Monitoring Land Cover and Land Use in Central Asia
Remote Sensing Contributions from selected German projects

NASA LCLUC Meeting, Tashkent, 11.-13.11.2013

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**Sixth oldest university in Germany** (1402)
Ten faculties, 400 professors
24,000 students

**Institute for Geography and Geology**
Five chairs, 14 professors
1,000 students
Highly ranked third party funding (incl. ~60 scientists and PhD students)

**Remote Sensing Department**
~16 team members, three major topics

- **Sustainable Land Management**
- **Biodiversity and Conservation**
- **Environmental Monitoring & Forest Inventory**

Stefan Dech, Chairholder and director of DLR-DFD
Department of Remote Sensing
Projects and cooperations in Central Asia

DLR cooperated with the NATO-GIS Center in Nukus 1990s

German-Uzbek Khorezm project (2001-2010)

German Initiative „Water in Central Asia“ (2008-2014)
Monitoring of snow cover

Snow Cover Dynamics from AVHRR/MODIS data (since 1982)

Parameters:
- Start of Season
- End of Season (Snow Melt)
- Snow Cover Duration
- Snow Cover Index (SCI)

Supports: Water management, indicator for soil moisture

For more information contact: andreas.dietz@dlr.de
Observation of land cover (change)

Regional Land Cover Classification (Central Asia)

- Spatial resolution of 250m (MODIS)
- 2001 and 2009 are available, 2006 and 2012 under construction
- Standardized processor (TWOPAC)

=> Monitoring of details

For more information contact: igor.klein@dlr.de
How can land cover maps be used?  
- by decision makers in Central Asia

### Illustrated land cover / land use in the Isfara Water Basin

<table>
<thead>
<tr>
<th>Land Cover Type</th>
<th>Geological formations</th>
<th>Open Forest</th>
<th>Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Settlements</td>
<td>Fruit Trees</td>
<td>Mountainous forest</td>
<td>River</td>
</tr>
<tr>
<td>Bare areas</td>
<td>Irrigated areas</td>
<td>Water</td>
<td></td>
</tr>
<tr>
<td>Shrubs</td>
<td>Mountainous grasslands</td>
<td>Snow and Glacier</td>
<td></td>
</tr>
<tr>
<td>Water Formation Zone</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Условные обозначения

- Граница бассейна
- дороги
- MX_каналы
- BX_каналы
- Реки
- Водохранилище
- Населенные пункты
- Зоны риска селевых потоков

### Площадь бассейна р. Исфара: 383 281 га

- Известняки без растительного покрова (4.1%)
- Полупустынные предгорные зоны (34.9%)
- Орошаемая площадь (5.3%)
- Орошаемые сады (6.1%)
- Кустарники (12.9%)
- Редколесье (5.0%)
- Горные леса (11.6%)
- Горные луга (2.1%)
- Скалистые зоны (11.1%)

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The story behind the Aral Problem
The story behind the Aral Problem
The story behind the Aral Problem
- from a Landsat perspective

Multi-temporal Landsat data (5 images per year)
=> simple rule-based differentiation of three classes

Edlinger, Conrad, Khasankhanova, et al. (2012)
Reproducing the Land & Water Use History
- Generating Discussion Support
The Water Use at its Limits?
Actually irrigated area / Land use intensity
- Water use at its limits?

- Random Forest classification of MODIS time series
- Analysis of the phenology by FFT transformation
Actually irrigated area ↔ water availability
- Water use at its limits?

Cyan and blue pixels show parts of the irrigation system, where the irrigated area extend is strongly correlated with the amount of irrigation water.

Diploma Thesis  N. Hanke, (Paeth, Conrad)

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Actually used area ↔ water availability
- Water use at its limits?

Cyan and blue pixels show parts of the irrigation system, where the irrigated area extend is strongly correlated with the amount of irrigation water

Diploma Thesis N. Hanke, (Paeth, Conrad)
Generating discussion support
=> irrigation subsystems to be addressed in drought situations

Cyan and blue pixels show parts of the irrigation system, where the irrigated area extent is strongly correlated with the amount of irrigation water

Diploma Thesis N. Hanke, (Paeth, Conrad)
What’s going on in the irrigation systems?
- water and irrigated land
What’s going on in the irrigation systems? - water and irrigated land

Detection of marginal land
GIS based multi-criteria analysis

Input: GIS data on land use, soils, infrastructure, & water

Output: unproductive, marginal areas

Challenge: Definition of marginality, validation, MODIS-scale

Duerbeck, Teresa, M.Sc. Study 2010
Fritsch and Duerbeck et al. (in preparation)
Zoom to field level
- identify areas suitable for alternative options

**Alternative land use?**
Elagnus angustifolia
Ulmus pumila

University of Bonn

Dürbeck (2010), Khorezm-Projekt
How can land cover maps be used?
- by decision makers in Central Asia
RapidEye Crop Identification:

- Crop acreage estimates, crop inventories (support of national mapping programmes)
- Baseline for yield prediction

Outlook:

- Multi-Sensor concepts (Sentinel-2, RapidEye, LDCM, TerraSAR-X, Sentinel-1)
Information below trees hardly available
Diversification of crops causes mixed pixels even at RapidEye scale
How can land cover maps be used?
- by decision makers in Central Asia
Remote Sensing + GIS (other disciplines) + Knowledge
=> Spatio-temporal Analysis + Models
=> Maps / Tables as Tool for Communication

Translation of classes/RS variables needed for acceptance and use of RS information (land use land cover maps)

Clear necessity to discuss and distinguish between
- Possible operational application (data, accuracy, etc.)
- Experimental fields of remote sensing

Data availability and exchange
- CAWA and Khorezm remote sensing information available for free
Thank you

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Conceptual Approach
- based on remote sensing and geoinformatics

Remote sensing based measurements
Classes: Land cover & Land use
Quantification of the status of
Vegetation  Soil  Water

GIS Information - additional measurements, secondary data

Geographical Indepth Knowledge
Spatial analysis, understanding of processes

Models and Applications
Decision & Discussion Support
Modeling Evapotranspiration

Conrad et al. (2007), Knoefel et al. (in preparation)

MODIS 1km regional application of the model SEBAL over the entire cropping season (>30 model runs)

Advantage: crop water consumption, performance indicators

Challenge: mixed pixel problem, validation