ASSESSING HABITAT TYPE IN KZN ESTUARIES USING VHR REMOTE SENSING IMAGERY

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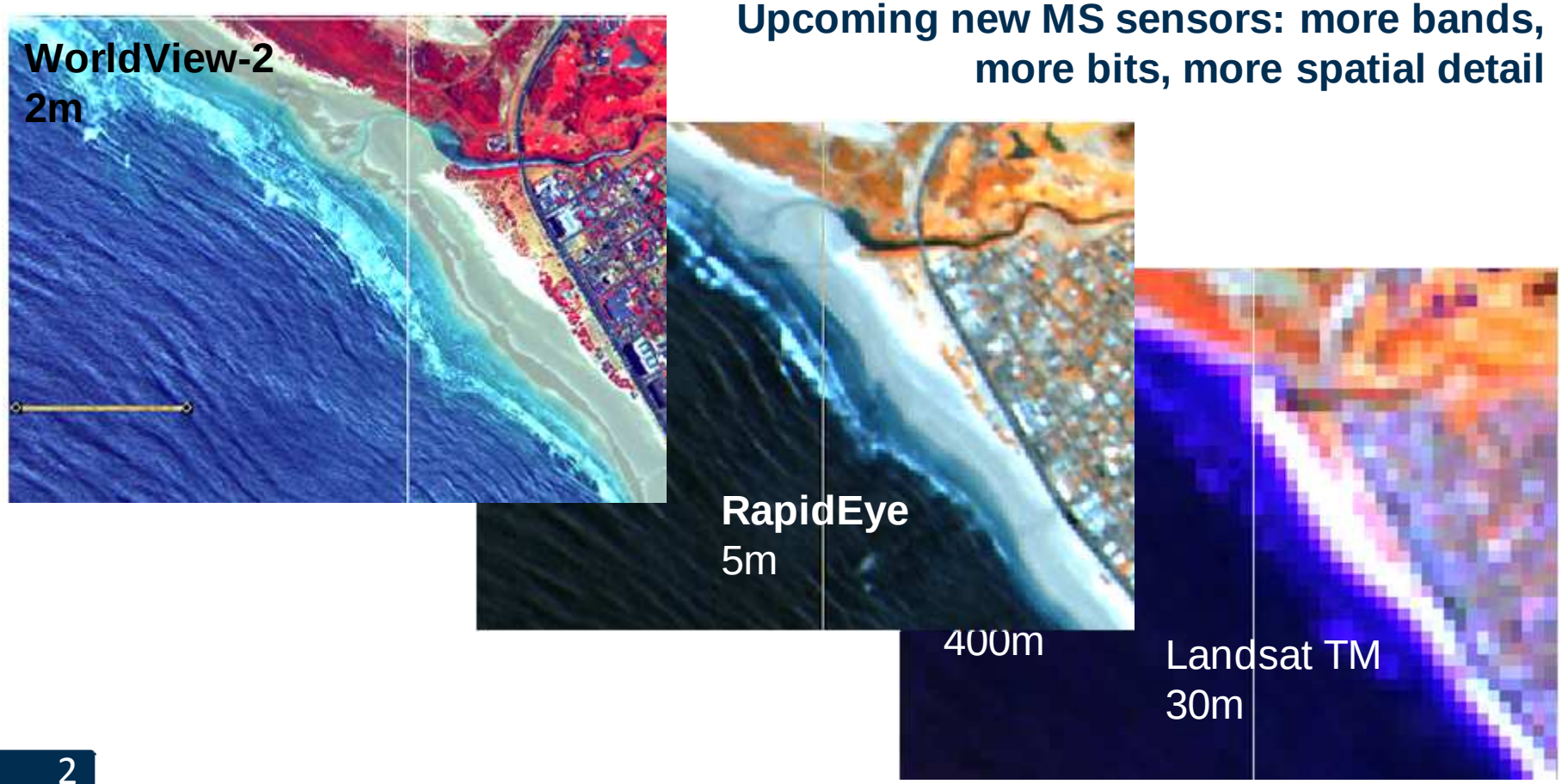
our future through science

Coastal remote sensing

- Coast has long been neglected by RS because of small scale pattern of landscape features
  → „traditional“ RS sensors of little use

Upcoming new MS sensors: more bands, more bits, more spatial detail



The opportunity: WRC project in St Lucia
(with Parliamentary Grant co-funding)

The uMfolozi/uMsunduzi/St Lucia estuaries (iSimangaliso Wetland Park) form the largest estuarine system in Africa.

