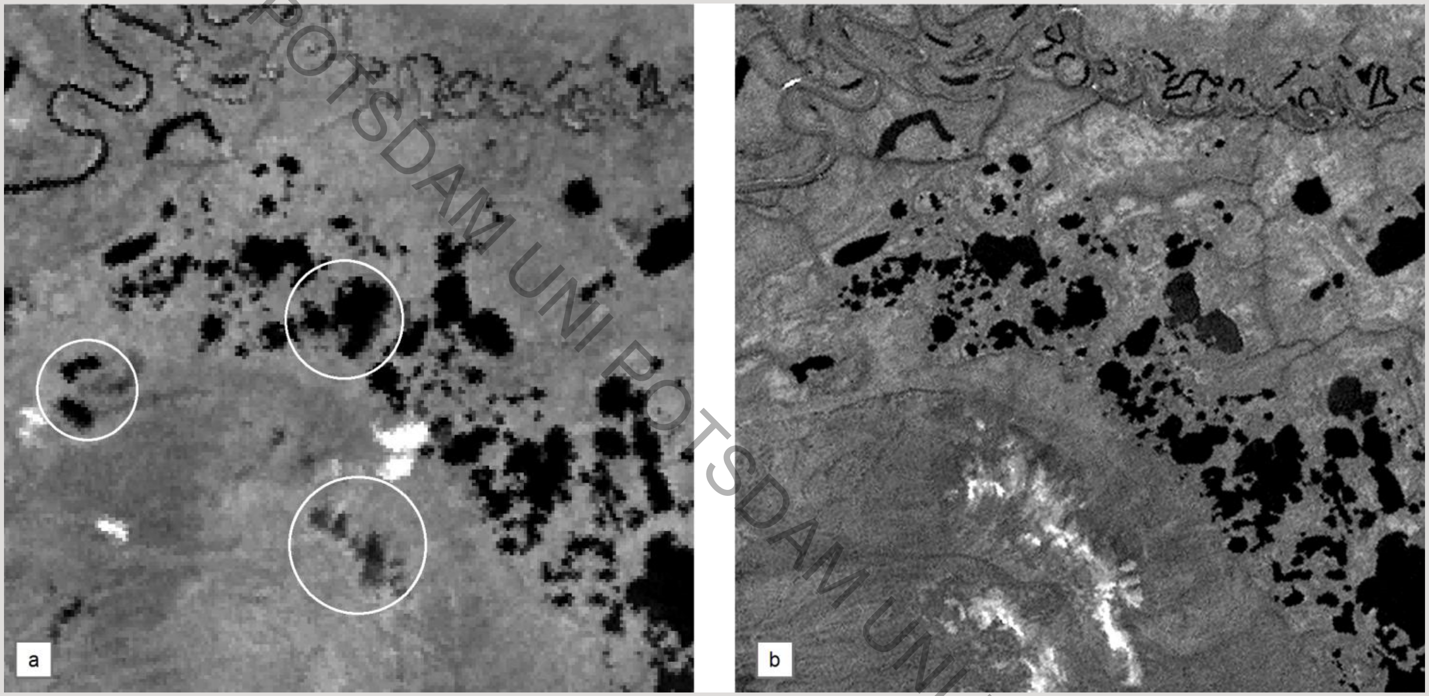
Automated Object-Identification for Isolated Transient Landforms in Remote-Sensing Data



Changes in the size and distribution of thermokarst lakes

- workflow of automated object identification
- object-catalogue based detection of landforms
- prime indicators of changing climatic conditions

