Data Exploitation della missione PRISMA, precursore delle missioni iperspettrali nazionali

Sede Agenzia Spaziale Italiana
Roma 01-03/03/2017

Valutazione dell'impatto ambientale di incendi: comparazione dei risultati ottenuti con dati iperspettrali e multispettrali

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Hyperspectral Data vs Multispectral Data

Hyperspectral Data vs. Multispectral Data
In
Fire Severity Assessment
by using a
Spectral Mixture Analysis
(SMA)
approach

Fire Severity Assesment

a) Detection – At least a single pixel of the burnt area is detected

b) Mapping – All the pixel of burnt area are detected

c) Fire Severity - Evaluation of fire impact (How?)

Fire Severity Assesment

a) Detection – At least a single pixel of the burnt area is detected

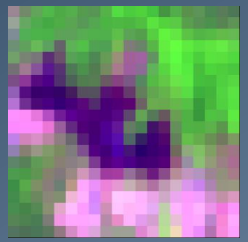
b) Mapping – All the pixel of burnt area are detected

c) Fire Severity - Evaluation of fire impact (How?)

- Fire temperature
- Impact on ecosystem
- Percentage of damaged vegetation

Comparison methodology

Multispectral data set
(ETM+)



Hyperspectral data set
(Hyperion)

Fire severity evaluation

Fire severity evaluation

Quantitative / Qualitative results

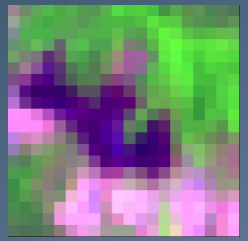
Comparison

Quantitative / Qualitative results

Comparison methodology

Multispectral data set
(ETM+)

Data set intercalibration
Geometric alignment



Hyperspectral data set
(Hyperion)

Fire severity evaluation
Spectral Mixture Analysis Approach

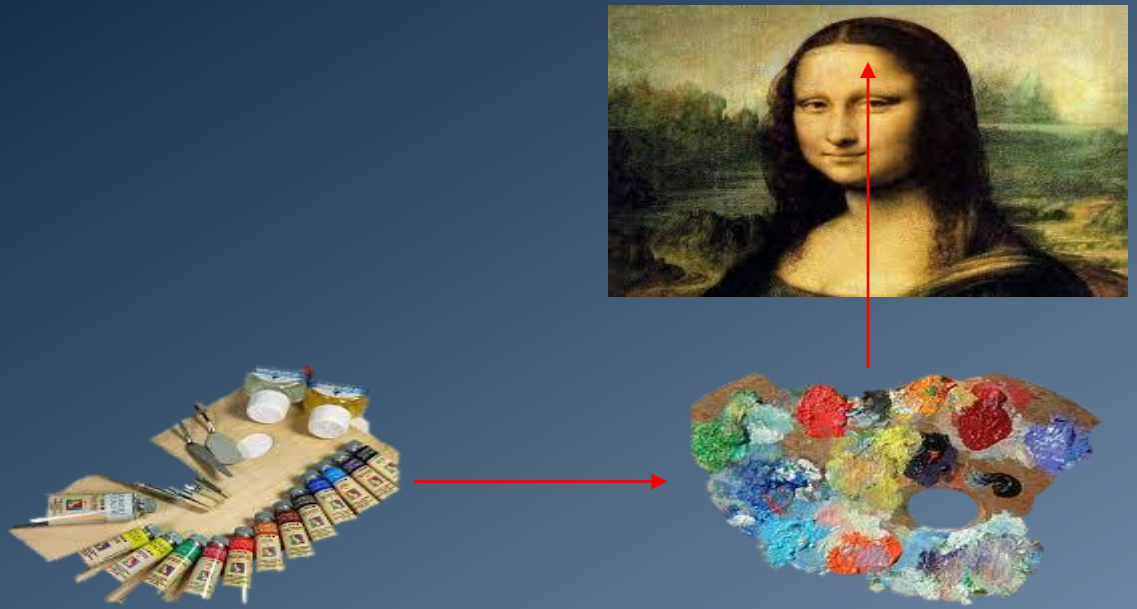
Fire severity evaluation
Spectral Mixture Analysis Approach

