Using MERIS and MODIS for Land Cover Mapping in the Netherlands

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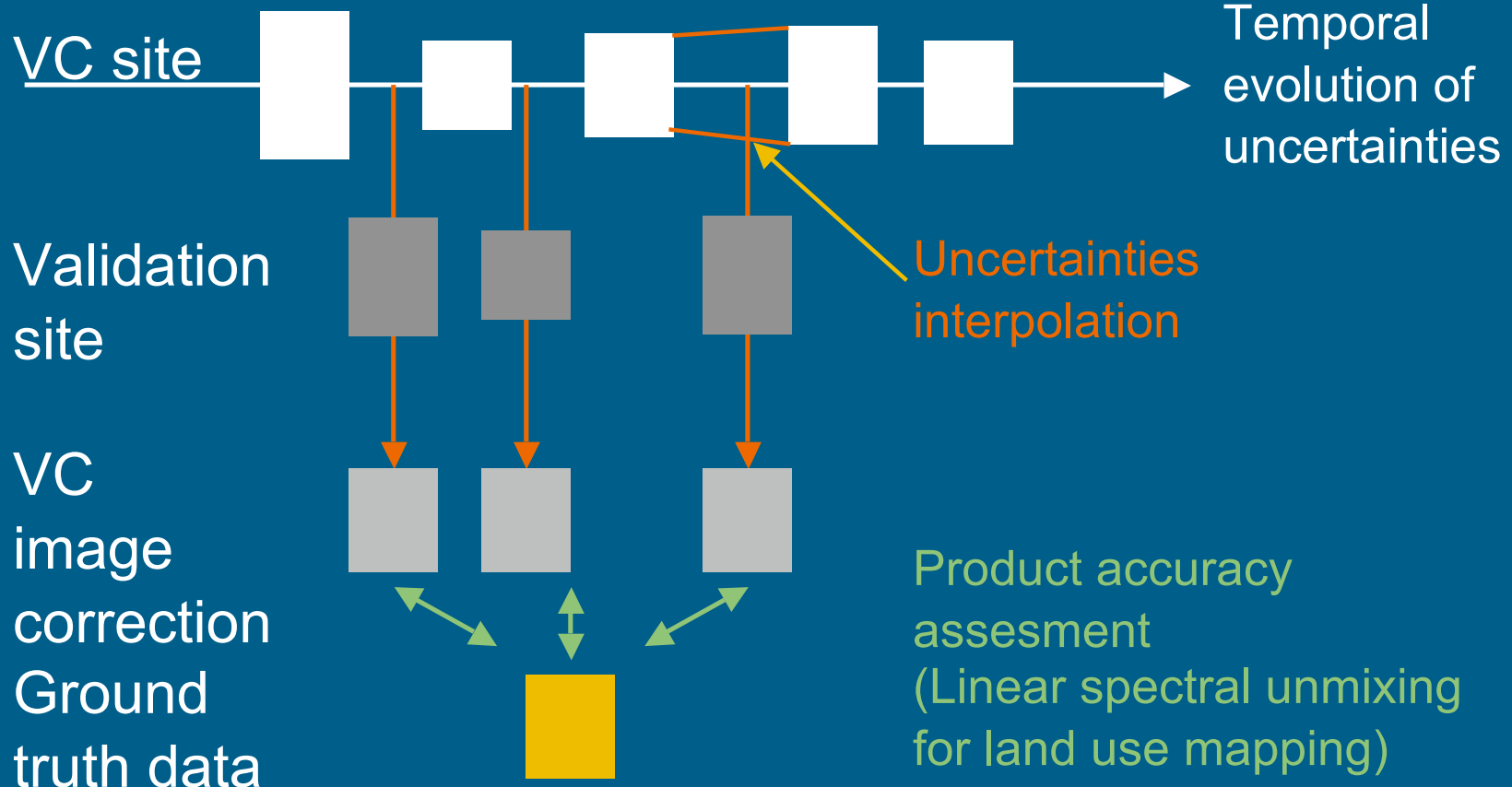
Introduction

- Actual and reliable information on land use and land cover is needed both for agricultural and enviromental applications.

- Medium resolution sensors can provide this information at a regional or global scale. They fill the gap between the low and the high spatial resolution sensors.

Introduction II



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Zurita Milla et al., 2004.Long-Term MERIS Land Product Accuracy Assessment Based on Vicarious Calibration and Regional Validation. ENVISAT Symposium. 6-10 Sept. 2004. Salzburg (Austria)

Objective

- Compare MERIS and MODIS for land use mapping
  - Study area: The Netherlands
  - Classifier: Linear Spectral Unmixing and Matched Filtering
  - Data type: Level 1b (Radiance)
  - Date: 14th July 2003
- Two study cases/comparisons
  - "Spatial resolution"
    - All medium resolution bands (<1km) will be used
    - Working scale will be 300m (resampling if necessary)
  - "Spectral resolution"
    - A similar spectral configuration will be studied