Content

- Motivation
- Goal
- Workflow, object catalogue
- Conclusion
- Outlook

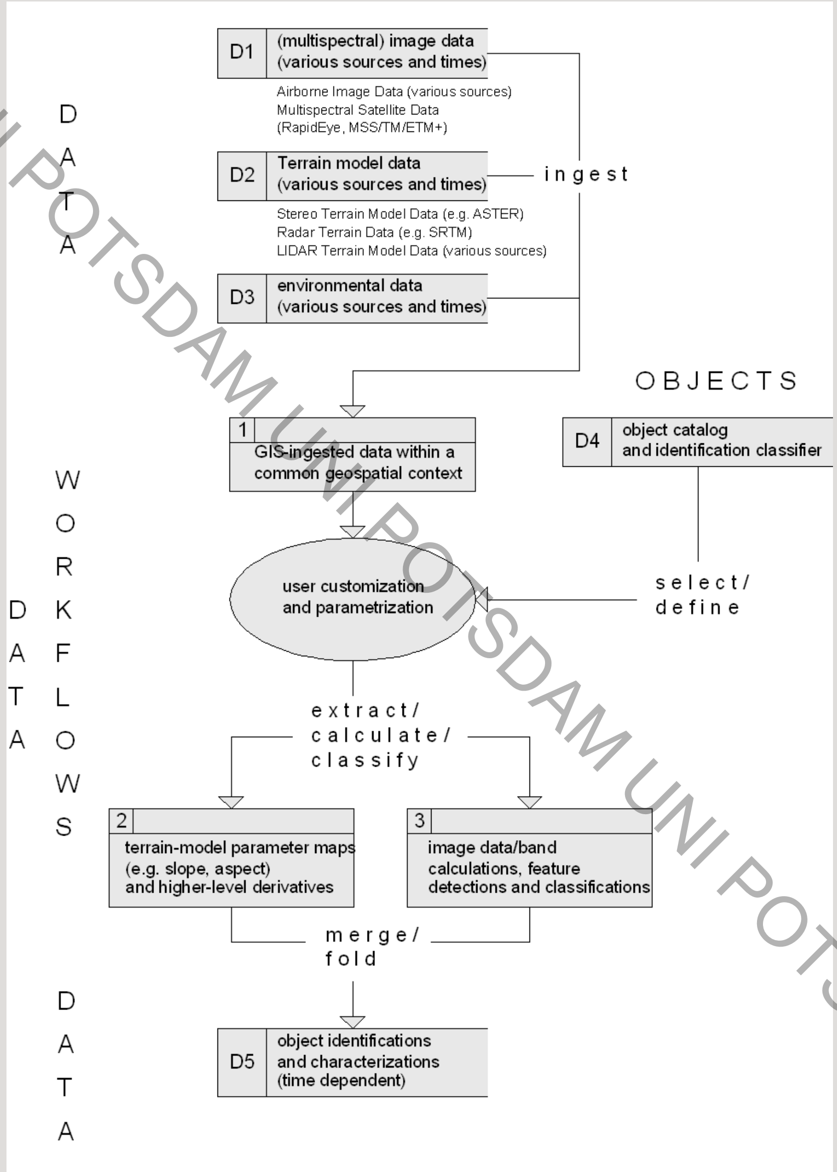
Motivation

- automated object identification and statistical characterization of morphometric parameters
- identification of climate processes
- automated detection of primary climate-related landforms and the assessment of their change through time and three decades of remote-sensing
- observations help to quantify and find predictors for the consequences of climate change