Quantitative / Qualitative results

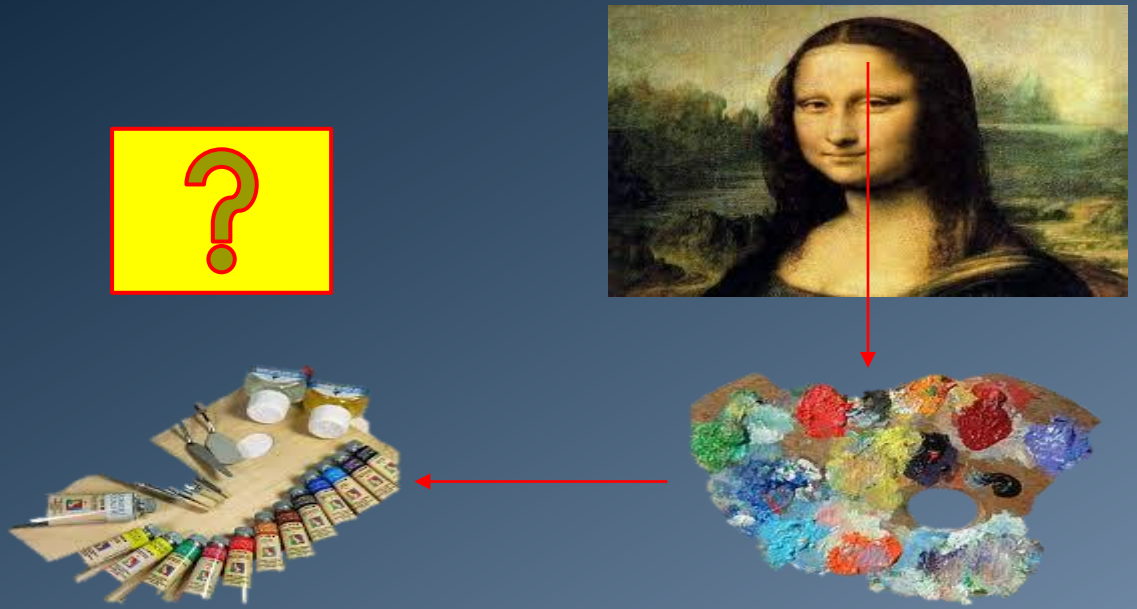
Comparison

Quantitative / Qualitative results

Spectral Mixture Analysis

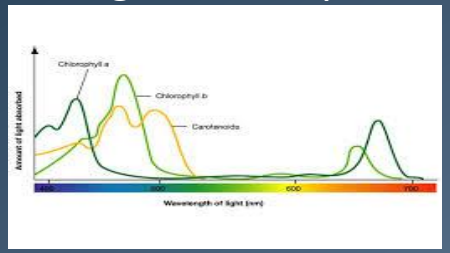


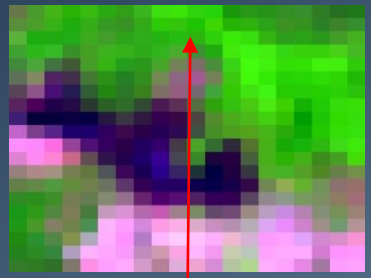
Spectral Mixture Analysis

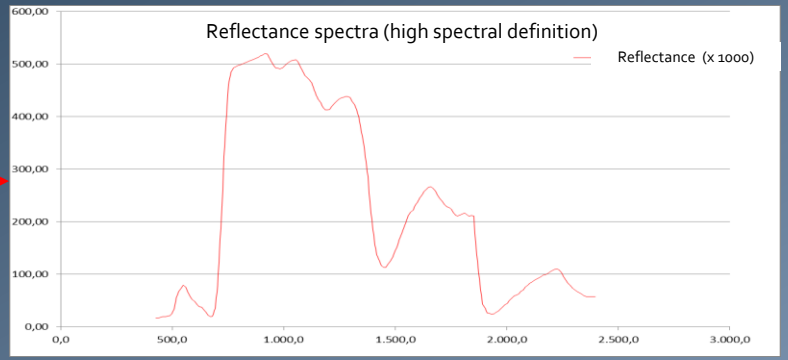


Spectral Mixture Analysis

Spectra related to materials located in imaged mixed pixel

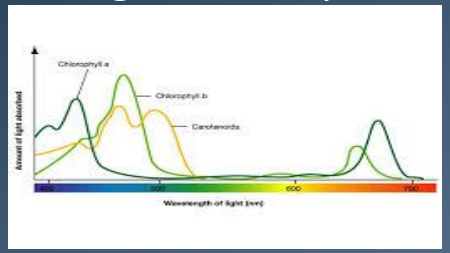


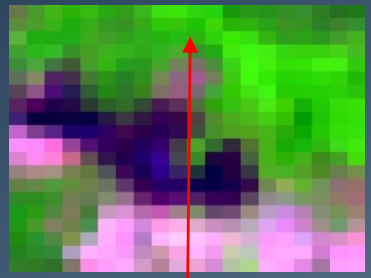


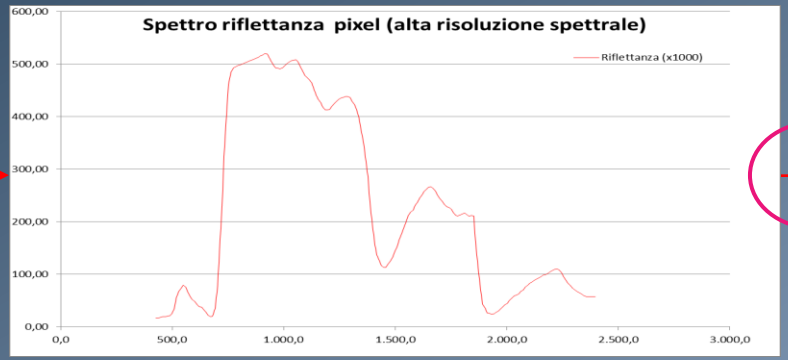


Spectral Mixture Analysis

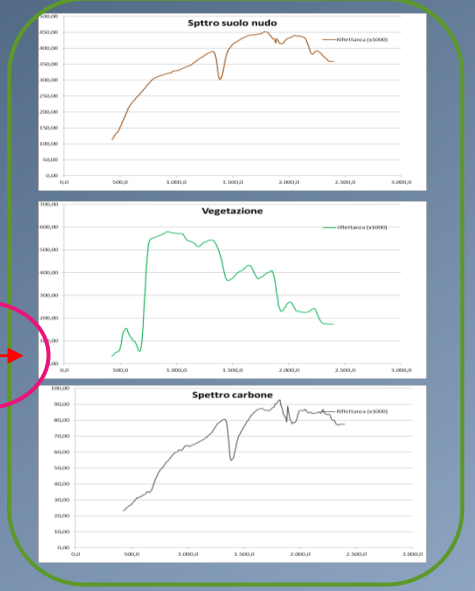
Spectra related to materials located in imaged mixed pixel