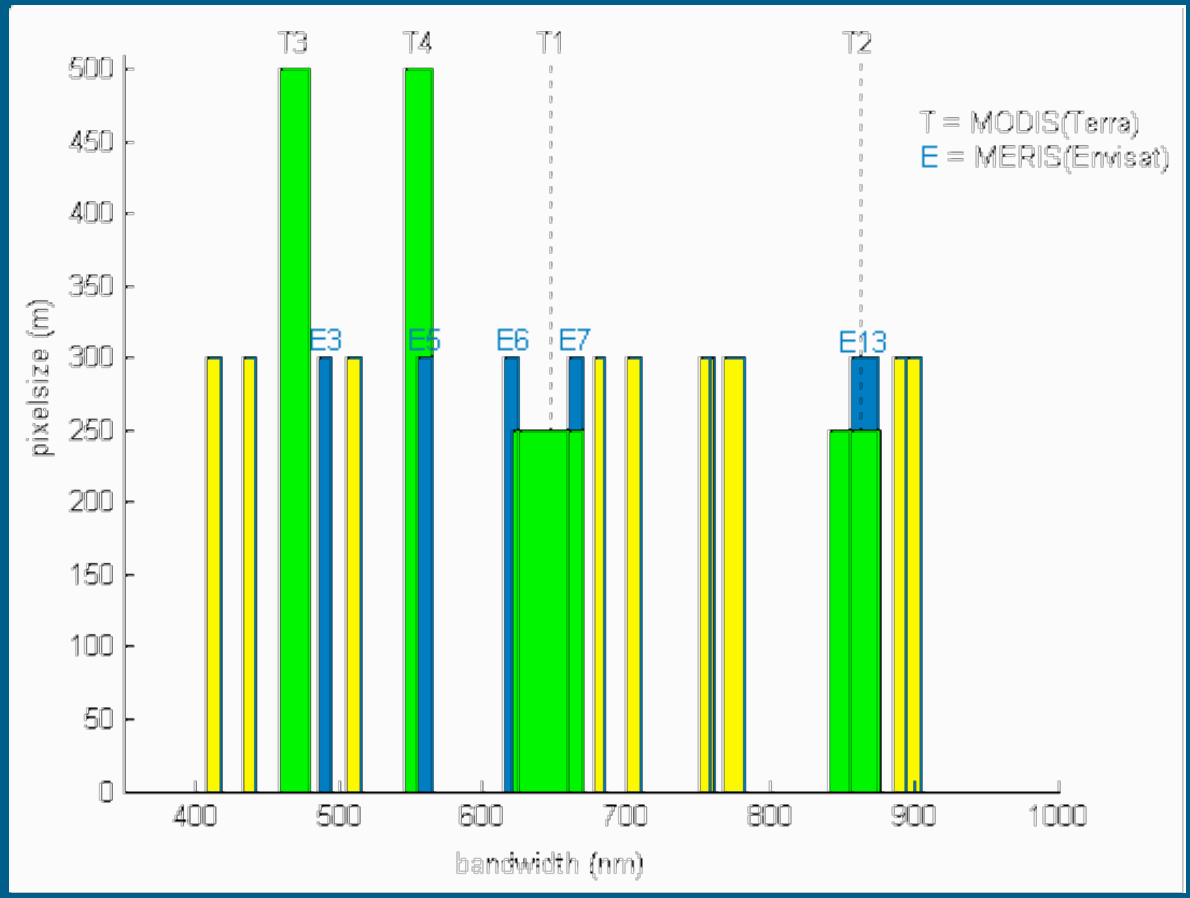
Basic Facts

	MERIS	**MODIS**
Organization	ESA	NASA
Primary Mission	Ocean color	Monitoring the Earth (Land Processes)
Swath	1150 Km	2230 km
Revisit Interval	2-3 days	1-2 days
Launch Date	March, 2002	Dec, 1999 (Terra) May, 2002 (Aqua)
Mission Duration	5-6 years	5-6 years

Basic Facts II & Study cases

MERIS	Center	Width	Pixel size
Band 3	490	10	300
Band 4	510	10	300
Band 5	560	10	300
Band 6	620	10	300
Band 7	665	10	300
Band 8	681.25	7.5	300
Band 9	705	10	300
Band 10	753.75	7.5	300
Band 12	775	15	300
Band 13	865	20	300
Band 14	890	10	300

MODIS	Center	Width	Pixel size
Band 1	645	50	250
Band 2	858.5	35	250
Band 3	469	20	500
Band 4	555	20	500
Band 5	1240	20	500
Band 6	1640	24	500
Band 7	2130	50	500



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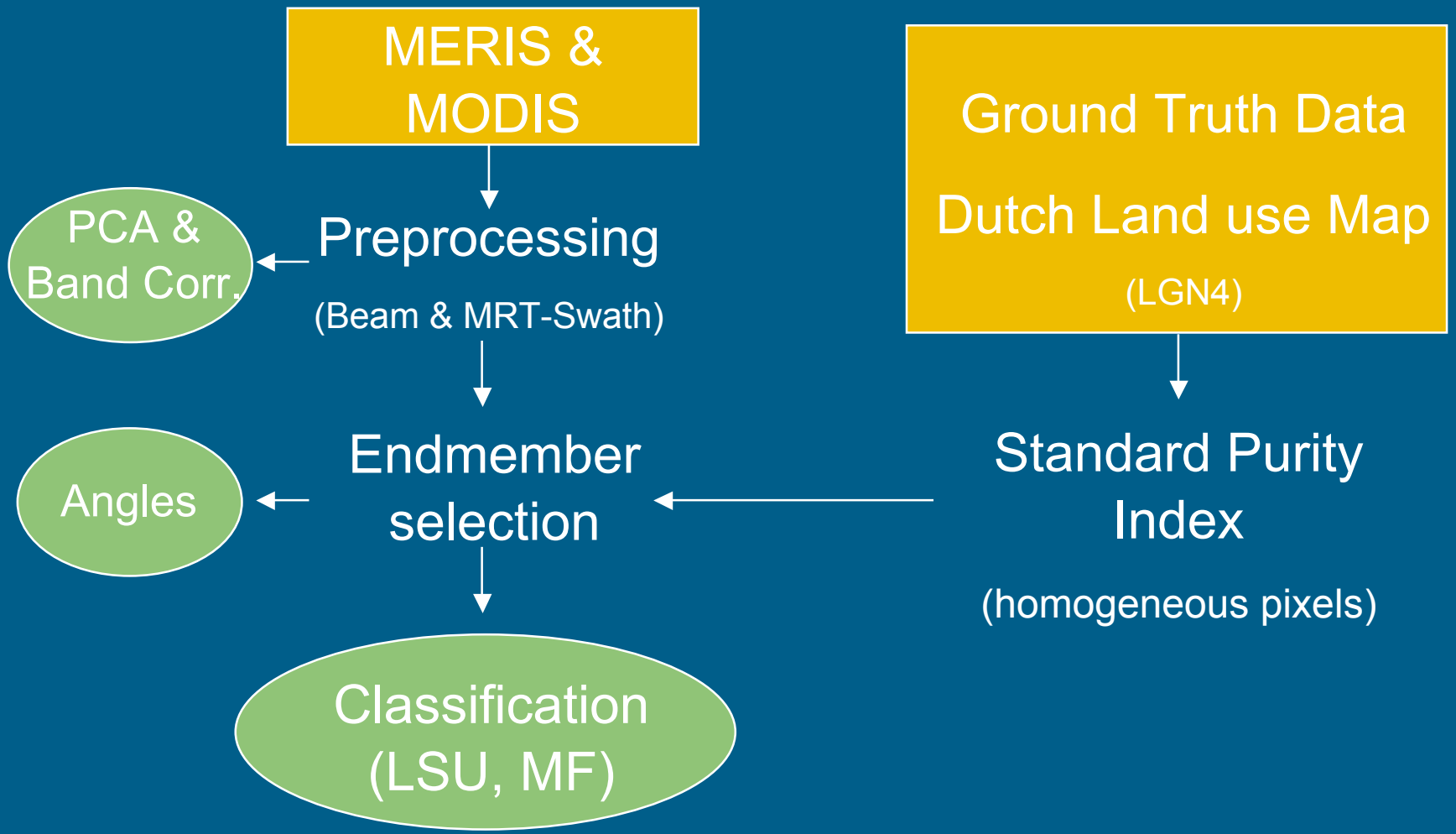
General Methodology



Preprocessing

- Geo-Coding and Radiance values

  Using BEAM and MRT Swath the images were geo-referenced and the radiance values were computed after applying the respective gain factors.