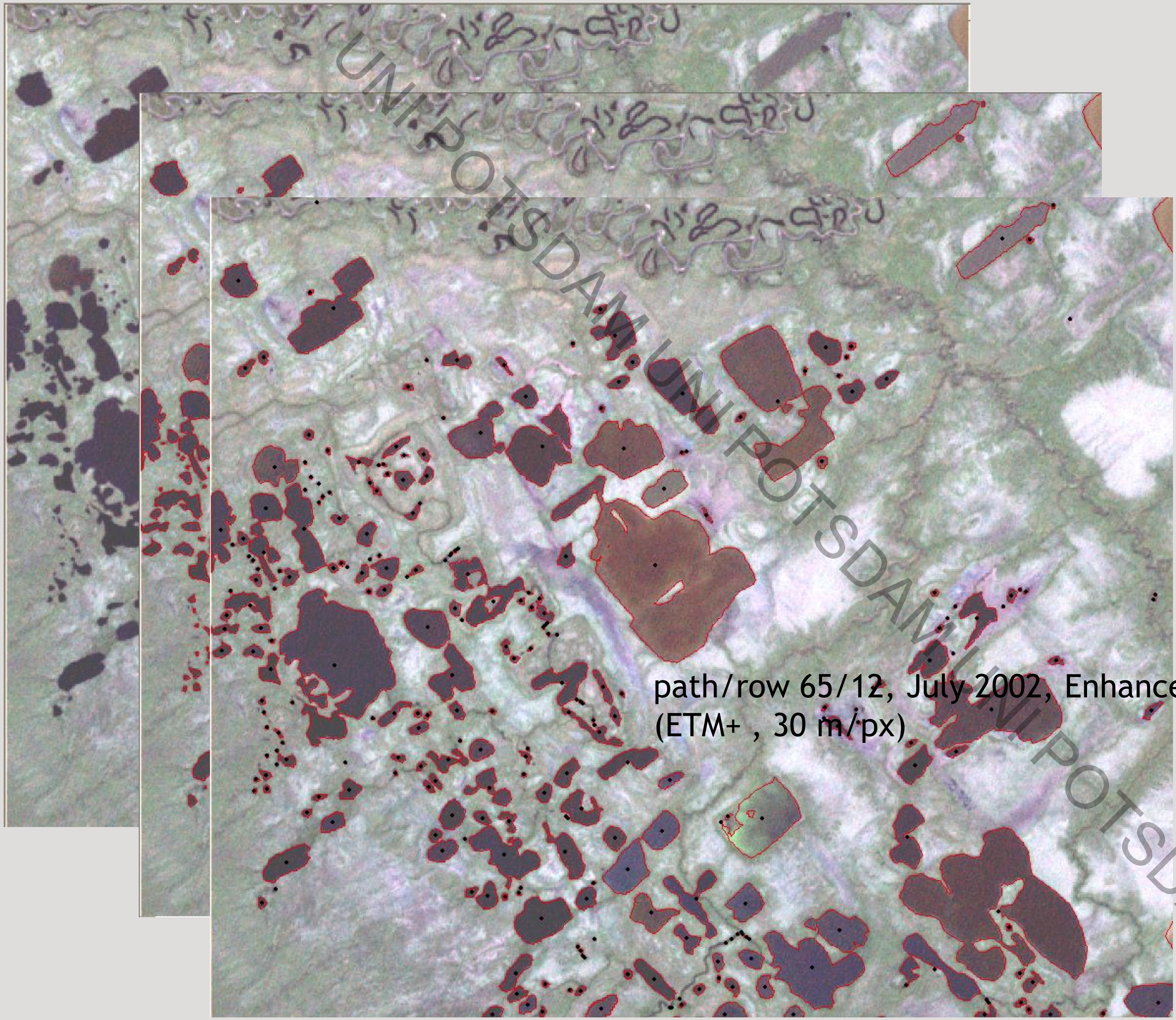
Goals

- to create approaches and concepts for object-catalogue based detection of landforms within a commercial GIS suite for the study cases of climate tracer: thermokarst features

- to provide GIS-integrated object-identification tools to support experts
- to allow for combined approaches and improve detection qualities
- to transfer the workflow onto other climate tracers
- to enable operational use of the workflow above the conceptual level