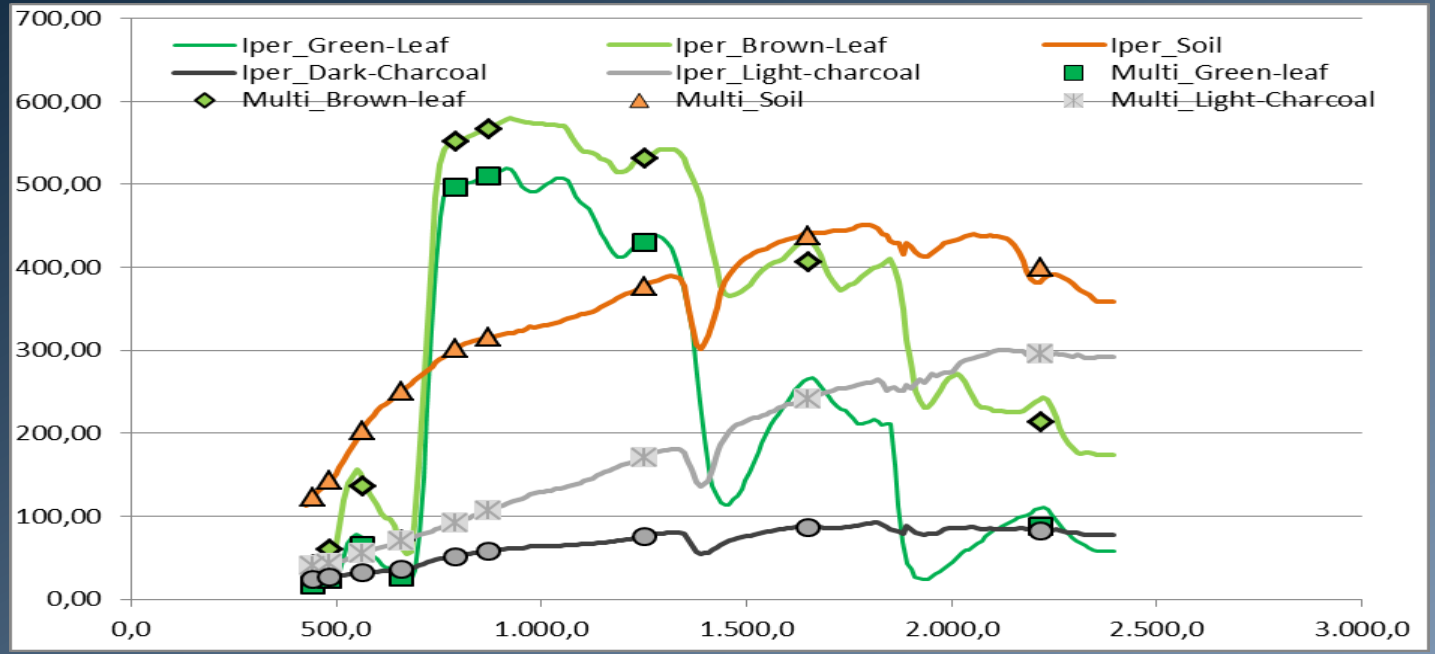




End-members Percentage



End members Spectra

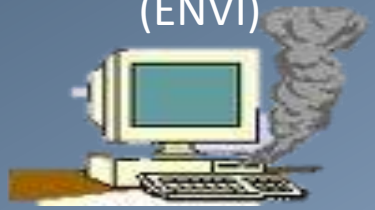


Spectral sampling→ Spectral Aliasing

Fire Severity classification

fire severity classification

IDL procedure (ENVI)



Fire Severity classification

End-members spectra (lab.)

Resampling
On hyperspectral
frequencies

Lab. Spectral Samples

Fire Severity classification

End-members spectra (lab.)

Resampling
On hyperspectral frequencies

Lab. Spectral Samples

Internal Spectral Samples

End-members samples
ne interni

Fire Severity classification

End-members spectra (lab.)

Resampling
On hyperspectral frequencies

Lab. Spectral Samples

Internal Spectral Samples

End-members samples
ne interni

Hyper. data

Fire Severity classification

End-members spectra (lab.)

Resampling
On hyperspectral
frequencies

Lab. Spectral Samples

Internal Spectral Samples

Hyper.
data

End-members
samples
ne interni

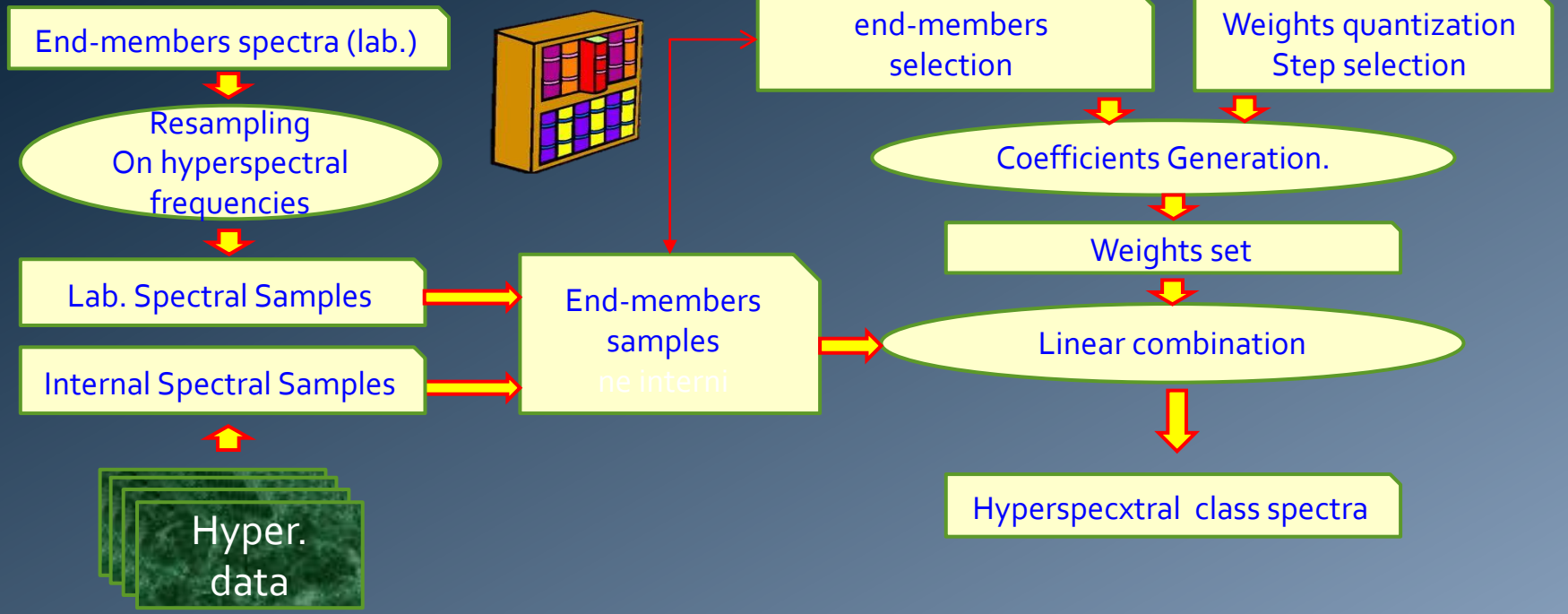
end-members
selection

Weights quantization
Step selection

Coefficients Generation.

Weights set

Fire Severity classification



Fire Severity classification

End-members spectra (lab.)

Resampling On hyperspectral frequencies

Lab. Spectral Samples

Internal Spectral Samples

Hyper. data

End-members samples

end-members selection 3

Weights quantization Step selection 0,5

Coefficients Generation.

Weights set

Linear combination

	End-member 1	End-member 2	End-member 3
Combinazione #			
1	1.00	0.00	0.00
2	0.50	0.50	0.00
3	0.00	1.00	0.00
4	0.50	0.00	0.50
5	0.00	0.50	0.50
6	0.00	0.00	1.00

Fire Severity classification

End-members spectra (lab.)