- MODIS pixel size

  250→ 300 m

  500→ 300 m

- Corrections

  MERIS Smile effect

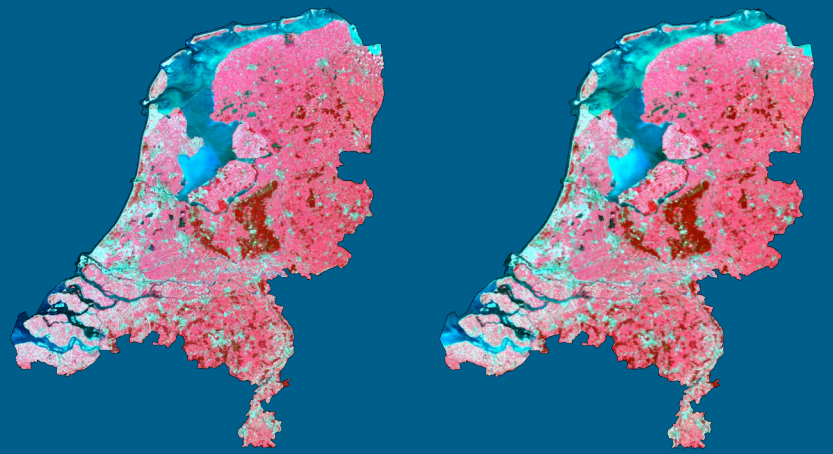
  MODIS Bow-Tie

- Image to Image registration

  using the LGN as a reference both the MERIS and the MODIS image were co-registered to this dataset.

  a 30 points, 3rd degree polynomial and NN transformation resulted in similar “errors”.

	RMSE
MERIS	0.4347
MODIS	0.4406



MERIS MODIS

July 14, 2003

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PCA and Correlation Analysis

- PCA

	MERIS	MODIS
PC1	90.80	89.08
PC2	8.70	8.19
PC3	0.28	1.79
Total	99.78	99.06

98% of PC1 is explained by the following bands:

MERIS 10,12,13 and14 (NIR)

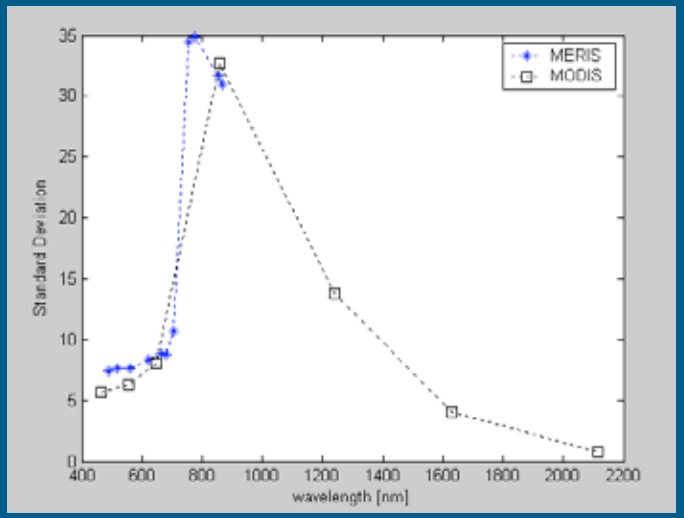
MODIS 2 and 5 (NIR)

- Correlation Analysis

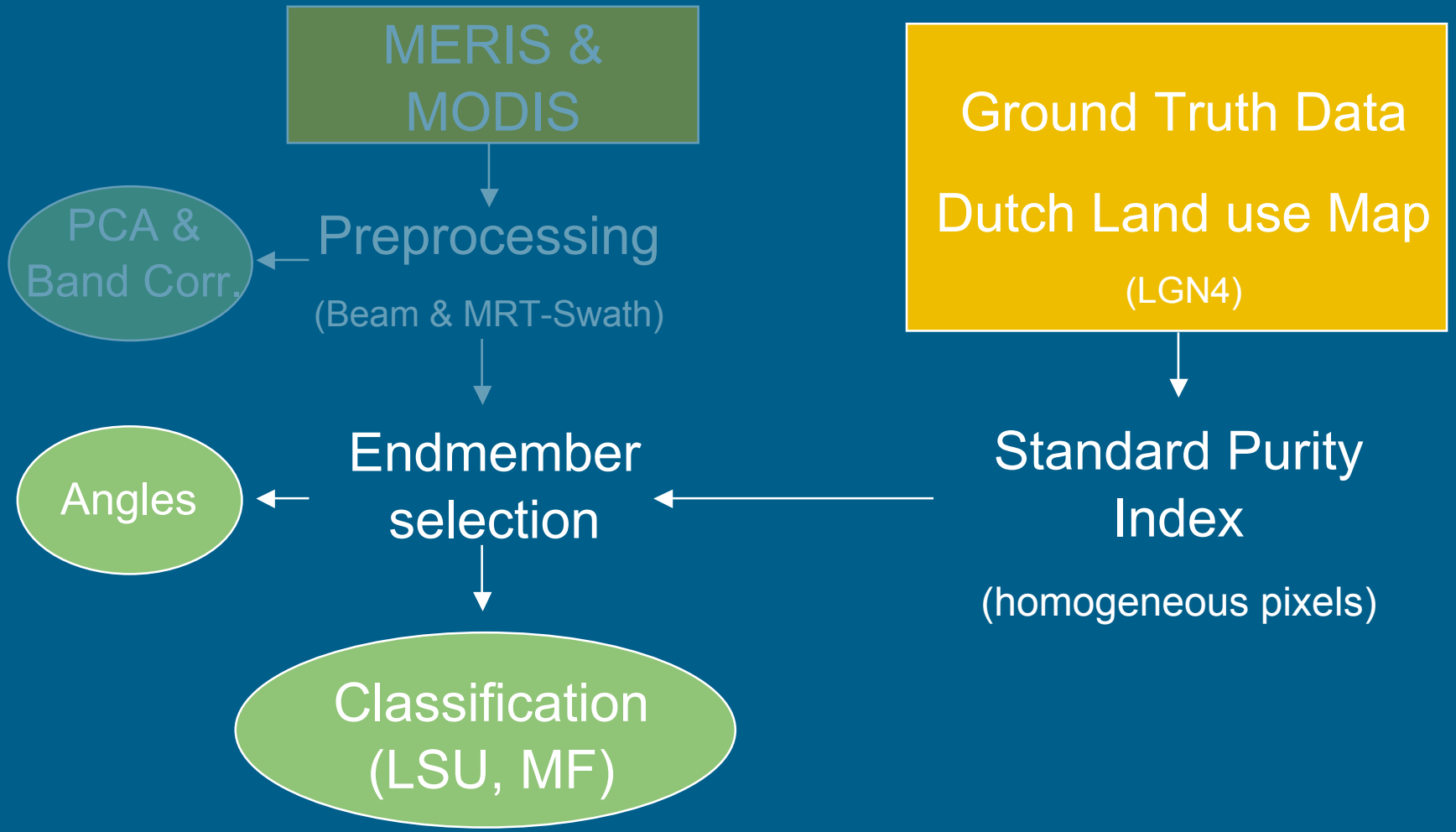
3 Groups can be identified for both sensors

