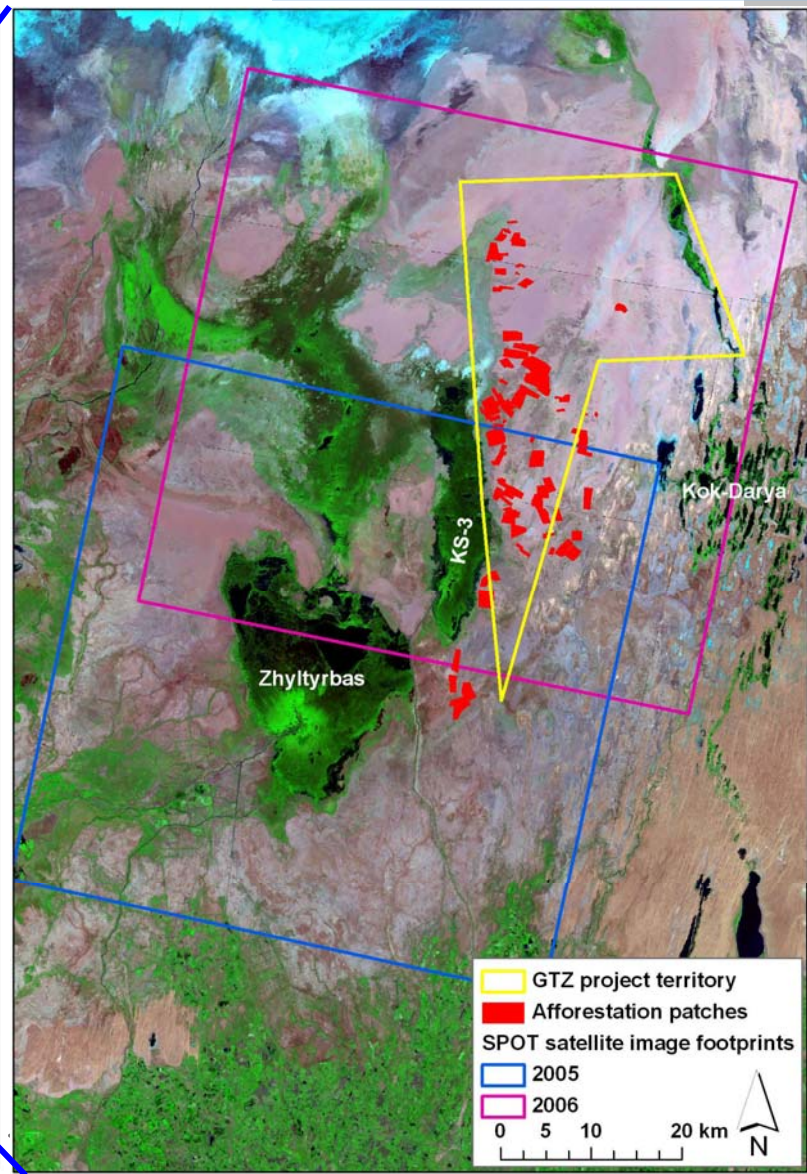
Tasks of the monitoring component:

- Remote sensing based inventory of afforestations on the dry Aral Sea bed

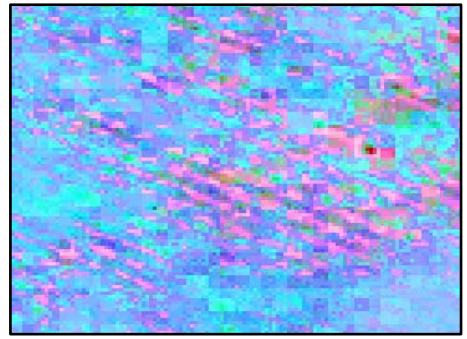
- Impact of the plantation measures on wind speed and aeolian soil erosion