Resampling
On hyperspectral
frequencies

Lab. Spectral Samples

Internal Spectral Samples

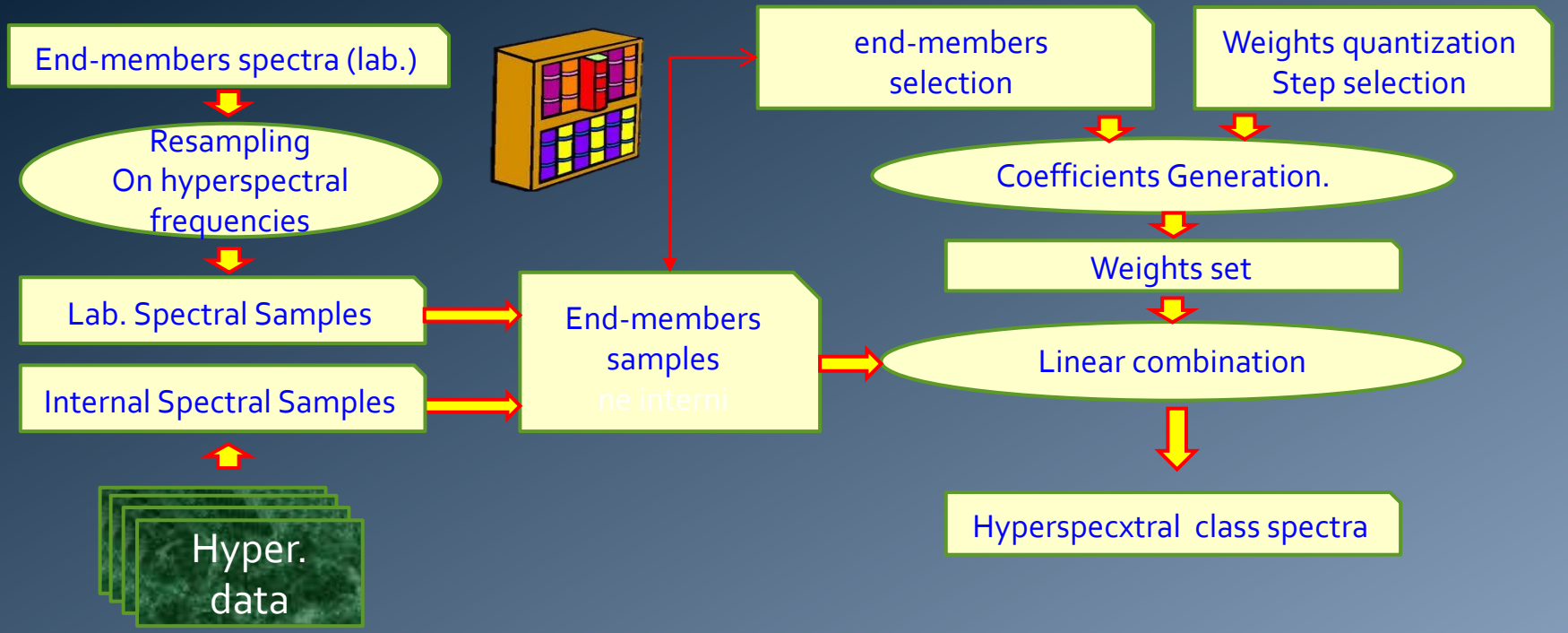
Hyper.
data

end-members selection	3

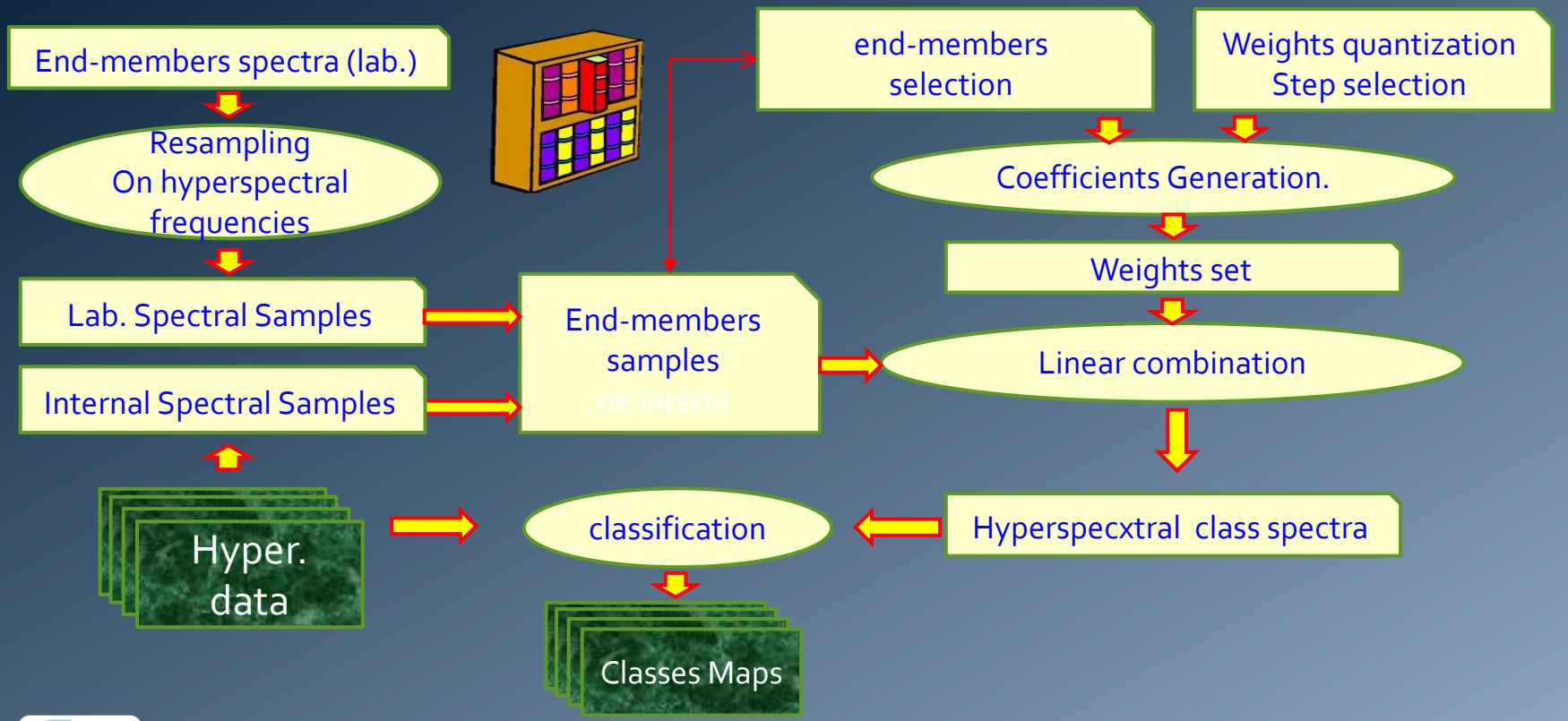
Weights quantization Step selection	0,25

	Green leafs	Soil	Dark charcoil
Combinazione #			
1	1.00	0.00	0.00
2	0.75	0.25	0.00
3	0.50	0.50	0.00
4	0.25	0.75	0.00
5	0.00	1.00	0.00
6	0.75	0.00	0.25
7	0.50	0.25	0.25
8	0.25	0.50	0.25
9	0.00	0.75	0.25
10	0.50	0.00	0.50
11	0.25	0.25	0.50
12	0.00	0.50	0.50
13	0.25	0.00	0.75
14	0.00	0.25	0.75
15	0.00	0.00	1.00