MERIS: VIS (3:8), Red-Edge (9), NIR (10:14)

MODIS: VIS (1-3-4), NIR (2-5-6) , SWIR (7)

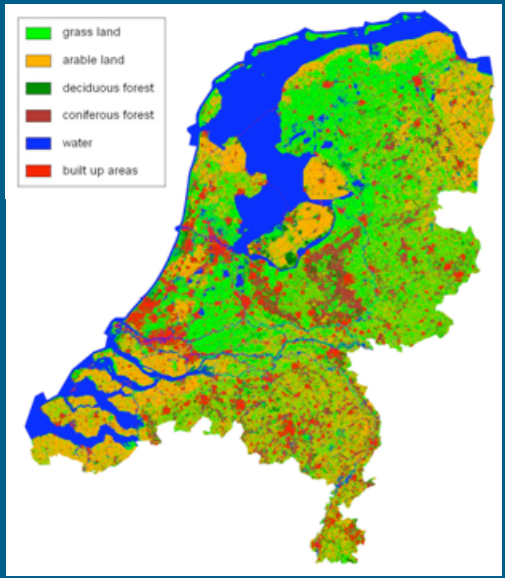


General Methodology



LGN

- Dutch Land Use Map
  - Based on multitemporal classification of satellite imagery and integration with ancillary data.
  - LGN4 was based on data from 1999 and 2000
  - The overall accuracy is 85-90%
  - “Spatial case’’: aggregation to main 6 classes and 300m
  - “Spectral case”: aggregation to main 4 classes and 300m

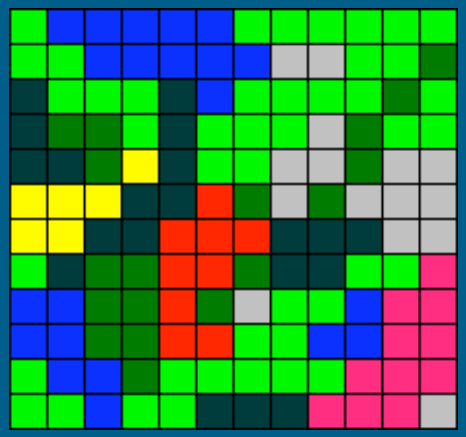


Land use	Cover [%]	Land use	Cover [%]
Grassland	39.92	Agriculture / Low vegetation	78.5
Arable land	24.37		
Deciduous forest	2.92	Forest	9.40
Coniferous forest	4.78		
Water	18.14	Water	*masked out*
Built up areas	9.87	Built up	12.05

Standard Purity Index

- The LGN4 was aggregated from 25 to 300m.
- During the aggregation the standard purity index (SPI) was computed

300 m



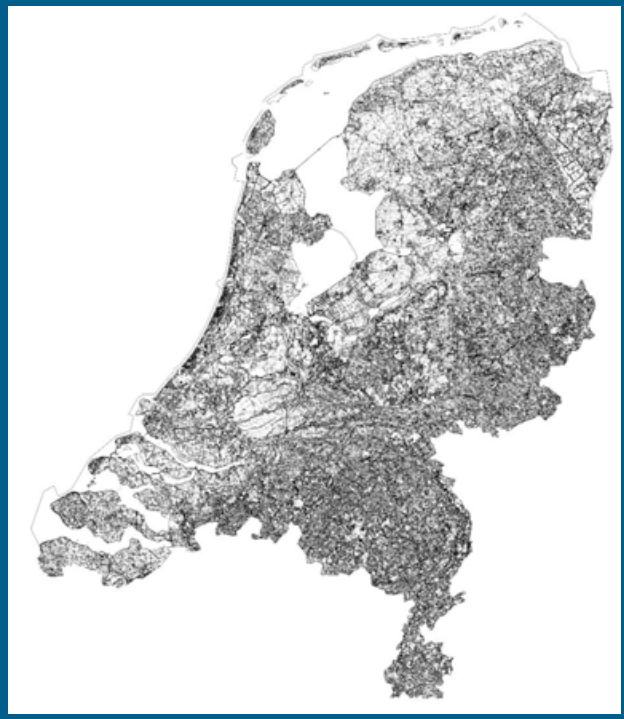
LGN 25 → 300 m

Majority filter

(12 x 12)