Appropriate management of this complex system requires full understanding (a) of provided ecosystem services; (b) impact of ecosystem condition on ES delivery; and (c) risk arising for dependent industry from ecosystem degradation.

To date, only few spatial-temporal information on estuarine vegetation composition, distribution and health exists.

In the context of an ongoing WRC project, remote sensing mapping has been used in the St Lucia estuaries region.

Given the small scale of the habitats, imagery with high spatial resolution had to be used.

The ultimate goal of the project is to assess the potential of new VHR sensors for its use in providing spatial information on vegetation type and habitat condition for informing Estuarine Management.

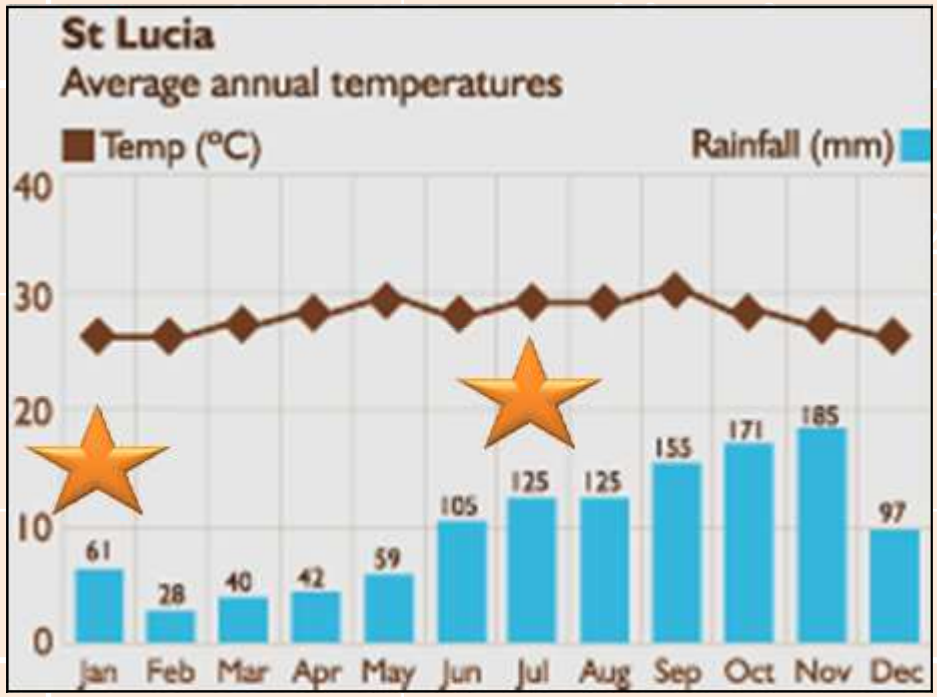
Aim of this mapping project

- To assess suitability of upcoming sensors for suitability in estuarine habitat mapping
- To assess different classification techniques (Maximum Likelihood vs. Decision Tree)
- To assess the value of LiDAR derived elevation data
- To assess impact of seasonality on classification results

Details of used sensors

Sensor	Resolution (m)	Spectral bands	Acquisition Date
WorldView2	2.0	8: Coastal, B, G, Y, R, RedEdge, NIR1, NIR2	9 Apr. 2010
RapidEye	5.0	5: B, G, R, RedEdge, NIR	18/20 July 2011 13 Jan. 2012
SPOT6	5.55	4: B, G, R, NIR	8 Feb. 2014
LiDAR-derived 25cm contours	Rasterised to match above	1	ca. July/Aug 2013