Fire Severity classification



Fire Severity classification



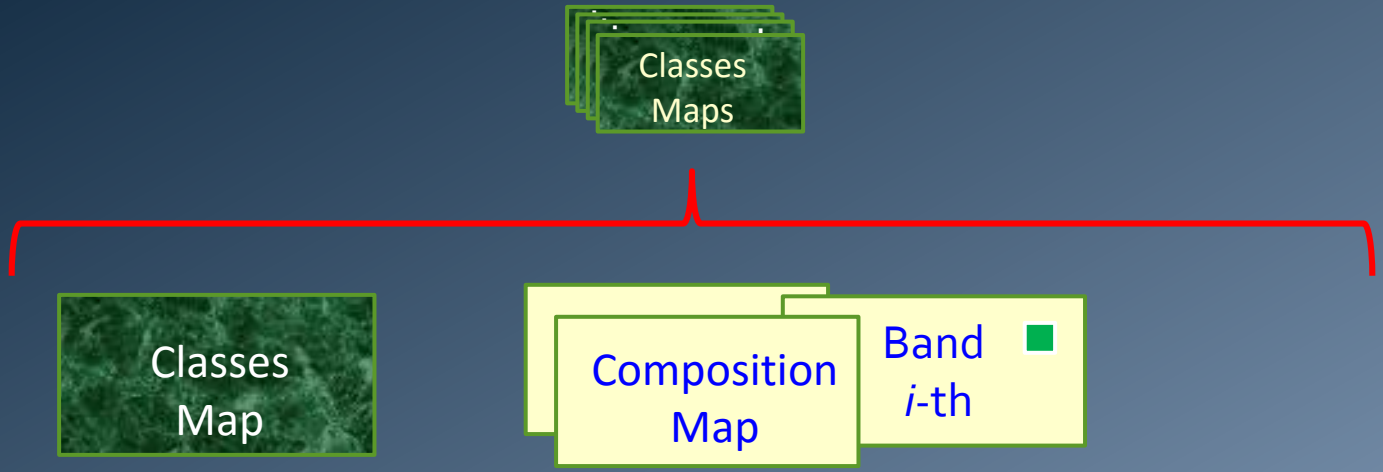
Fire Severity classification

Classes Map

Pixel Value is the class number

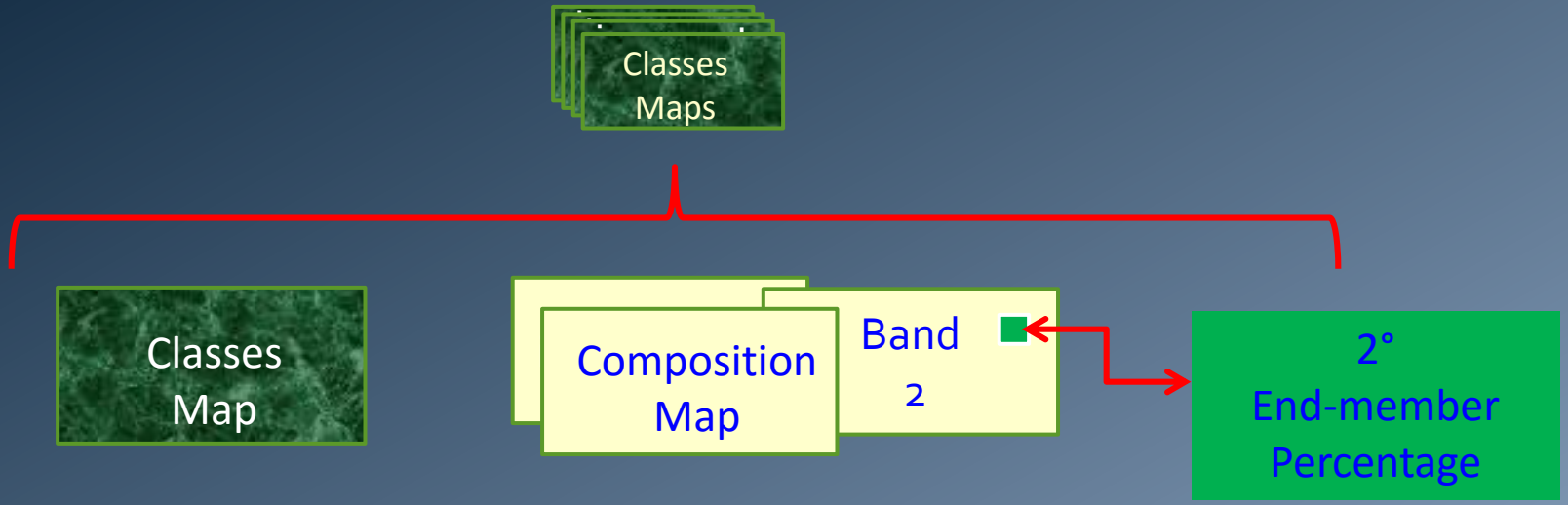
	End-member 1	End-member 2	End-member 3
Comb.ne #			
1	1.00	0.00	0.00
2	0.50	0.50	0.00
3	0.00	1.00	0.00
4	0.50	0.00	0.50
5	0.00	0.50	0.50
6	0.00	0.00	1.00

Fire Severity classification



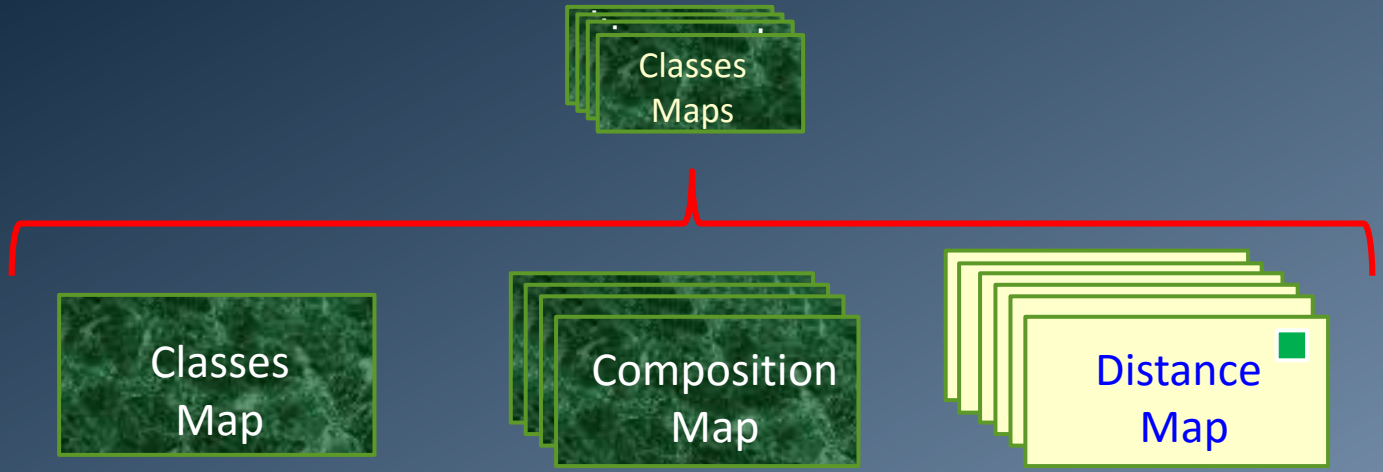
Pixel Value of *i* -th band
is the percentage of *i* -th end-members
in that pixel