Study area

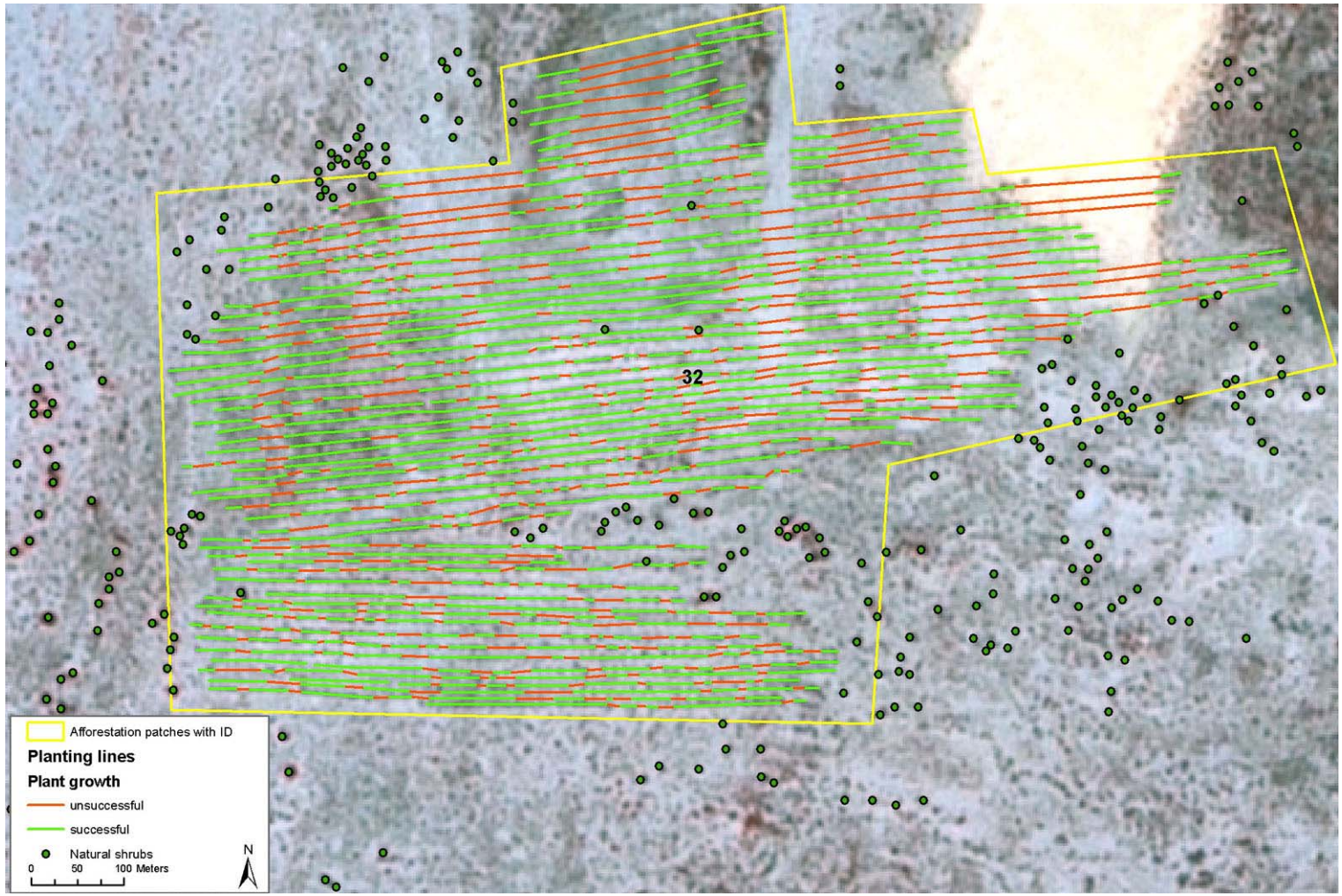




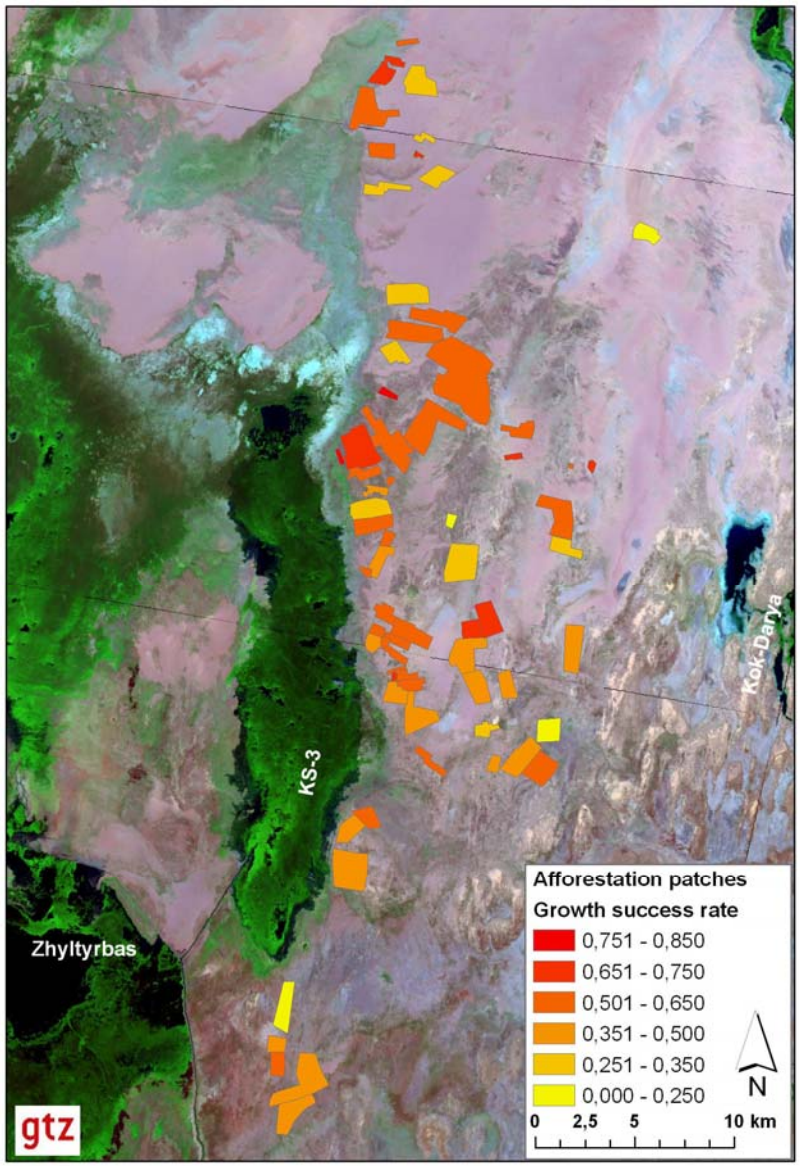
Target: Saxaul afforestations

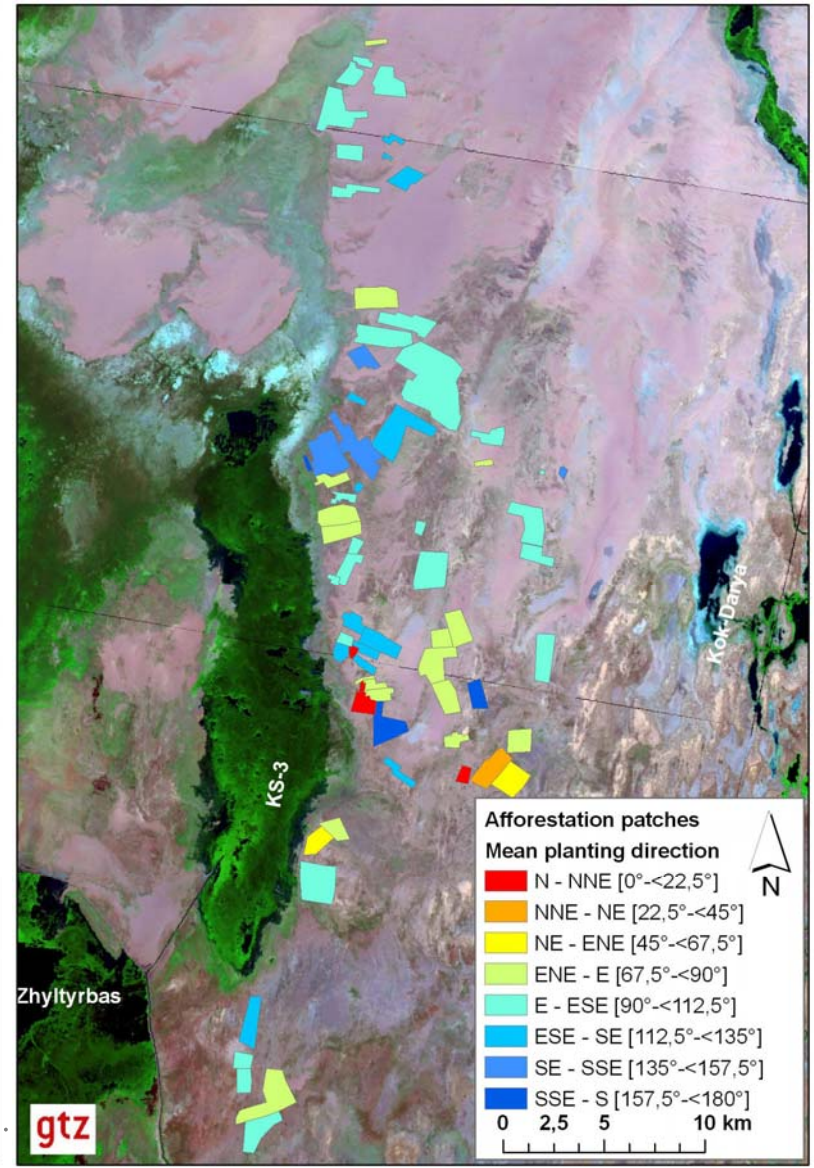


Results:
Maps of afforestation patches



Results: Maps



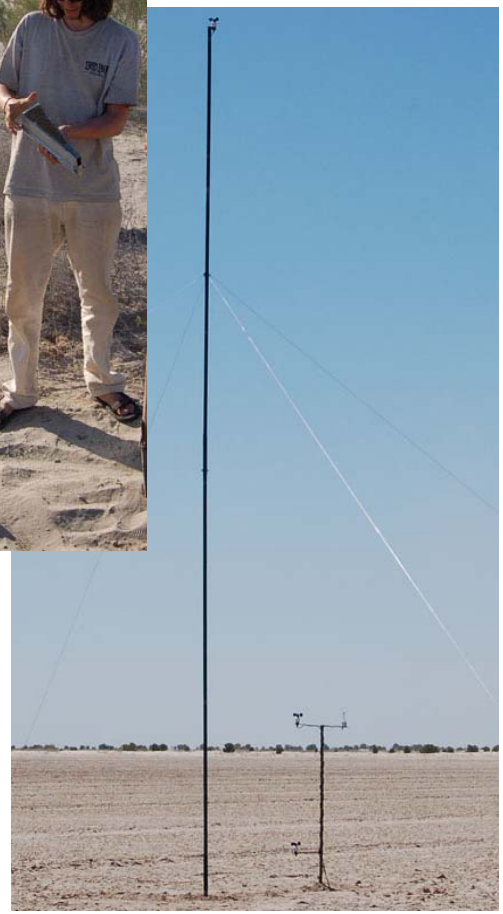


Results: Inventory

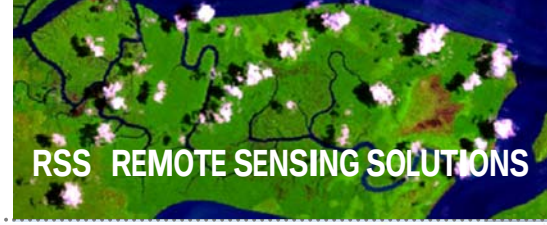
- 70 afforestation patches (9188 ha) inventorized
- Overall growth success rate ~ 60% (normal distributed)
- High variability in growth success among patches
- 60% of the afforestations area perpendicular to the dominant wind direction