Dry and wet season images

Sensor			Acquisition Date
WorldView2			9 Apr. 2010
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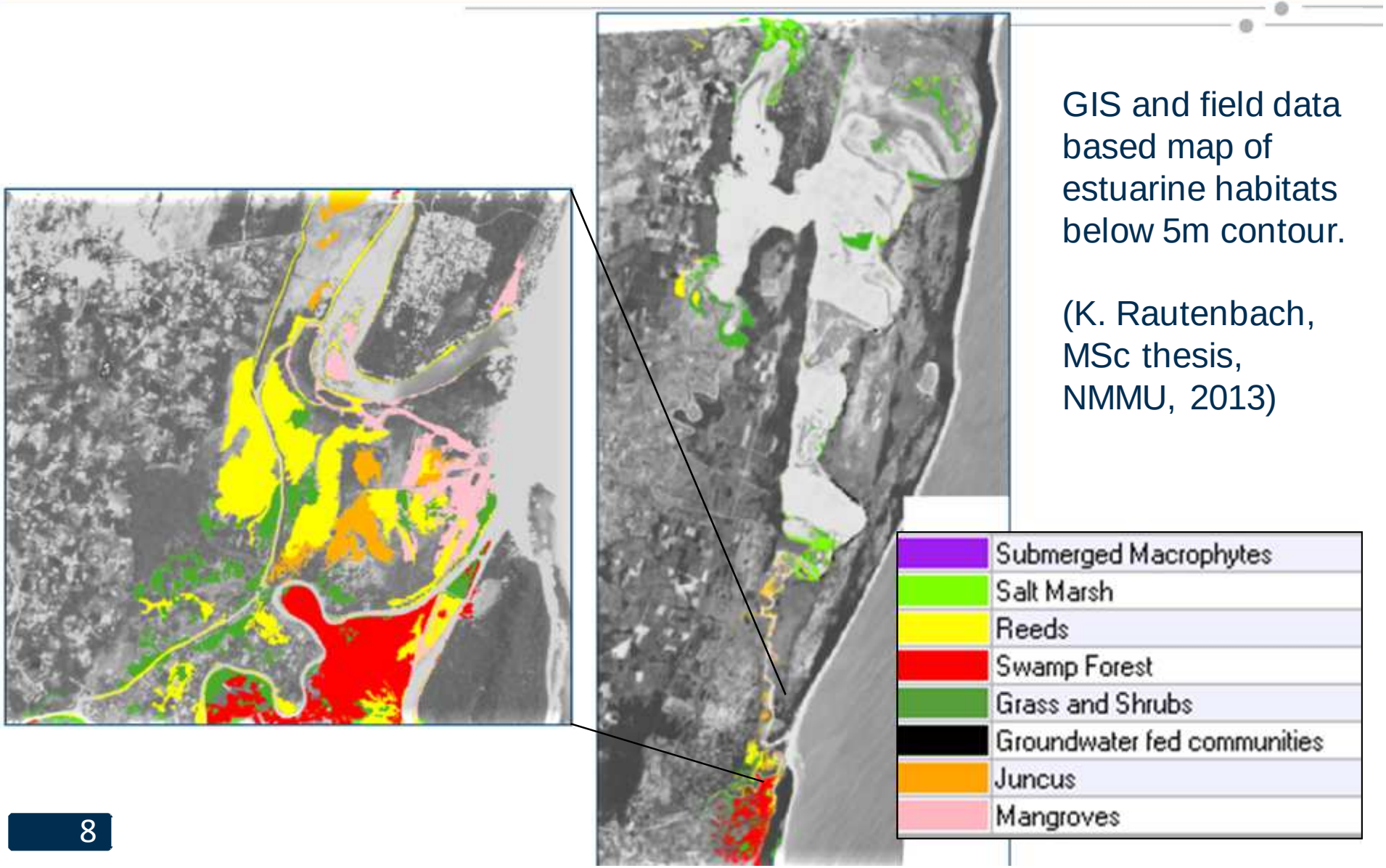
Coverage of data

SPOT6 & RapidEye Coverage

WorldView-2 Coverage

Reference data



GIS and field data based map of estuarine habitats below 5m contour.

(K. Rautenbach, MSc thesis, NMMU, 2013)

Methods

- Preprocessing
  - Atmospheric correction
  - Mosaicking of image tiles
  - Reprojection to match reference data
- Generation of training and validation points
  - Stratified random from Kelly's GIS-based habitat map
  - Cleaned for obvious temporal changes:
    - some swamp forest points in 2013 reference were open grass and shrub land in 2010 (abandoned forest plantation)
    - Some mangroves disappeared.