Fire Severity classification

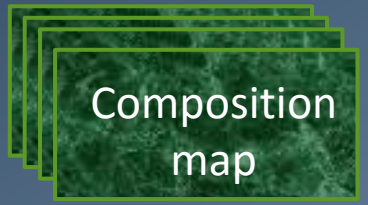


	End-member 1	End-member 2	End-member 3
Comb.ne #			
1	1.00	0.00	0.00
2	0.50	0.50	0.00
3	0.00	1.00	0.00
4	0.50	0.00	0.50
5	0.00	0.50	0.50
6	0.00	0.00	1.00

Fire Severity classification



Fire Severity classification

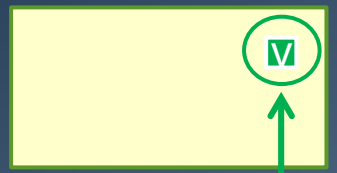


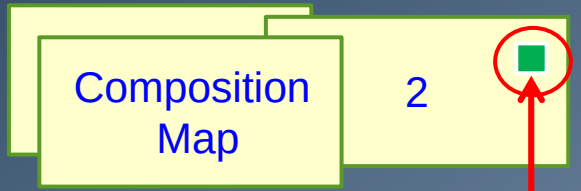
	End-member 1	End-member 2	End-member 3
Combination #			
1	1.00	0.00	0.00
2	0.50	0.50	0.00
3	0.00	1.00	0.00
4	0.50	0.00	0.50
5	0.00	0.50	0.50
6	0.00	0.00	1.00

Distance pixel spectrum
↔
2° combination spectrum

Fire Severity classification

ENVI procedure





	End-member 1	End-member 2	End-member 3
Comb.ne #			
1	1.00	0.00	0.00
2	0.50	0.50	0.00
3	0.00	1.00	0.00
4	0.50	0.00	0.50
5	0.00	0.50	0.50
6	0.00	0.00	1.00

2° end-member Percentage

Distance pixel spectrum ↔ 2° combination spectrum

Comparation

Evaluation of hyperpectral result

Comparation hyperspectral results vs. multispectral results

Comparation

Evaluation of hyperpectral result

Comparation hyperspectral results vs. multispectral results

Ground truth not available

Quantitative evaluation is not possible

Comparation

Evaluation of hyperpectral result

Comparation hyperspectral results vs. multispectral results

Ground truth not available

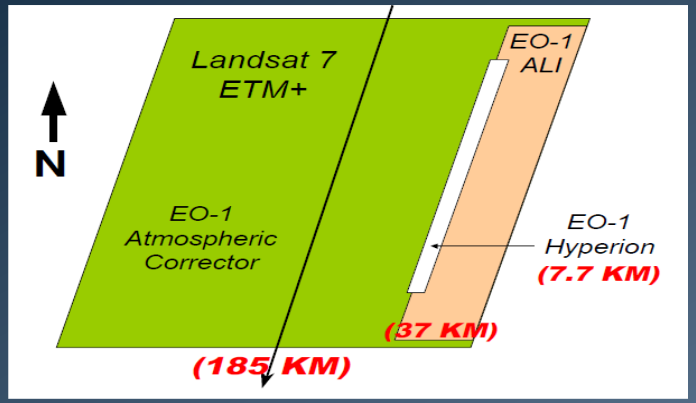
Quantitative evaluation is not possible

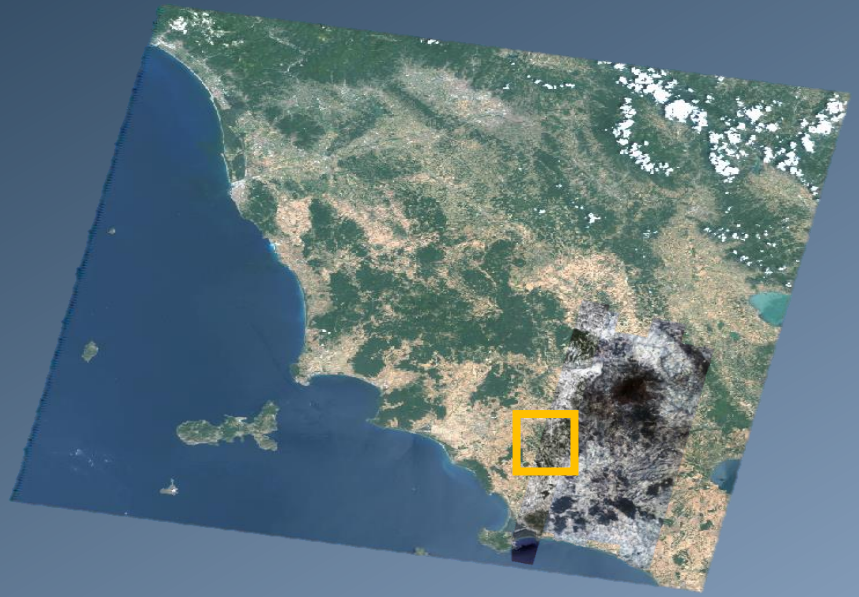
Qualitative evaluation of results from hyperspectral data

Comparison

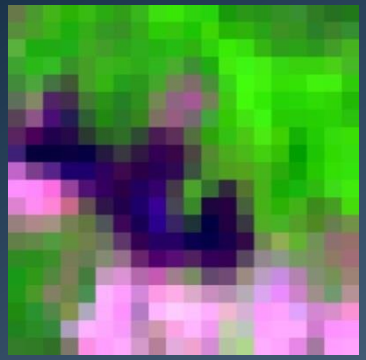
Qualitative evaluation of results from multispectral data