Impact assessment: Wind and erosion measurements

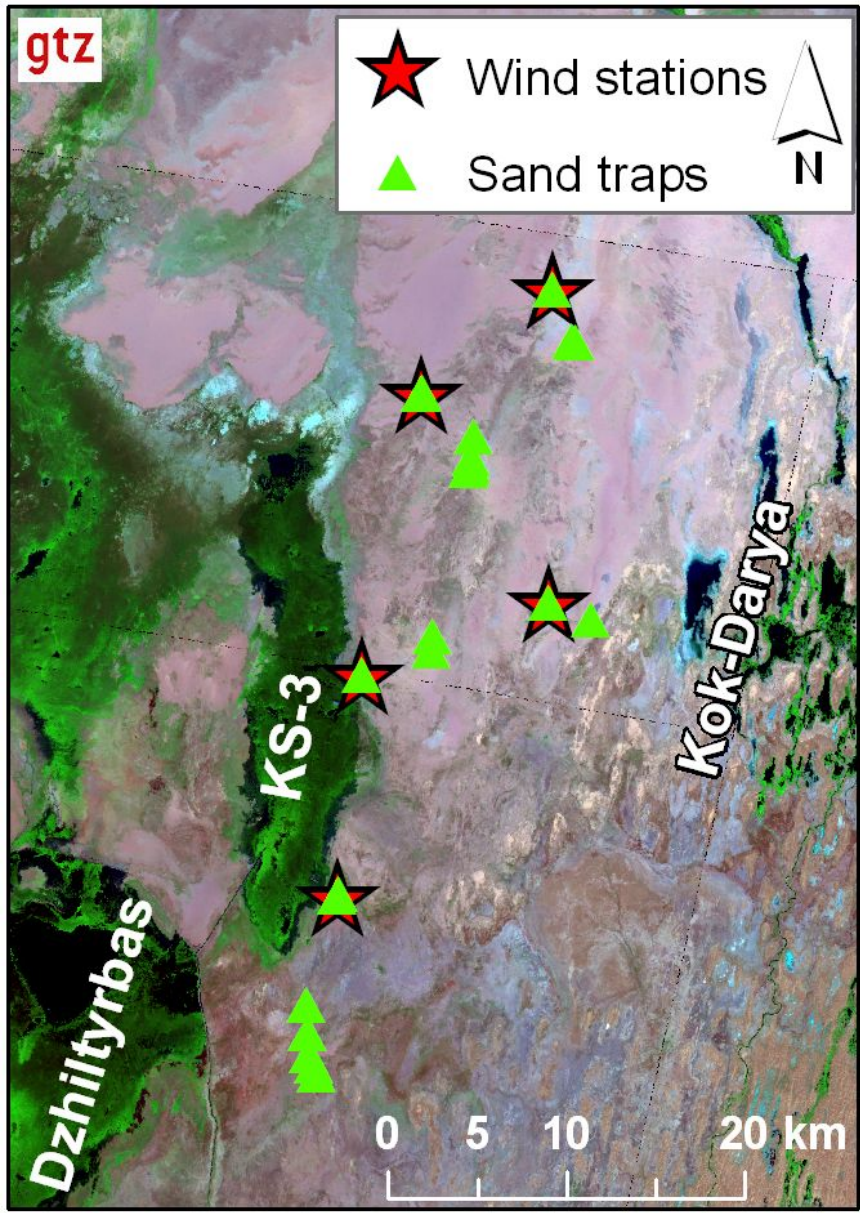
- 5 wind stations; 3 anemometers each, 20 sec measurement interval
- 23 sand trap clusters (BSNE saltation samplers), 4 heights, monthly measurement interval
- Diversive locations (landscapes, vegetation, soils, relief)



Wind and erosion measurements – Spatial layout



- Criteria:
- Maximum spatial coverage of the study area
- Diversity of surface types
- Diversity of vegetation cover
- accessibility