$$SPI = \sqrt{\frac{\sum_{i=1}^{i=n}(f_i - f_{\max class})^2}{n-1}}$$

SPI MAP



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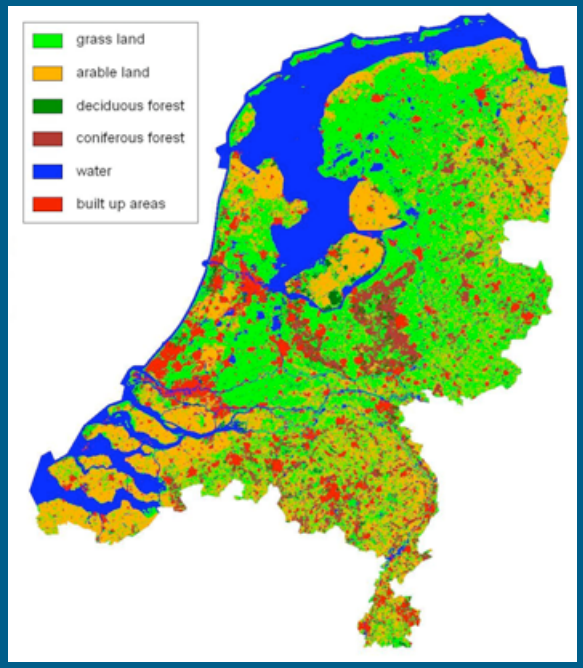
Pure pixels 6 classes

- SPI>0.95 and a moving window filter of 3*3 (minimisation of adjacent effects) were used for the selection of the most homogenous pixels in The Netherlands



LGN 300m 6 classes

'Pure' Pixels

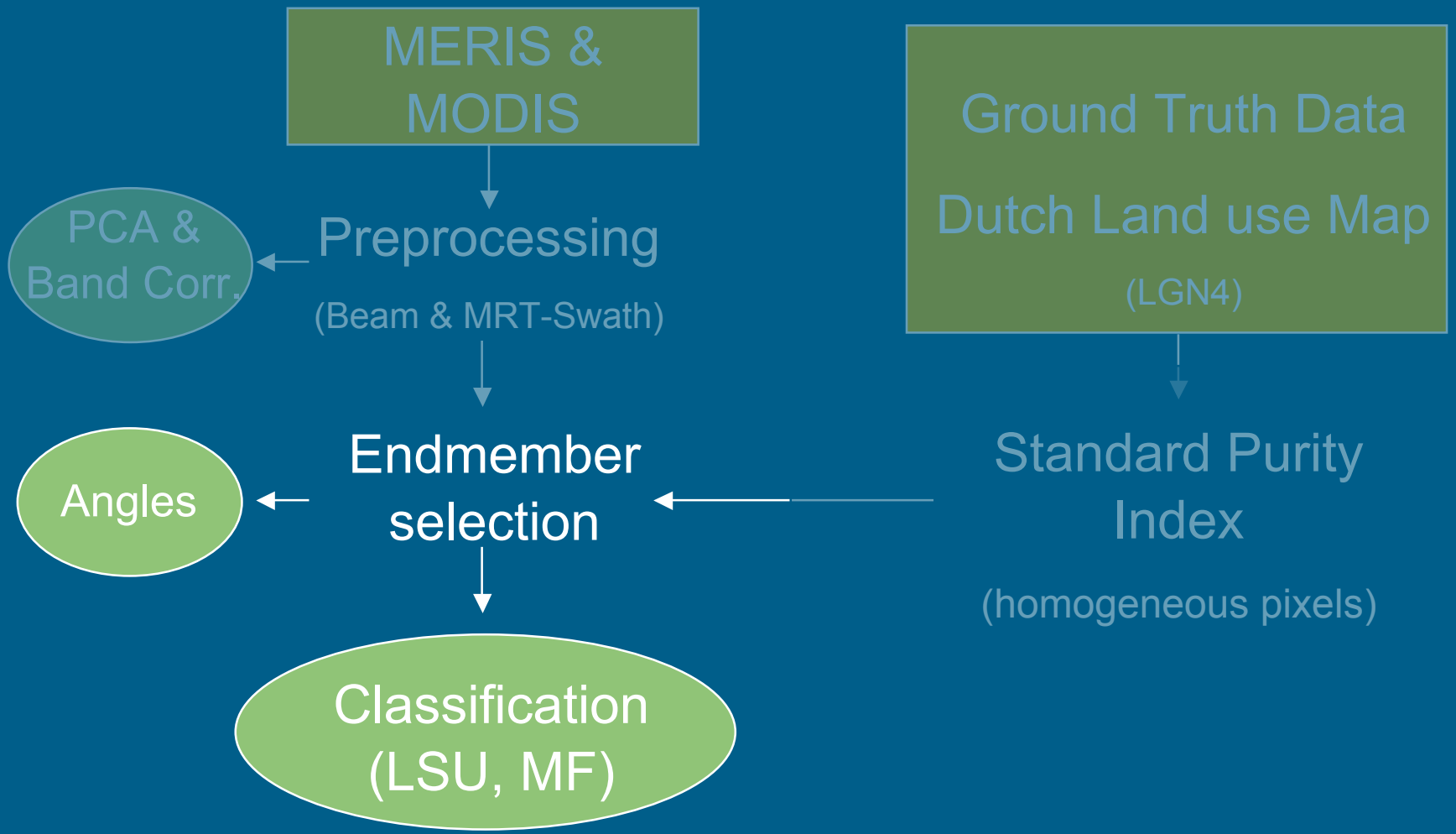
Pure pixels 4 classes

- The water was masked out since a low spectral confusion was expected with the rest of the classes