Test Area


Landsat 7
ETM+
EO-1
ALI
N
EO-1
Atmospheric
Corrector
EO-1
Hyperion
(7.7 KM)
(37 KM)
(185 KM)

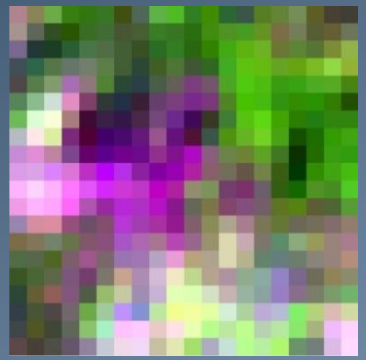


Test Area



12/07/2002

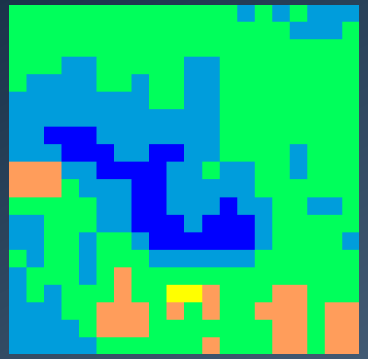
ETM+
RGB=432



14/07/2002

Comparison

Hyperspectral results



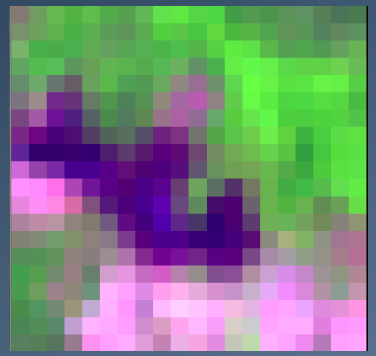
Soil

Green Leafs

Dark Charcoil

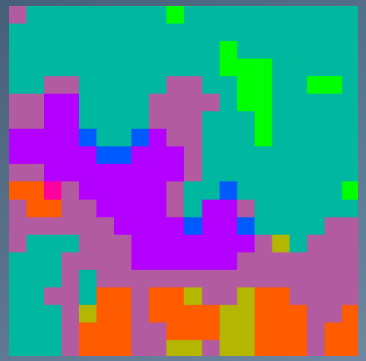
3 end-members
5 weight

ETM 12/07/2002



%	Veg.	Suolo nudo	Carbone
	0%	0%	100%
	25%	0%	75%
	0%	25%	75%
	25%	25%	50%
	25%	25%	50%
	50%	25%	25%
	75%	0%	25%
	25%	50%	25%
	50%	25%	25%

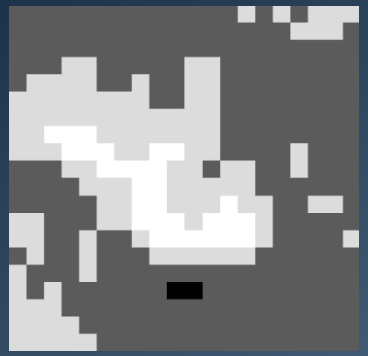
Multispectra results



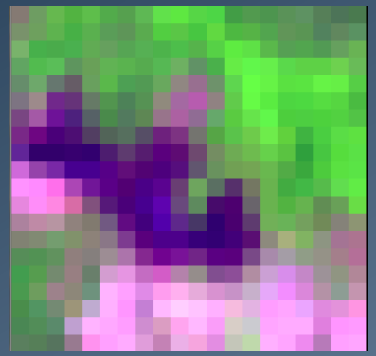
Results from hyperspectral data are more plausible

Comparison

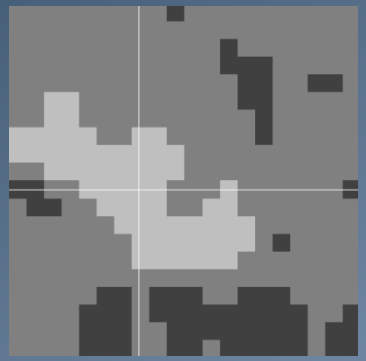
Hyperspectral results



ETM 12/07/2002



Multispectra results



In hyperspectral results the internal area 100% burned is surrounded by pixel with 75% charcoal and 25% vegetation

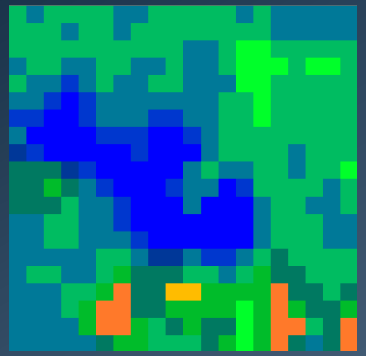
0%

100%Charcoal

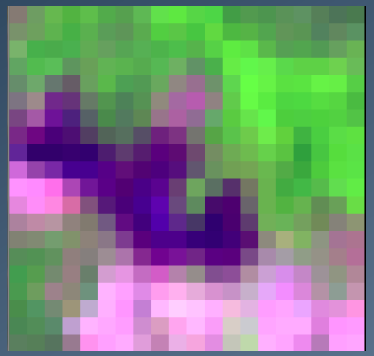
In hyperspectral results some false positive are present; a hierachical strategy is therefore suggested

Comparison

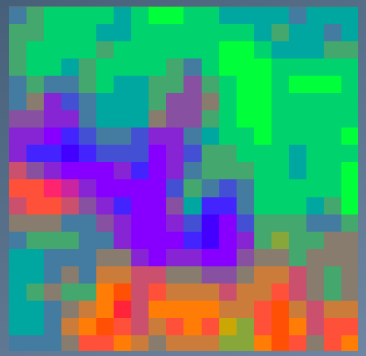
Hyperspectral results



ETM 12/07/2002



Multispectra results



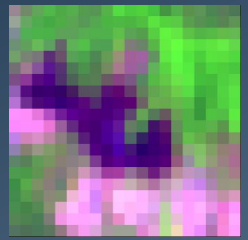
%	Vegetation	Bare soil	Charcoal
	0%	0%	100%
	25%	0%	75%
	0%	25%	75%
	25%	25%	50%
	25%	25%	50%
	50%	25%	25%
	75%	0%	25%
	25%	50%	25%
	50%	25%	25%

10 steps
5 steps

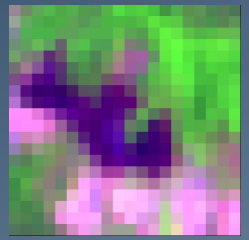
Results from hyperspectral data are more plausible also by increasing the spectral combinations