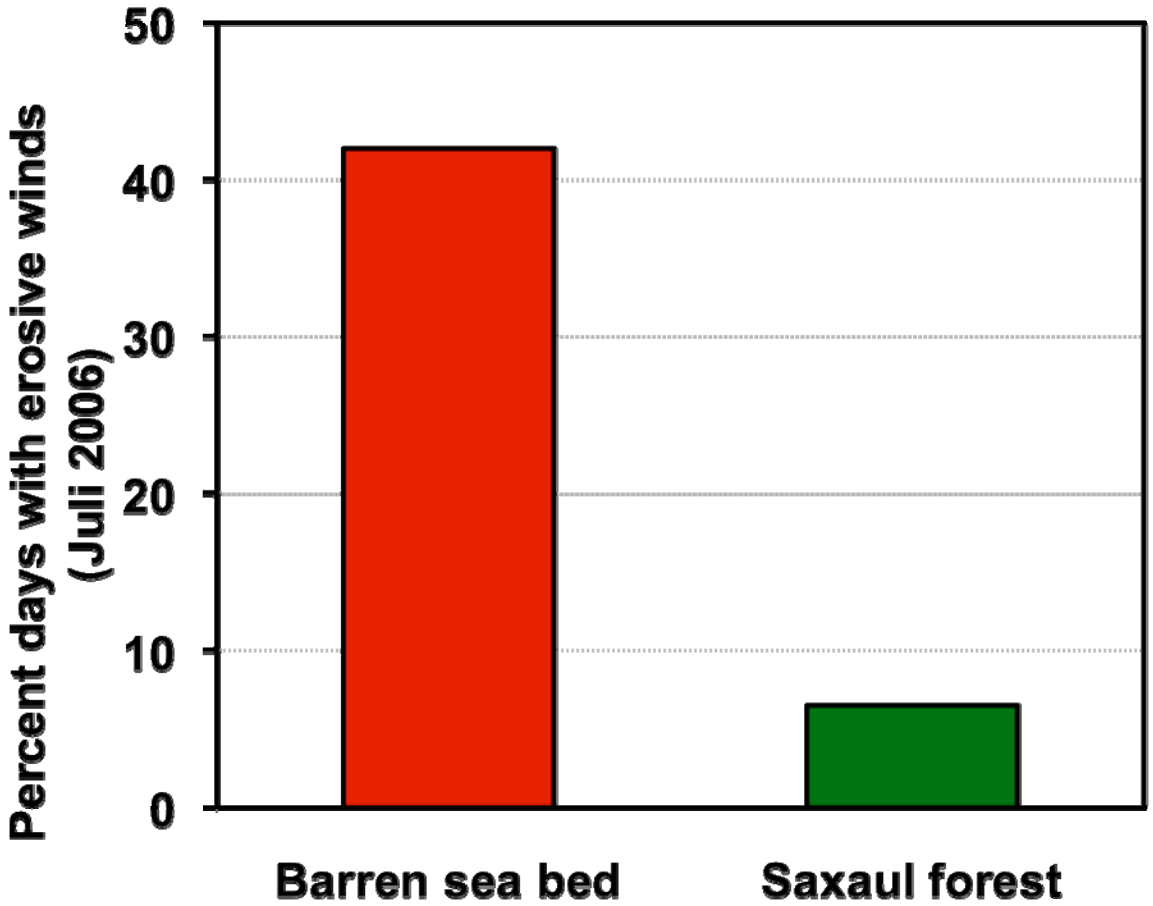
Results:
Impact of a „Black Saxaul“ afforestation on wind speed

Two stations in comparison:

- Afforestation:
  5 year old afforestation, healthy plant growth, growth height > 2m
- No vegetation:
  Solonchak flat with no vegetation
- Distance between stations: 9.3 km

Height		$\bar{v}$ (m/s)		v_{max}(m/s)	
		afforestation	No vegetation	afforestation	No vegetation
July 01st – 14th	0,5 m	1.2	2.3	4.9	7.0
	2m	1.8	2.8	6.4	8.0
	10 m	4.1	3.9	10.5	10.1
July 15th –31th	0,5 m	1.1	2.0	4.5	6.6
	2m	1.6	2.4	5.8	7.6
	10 m	3.8	3.5	10.5	9.6

Results:
Impact of a „Black Saxaul“ afforestation on wind speed



Results:
Impact of a „Black Saxaul“ afforestation on sand transport

Three saltation sampler clusters, situated in a N-S transect within a Saxaul afforestation of 2001