LGN 300m 4 classes

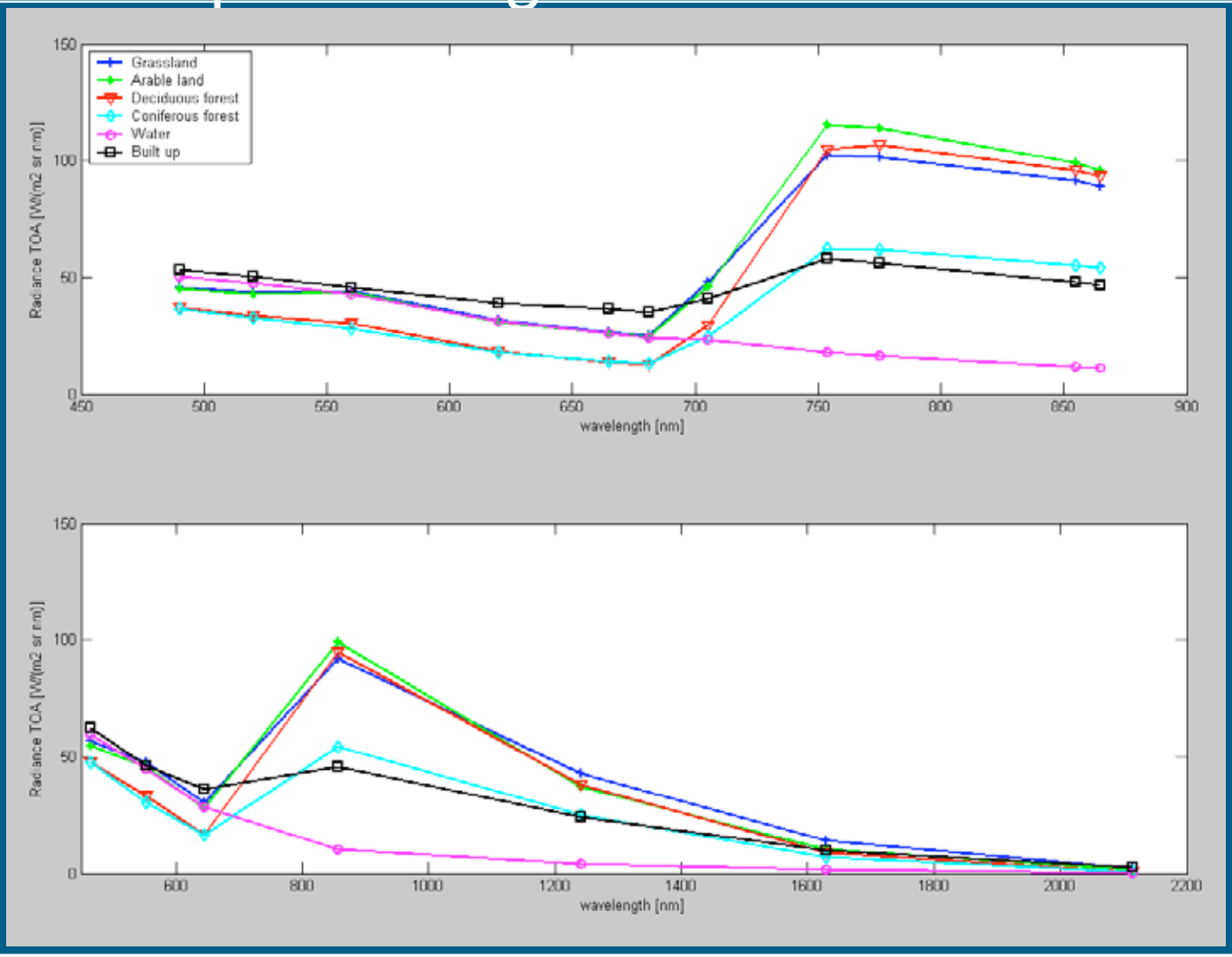
'Pure' Pixels

General Methodology



Results: Spectral Signatures of 6 endmembers

MERIS



MODIS

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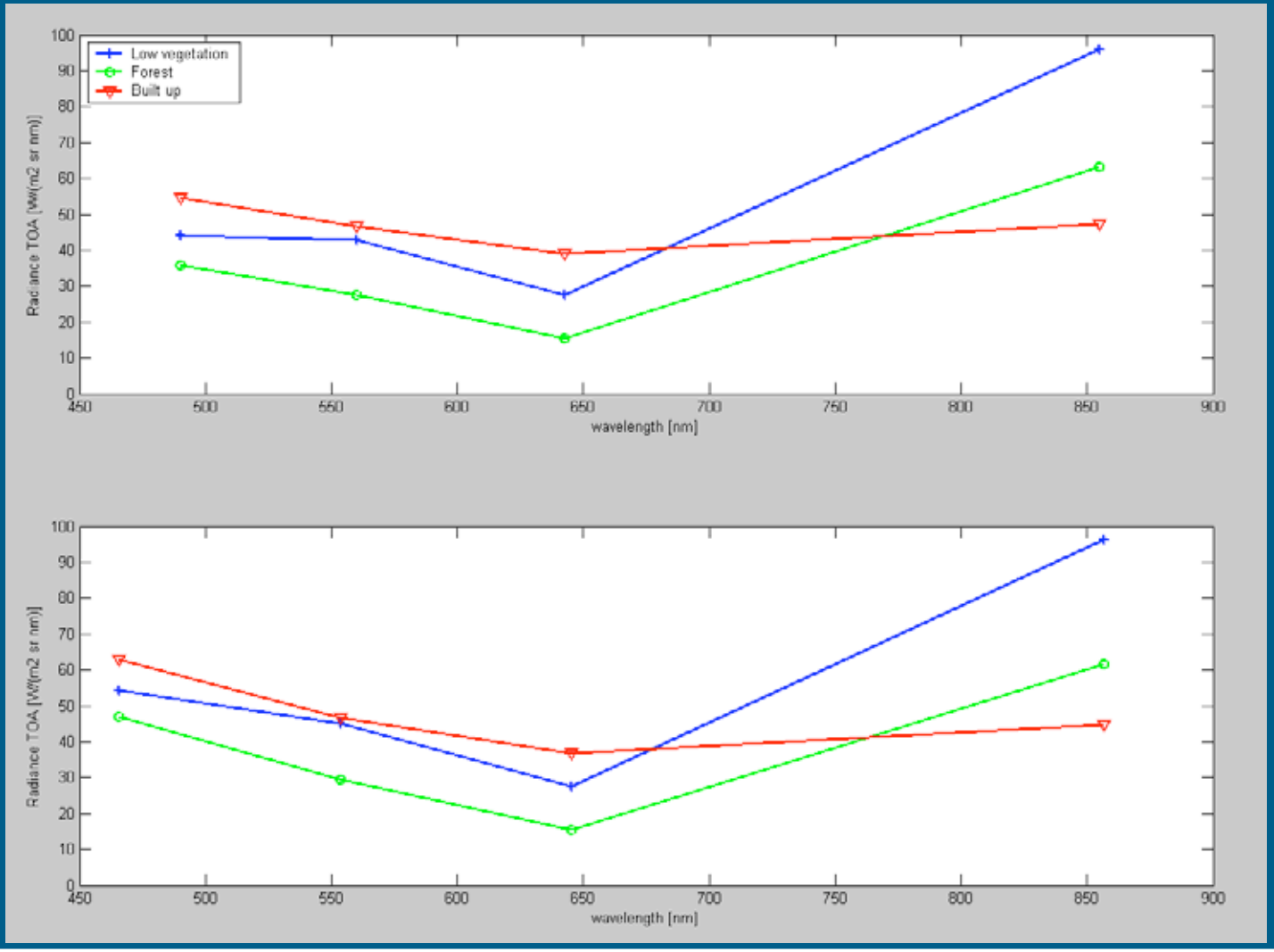
Results: Spectral Signatures of 3 endmembers