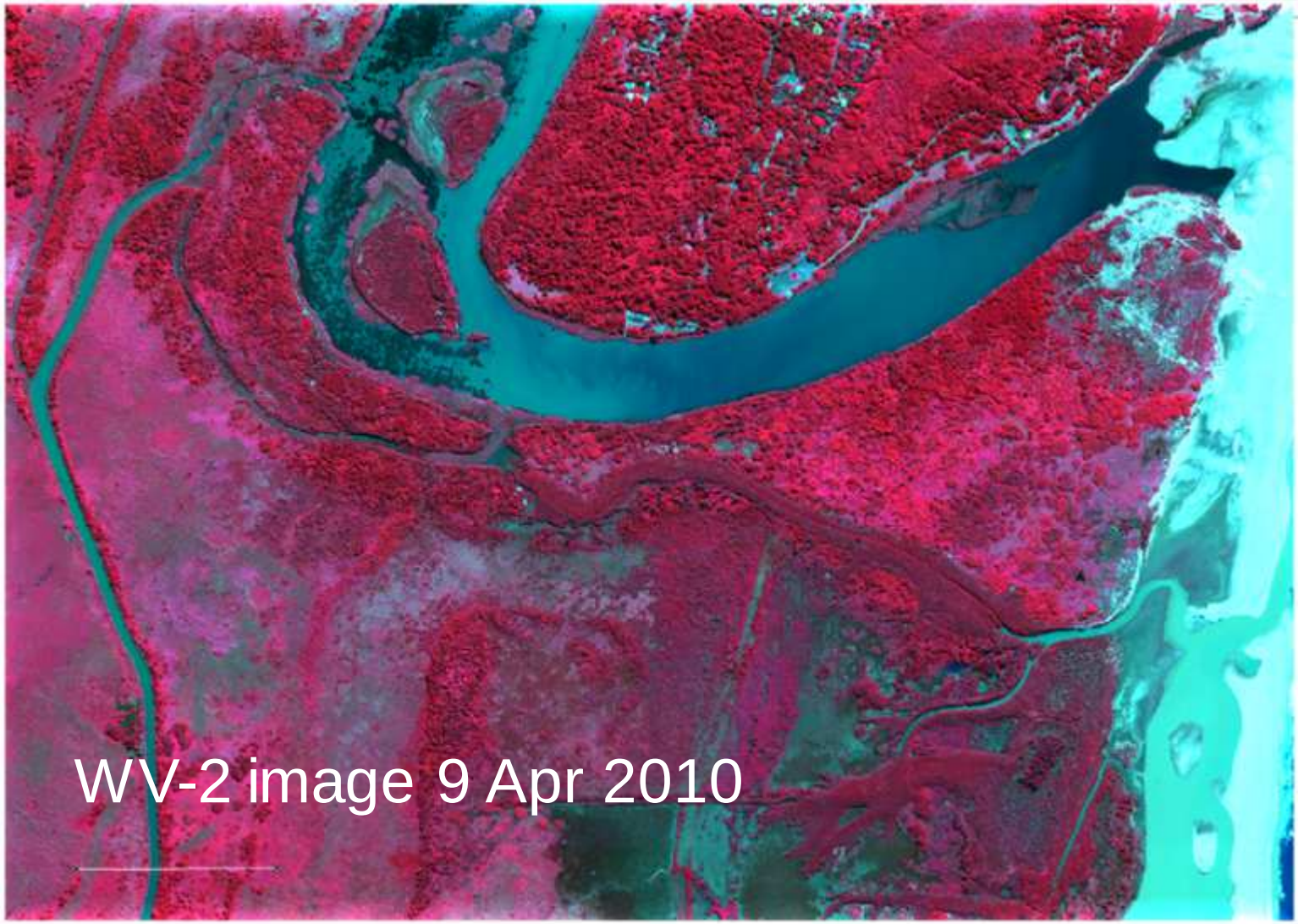
Classification

1. Maximum Likelihood (ML)
   - of resp. multispectral images
   - of multispectral stacked with LiDAR surface data

2. Non-parametric Decision tree (DT)
   - (of resp. multispectral images)
   - of multispectral stacked with LiDAR surface data