Sampler 1

North of afforestation
Upwind

Active barchanoid dune field

Sampler 2

Center of afforestation

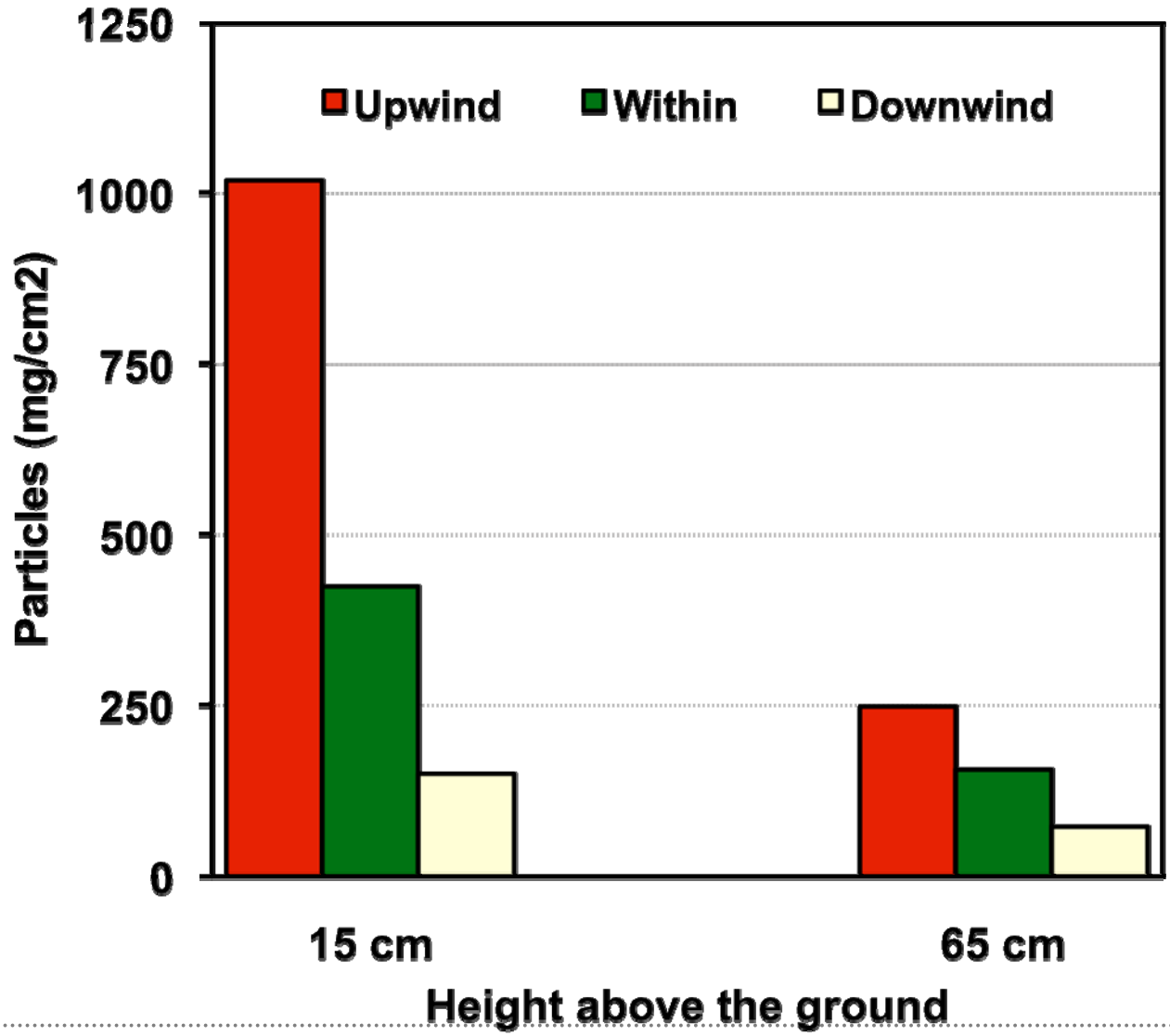
2,5m Saxaul on flat dunes/ sand sheet

Sampler 3

South of afforestation
Downwind

Flat sand sheet with natural overgrowing

Results:
Impact of a „Black Saxaul“ afforestation on sand transport



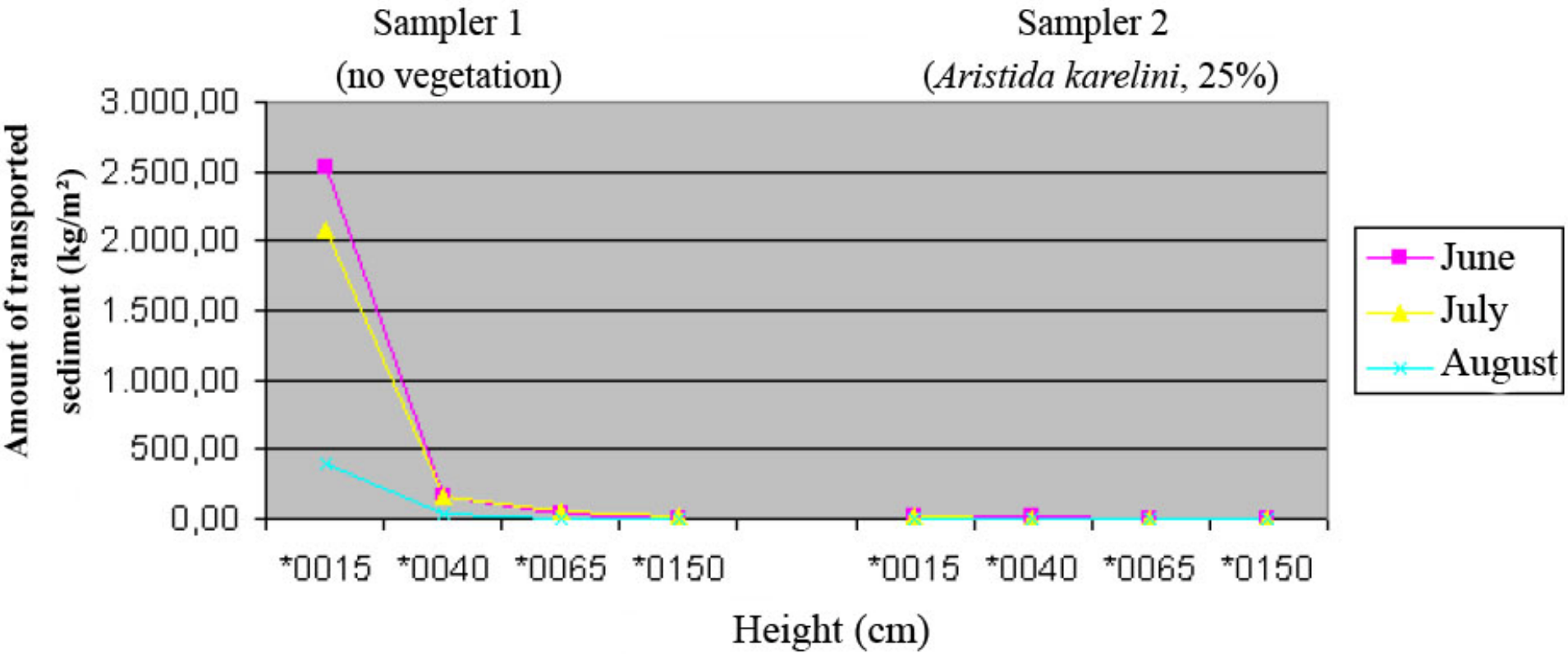
Results:
Impact of a „Selin“ afforestation on sand transport

Two saltation sampler clusters at 800m distance

Sampler 1
Sand flat with shell rock

Sampler 2
Sand flat with mussels and *Aristida karelini* (*approx. 25%* cover)