D1
(multispectral) image data
(various sources and times)
Airborne Image Data (various sources)
Multispectral Satellite Data
(RapidEye, MSS/TM/ETM+)
D2
Terrain model data
(various sources and times)
Stereo Terrain Model Data (e.g. ASTER)
Radar Terrain Data (e.g. SRTM)
LIDAR Terrain Model Data (various sources)
D3
environmental data
(various sources and times)
ingest
D A T A
OBJECTS
D4
object catalog
and identification classifier
1
GIS-ingested data within a
common geospatial context
WORKFLOWS
DATA
user customization
and parametrization
select/
define
extract/
calculate/
classify
2
terrain-model parameter maps
(e.g. slope, aspect)
and higher-level derivatives
3
image data/band
calculations, feature
detections and classifications
merge/
fold
D5
object identifications
and characterizations
(time dependent)
D A T A

Priority	2D: Object Properties	2D: Attributes	2,5D: Object Properties	2,5D: Attributes
1. must have				
1	*Geographic position* : (longitude and latitude)	Northern Hemisphere, (180°W-180°E, 25°N-90°N) permafrost distribution (BROWN, et al, 1997)	Geographic information about position (x, y, z)	
1	*Neighbour relations:* Euclidean distance to other geoobjects	Neighbourhood to degraded permafrost, distance to a sea (greater distance), distance to a glacier (smaller distance)	Height for block glaciers distribution	
1	*Climate conditions* : temperature , precipitations, temperature fluctuations, seasonal frost cycle, climatic zones	Temperature from -12° to +1°C (WASHBURN, 1979), Precipitation 50 - 1250 mm (WASHBURN, 1979), Temperature fluctuation, Seasonal frost cycle, Climatic zones (KÖPPEN & GEIGER, 1954)		
1	*Distribution:* Distribution function and object/density	Distance from one another, Clustering	Object height	
1	Orientation: Elongation, ellipticity	Thermokarst – Main axis (FRENCH, 2007)	Exposition	South dominant
1	Object form: Width, length	Form: oblong, elliptic, D-form, lightly curved edge, (FRENCH, 2007)	Inclination	up to 30° (high inclination)
1	*Average size:* Area of a form	Diameter : 80 - 300 m (some up to 2 km)	Horizontal curvature	(MINÁR & EVANS, 2007)
1	Water depth	Water depth - shallow, large thermokarst lakes - central pool 2 – 4m, surrounding a central pool only 0,3 – 0,5m	Vertical curvature	(MITASOVA et al, 2005)
1	Form parameters ratio	Width to length 1:1 - 1:5, slopes to one another : asymmetric *IR/CIR		
1	Texture	Haralick Matrix and Derivates		
2. should have				
2	Loose rock	Granular size		
2	Water volume	Water - high IR absorption *IR/CIR		
2	Form convexity	Concave, bowl-formed but asymmetric (AHNERT, 2003)	Slope profile	
2	Degree of reflection in separate channels	Higher degree of reflection in BL/GR		
2	Planar symmetry (Exposition/Insolation)	High IR/(BL-GR)^2 ratio OR low IR/BL ratio		
3.nice to have				
3	Water temperature	in the centre: from -3 to -4°C, water surface : -2 -3°C		
3	Roughness factor	Wave lengths		



path/row 65/12, July 2002, Enhanced Thematic Mapper (ETM+ , 30 m/px)

Conclusion

- will not completely replace manual object identification,
- object identification and mapping still has to be carried out by an expert interpreter,
- detection tools help to identify landforms on an a-priori level,
- if GIS-integrated, such tools are available for a wide range of researchers and object location takes place within a proper geospatial context required for data exchange and ongoing studies,
- less time-consuming and provides means to extract statistical parameters over large areas and, if multitemporal, over timespans.

Outlook

- compare object properties taken from references and from our research
- 3D, 4D object properties
- Geoviz

Thank you for your attention!

- Lucia Tyrallová

  University of Potsdam

  Geoinformation Research Group

  Department of Geography, Potsdam, Germany

  E-Mail: lucia.tyrallova@uni-potsdam.de

- Stephan van Gasselt

  Free University of Berlin

  Institute of Geological Sciences, Berlin, Germany

- Hartmut Asche

  University of Potsdam

  Department of Geography, Potsdam, Germany