- Filtering of results to remove single pixels

Example WV2-based classification results



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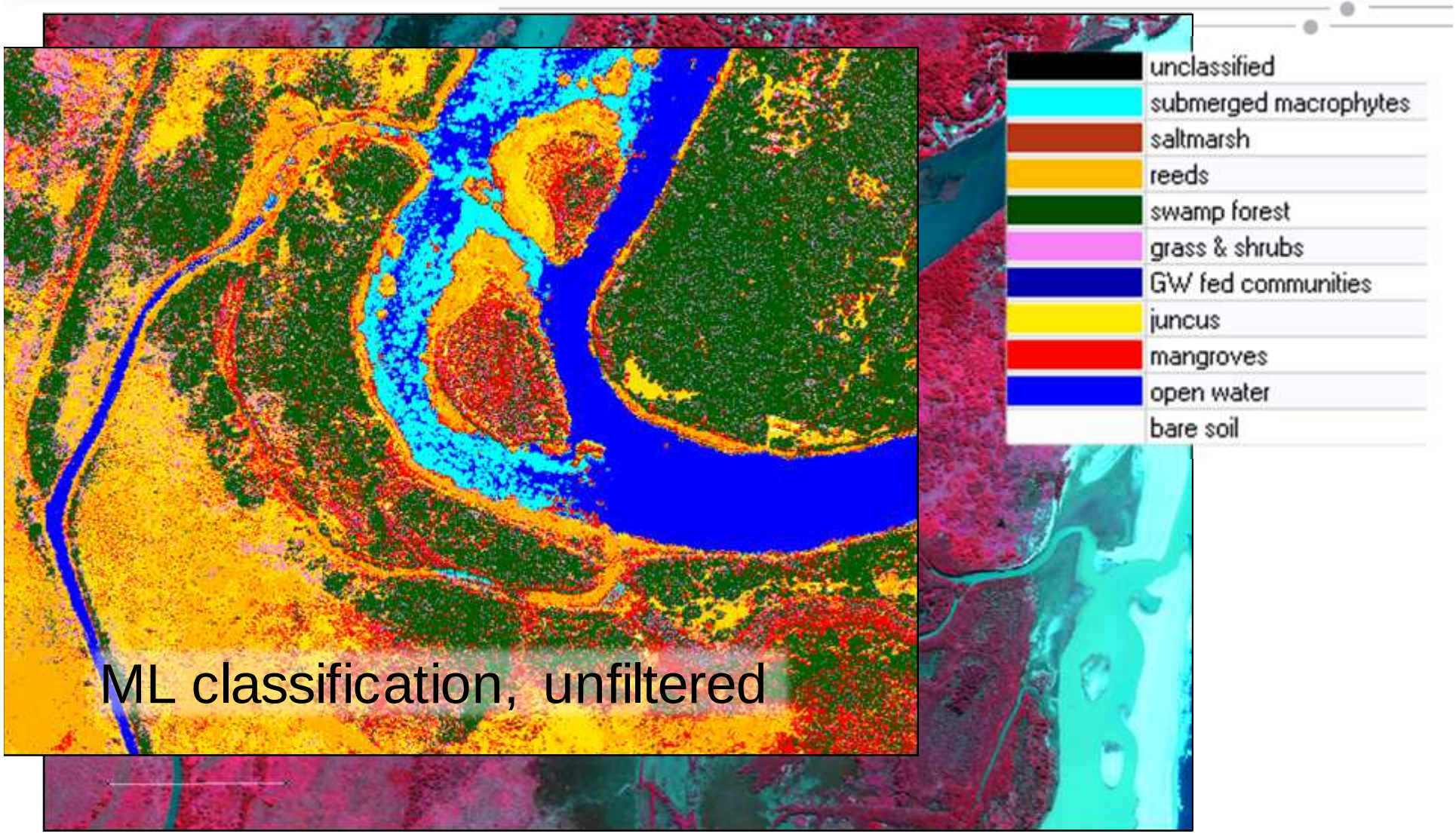