Results:
Impact of a „Selin“ afforestation on sand transport



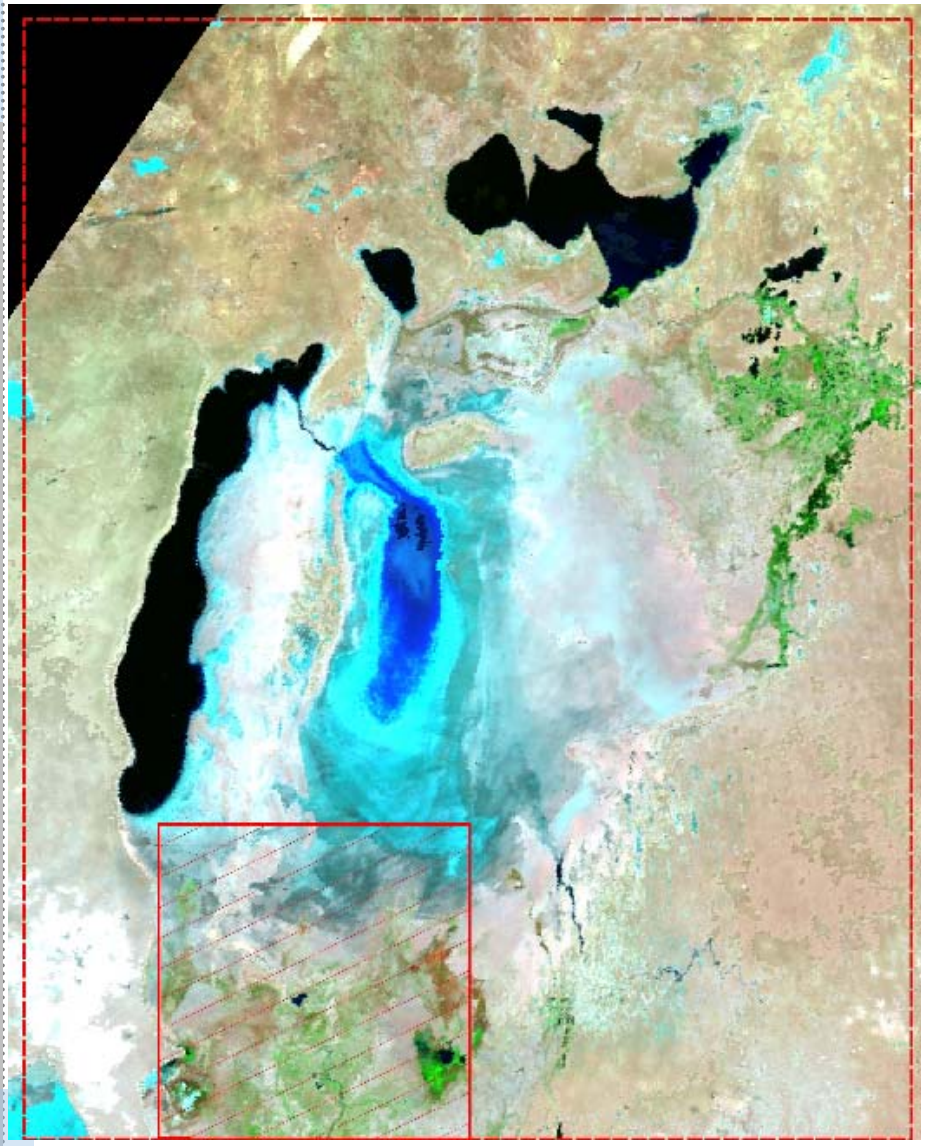
Conclusions

- Highly variable establishment rate of the Saxaul plantations, depending site conditions (salinity, texture, geomorphology)
- Positive effects of afforestation measures on erosion/ sand transport
- Very good soil fixation capability of Selin

Recommendations

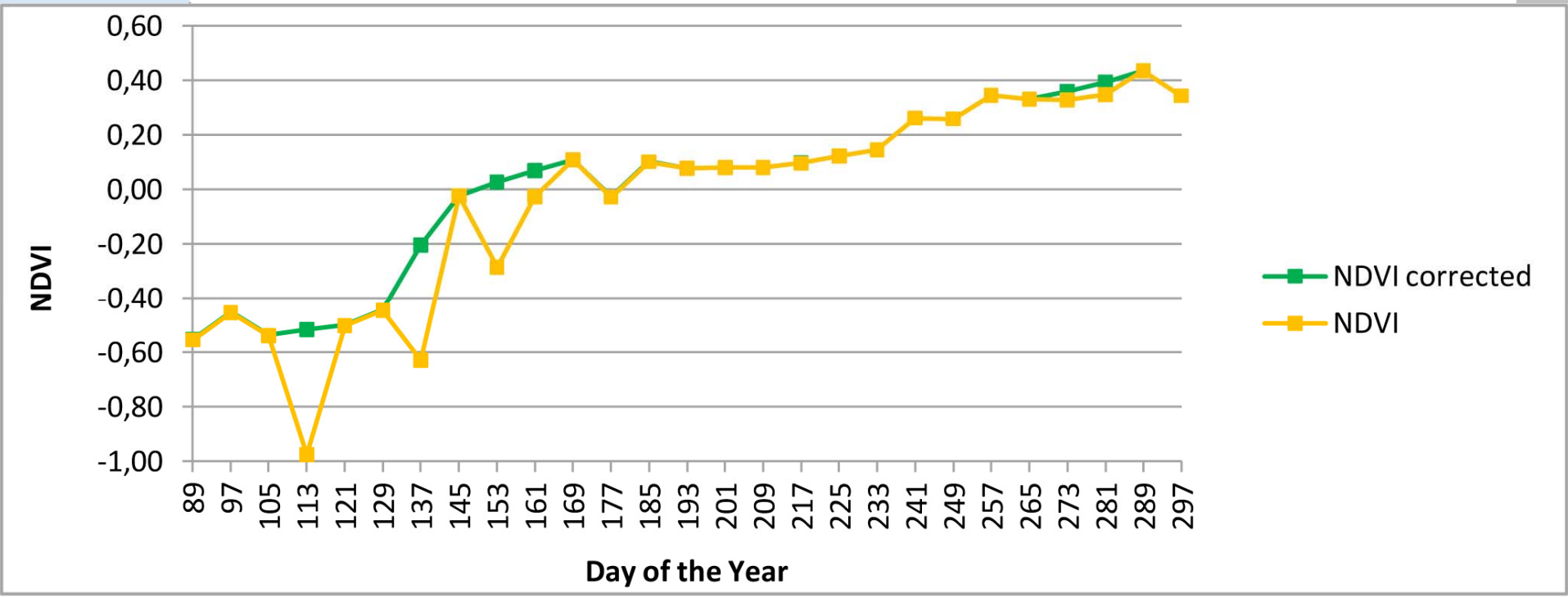
- Detailed scientific surveying and monitoring necessary for future afforestation measures
- Investigation of planting suitability prior to planting to maximize growth success
- Preparation of suitable sites prior to planting
- Concentration of plantations on high risk zones