MERIS



MODIS

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Results: Endmembers' Angles

$$\theta = \cos^{-1}\left[\frac{\int S_1(\lambda)S_2(\lambda)d\lambda}{\left[\int S_1(\lambda)d\lambda\right]^{1/2}\left[\int S_2(\lambda)d\lambda\right]^{1/2}}\right]$$ *

	Low vegetation	Forest	Built up
Low vegetation	--		
Forest	MODIS	--	
Built up	MERIS	MERIS	--

3 classes

	Grassland	Arable land	Deciduous forest	Coniferous forest	Water	Built up
Grassland	--					
Arable land	MODIS	--				
Deciduous forest	MODIS	MERIS	--			
Coniferous forest	MODIS	MODIS	MODIS	--		
Water	MERIS	MERIS	MERIS	MERIS	--	
Built up	MODIS	MODIS	MERIS	MERIS	MERIS	--

6 classes

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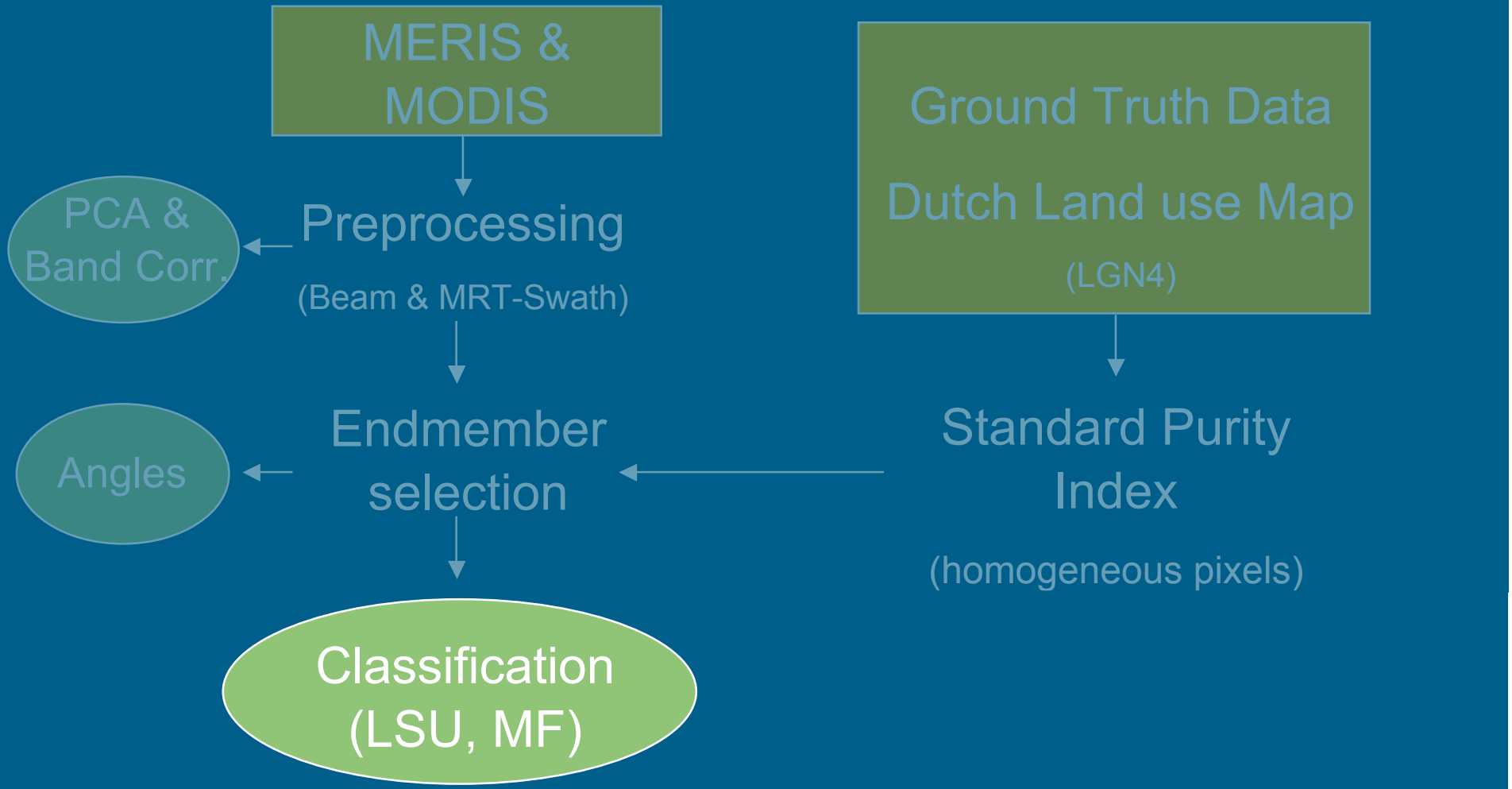
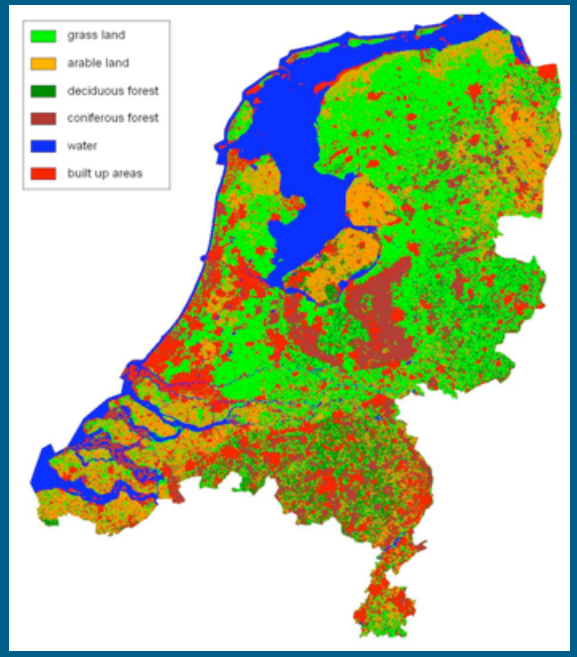
*Price, J.C 1994. How unique are spectral signatures?