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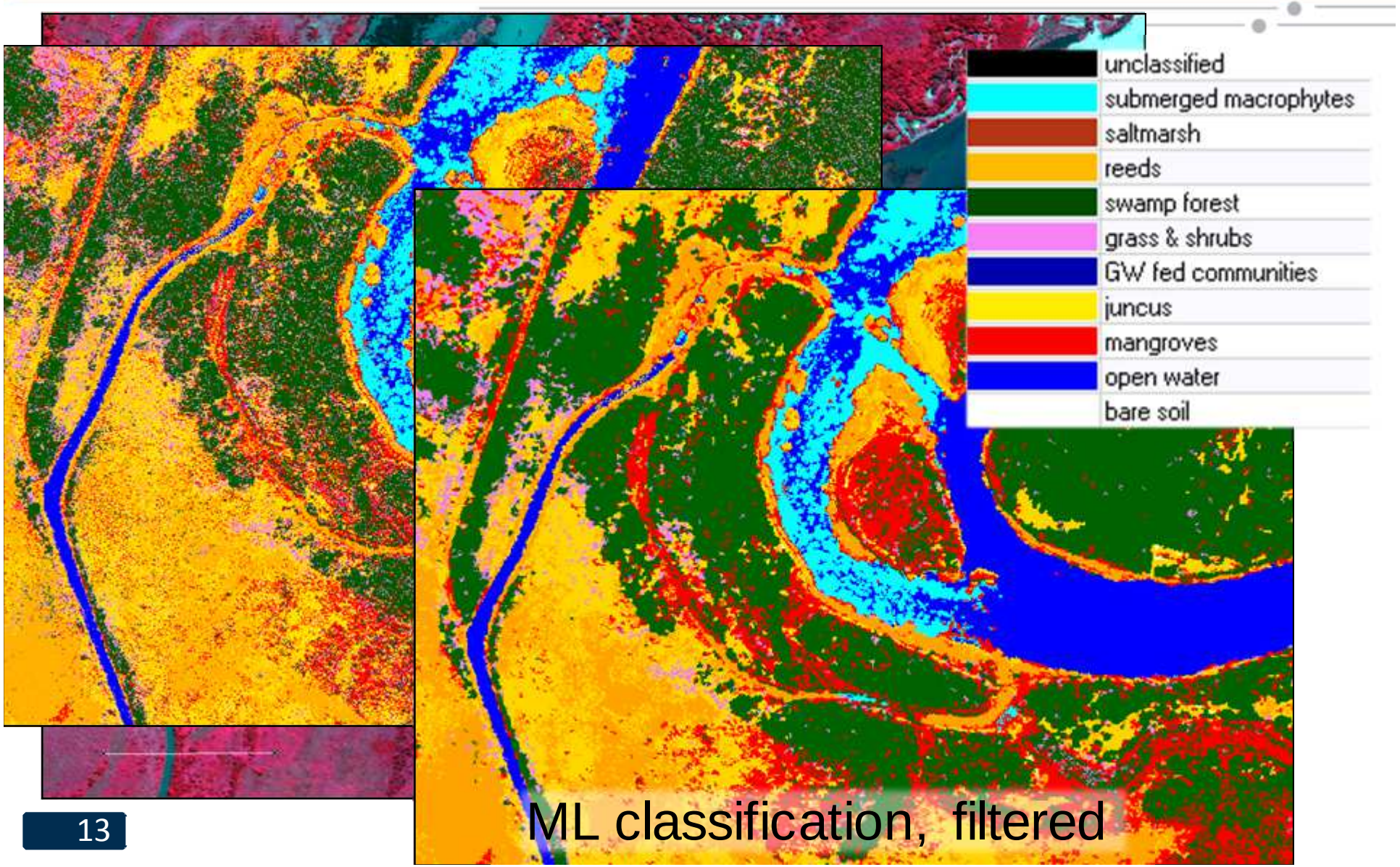

Results multispectral ML classifications

	Spectral bands only	
Sensor	**overall acc.**	**Kappa**
WV2_2010	67.1%	0.60
RE_2011	49.1%	0.43
RE_2012	56.3%	0.51
SPOT_2014	60.5%	0.55

Validation basis: Stratified random points from GIS reference, cleaned for obvious temporal changes.

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Results rather disappointing. WHY ??

Validation basis: Stratified random points from GIS reference.

Error matrices: SPOT6

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Submerged Macrophytes	17	14	14	82%	100%
Saltmarsh	20	21	12	60%	57%
Reeds	17	16	7	41%	44%
Swamp Forest	28	17	15	54%	88%
Grass & Shrubs	34	64	23	68%	36%
Groundwater-fed comms.	19	26	14	74%	54%
Juncus	20	5	3	15%	60%
Mangroves	13	12	9	69%	75%
Open Water	24	16	16	67%	100%
Bare Soil	13	13	11	85%	85%
Totals	205	205	124		