Current activities and outlook: MODIS time series analysis



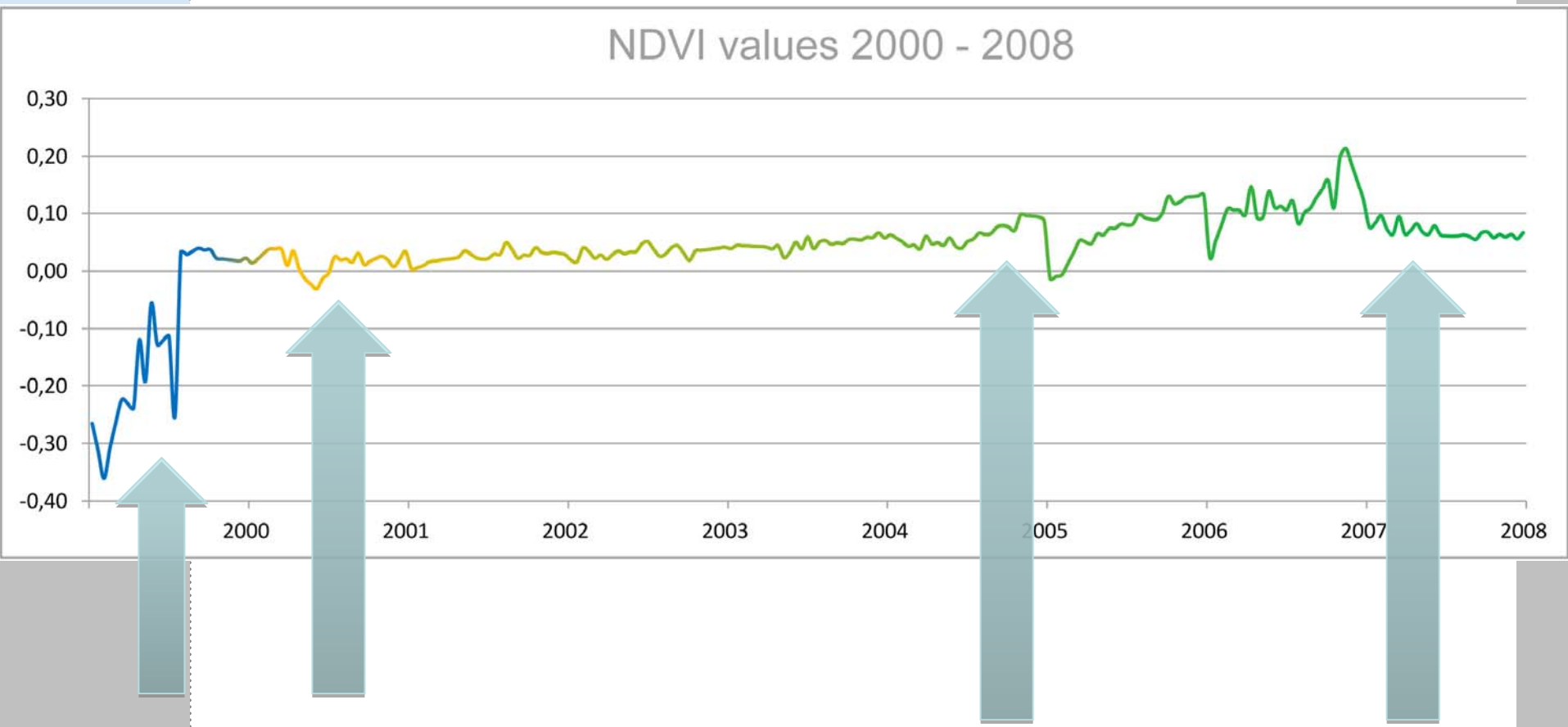
- MODIS time series 2000-2009
- 8-day composites
- 500m resolution

Generation of time series: Temporal interpolation of errors



Used tool: TiSeG (Time Series Generator)
Developed by Unversity of Würzburg (Conrad et al. 2005)

Visualization of primary succession (Kok Darya delta)

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