Remote Sens. Environ. 49:181-186.

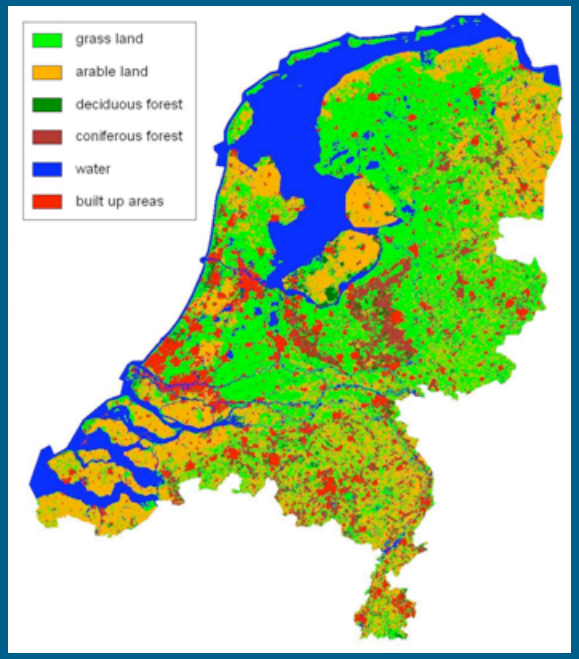
General Methodology



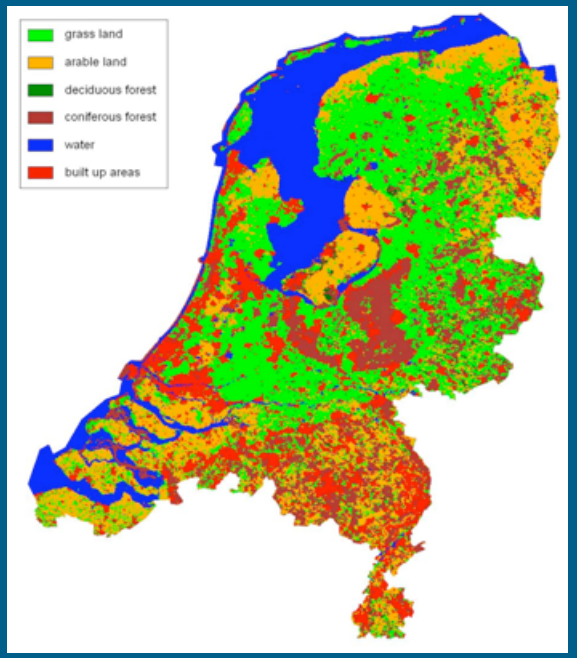
Results: Unmixed images MF 6 classes



MERIS

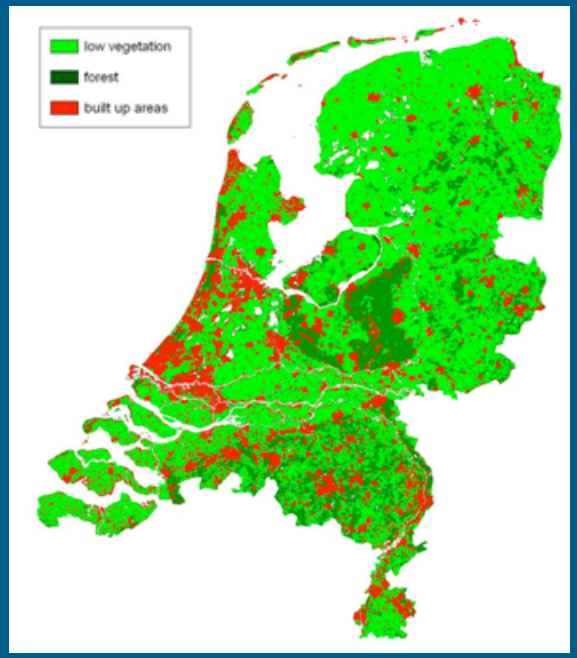


LGN



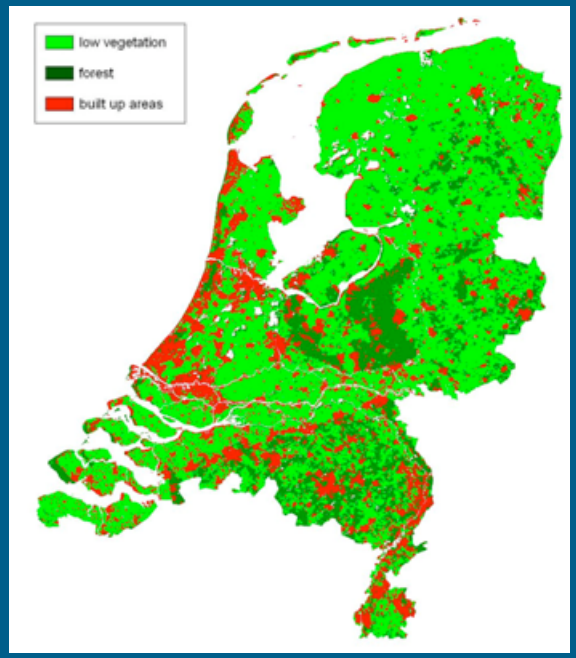
MODIS

Results: Unmixed images MF 3 classes



MERIS

LGN



MODIS

Results: Quantification

Overall Accuracy (%)

	MERIS		MODIS	
	LSU	MF	LSU	MF
6 classes	57.08	60.25	40.58	61.29
3 classes	82.54	76.61	82.35	78.47

LSU: Linear Spectral Unmixing

MF: Matched Filtering

Conclusions and Recommendations

- Geometric and radiometric properties both of MERIS and MODIS seem OK.
- Both instruments showed a good performance for classifying land use in The Netherlands.
  - MERIS is slightly better when working with LSU
  - MODIS is slightly better when working with MF
- Combined use of MERIS and MODIS (Hierarchical schemes) could lead to an improved classification accuracy

Outlook

- Multitemporal classifications and the use of other classifiers (e.g. DT or Fuzzy) will be investigated in the near future.

Acknowledgements

- Many thanks to Anne van Gijsel for her precious help with the data pre-processing
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Thank you for your attention!

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