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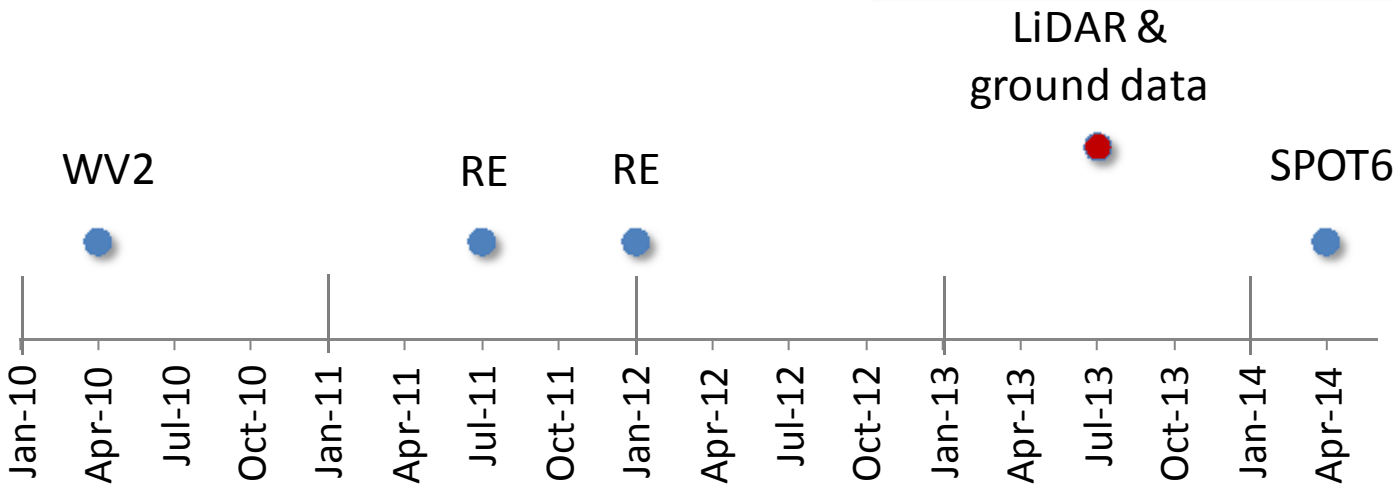
Observed confusions

- Reeds – Juncus
- Swamp forest – Grass & shrubs
- Bare soil – salt marsh
- Water – submerged macrophytes or saltmarsh

Impact of time lag between images and reference data



Reference data are entirely from highly dynamic zone < 5m elevation and time lag between data leading to:

- Various degrees of flooding between images in saltmarsh, groundwater fed, reeds, juncus, mangroves
- Rapid vegetation succession from grass/shrubs to swamp forest
- Single flood events eradicated entire submerged vegetation patches
- Salinity changes (?) prompted shift from submerged to reeds

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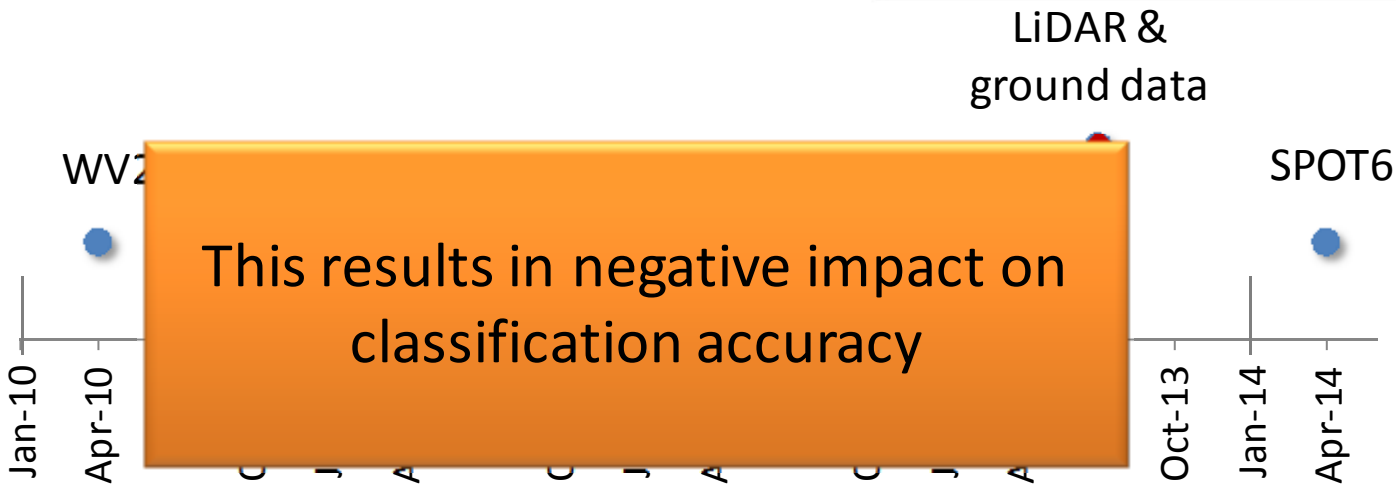

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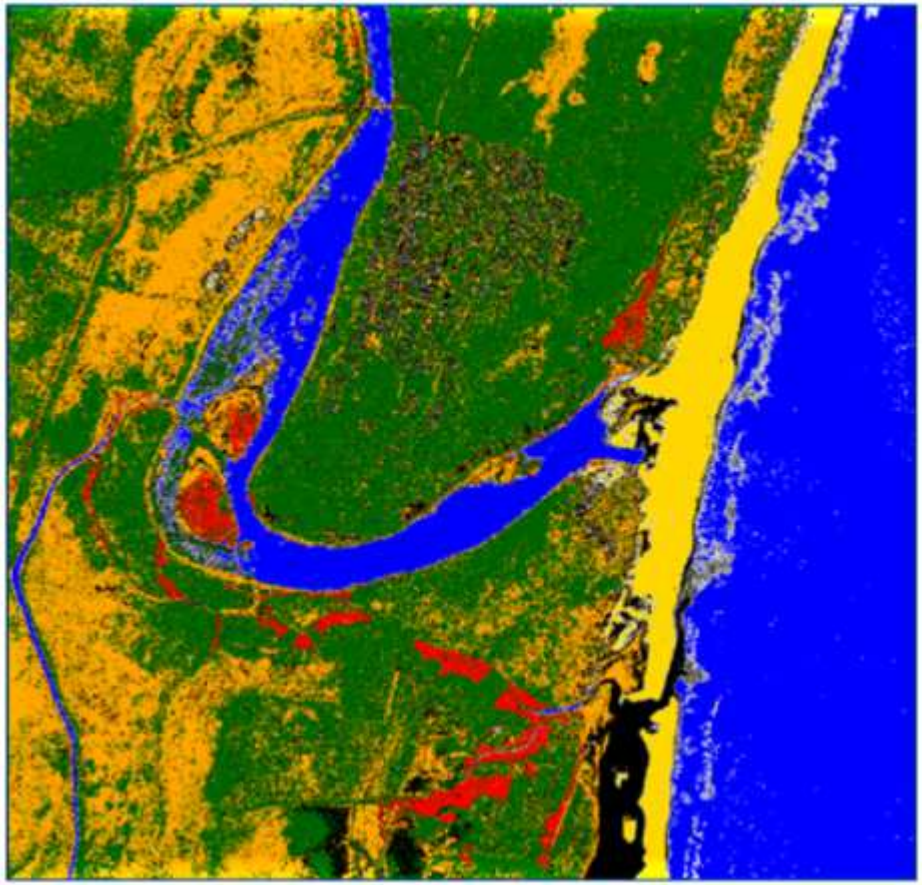
ML classification results LiDAR stacks

	Spectral bands only		Spectral + LiDAR	
Sensor	**overall acc.**	**Kappa**	**overall acc.**	**Kappa**
WV2_2010	67.1%	0.60	62.6%	0.55
RE_2011	49.1%	0.43	55.0%	0.50
RE_2012	56.3%	0.51		
SPOT_2014	60.5%	0.55		

WV2 Decision tree results

unclassified
bare soil
non-woody vegetation
forest (swamp & other)
mangroves
water

Preliminary results look good, validation still outstanding though...



Lessons learnt

- Coastal specific challenges:
  - High landscape dynamics
    - Ground data optimally to match image dates
  - Spectrally similar classes
    - Surface/elevation data for distinguishing
  - Wind & weather conditions
    - May cause turbid water conditions
  - Submerged & temporarily flooded vegetation types

Way forward

The presented is ongoing work. We still need to:

- Complete work on outstanding ML classifications including LiDAR
- Complete work on Decision trees
- Get “more realistic” validation of results from local experts
- Recommendations on data sets and classification type

Thank you!

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