Comparison

HS →MS



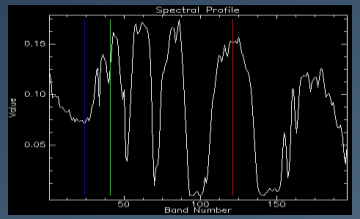
MS →HS



Hyperspectral Data (Hyperion)

Simulated Multispectral Data (Simulated ETM+)

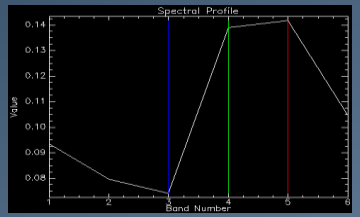
Simulated Hyperspectral Data (Simulated Hyperion)

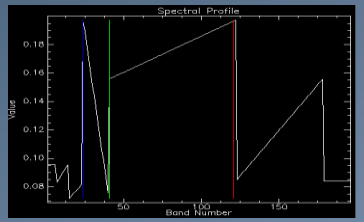


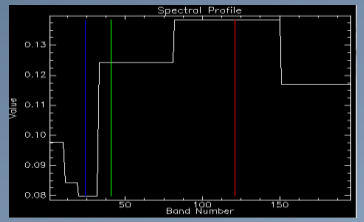
Hyperspectral data simulation

Linear Interpolation

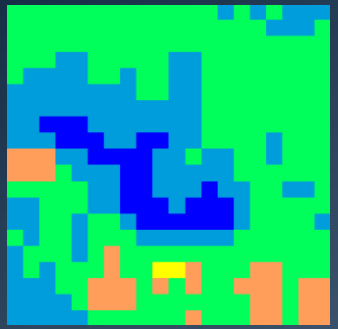
nearest neighbourhood



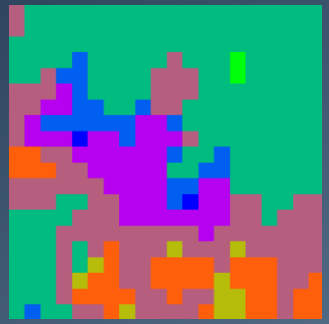




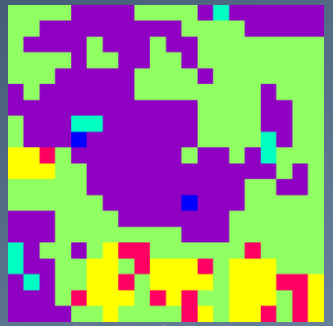
Comparison



Hyperion

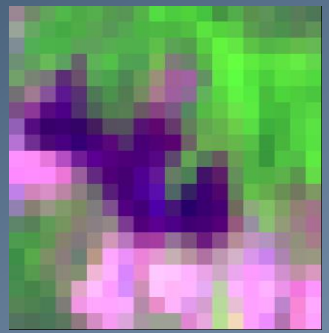


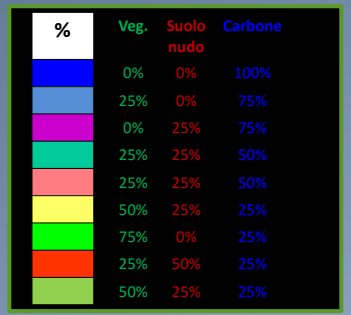
Simulated Hyperion
n.n. interpolation



Simulated Hyperion
Linear interpolation

Increased plausibility not related to higher number of samples





Comparison

5 end members
3 end-members

5 End-members

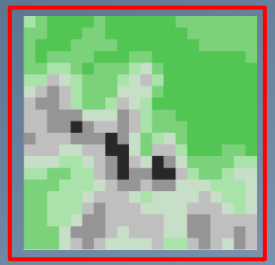
- Suolo nudo:
- Green Leaf
- Brown Leaf
- Light Charcoil
- Brown Charcoil

What happens if numbers of end-members increase?

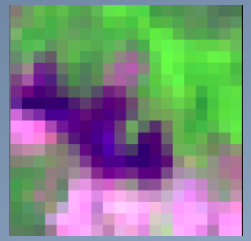
12/07/2002
10 weight levels

ETM + RGB=432

NDVI



ETM + RGB=543



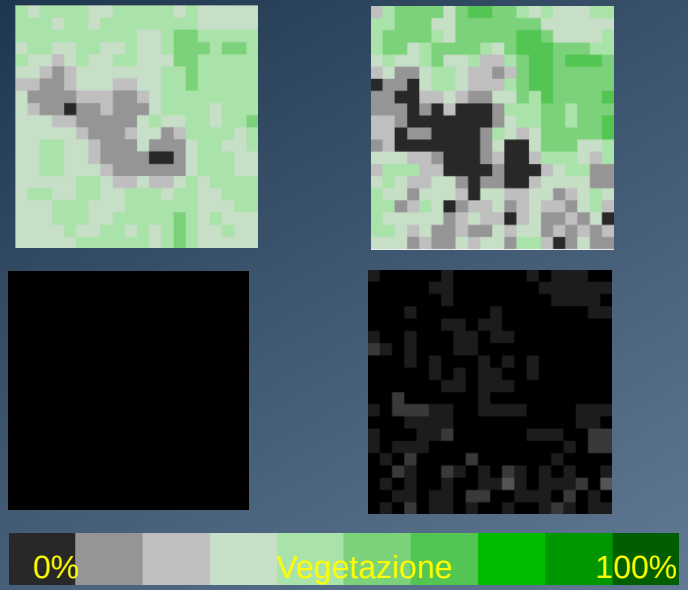
Comparison

Hyperspectral data

Multispectral Data

Green Leaf

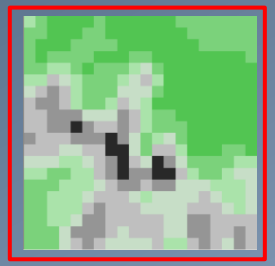
Brown Leaf



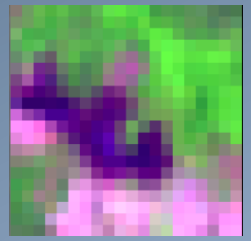
5 end members
10 weight levels

ETM + RGB=432

NDVI



ETM + RGB=543



Comparison

Hyperspectral data

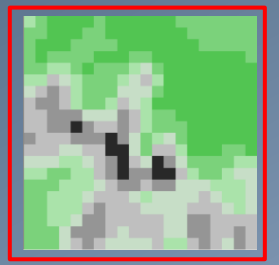
Multispectral Data

Bare Soil

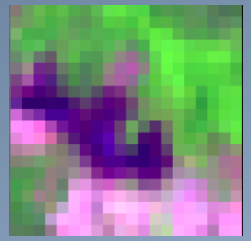
5 end members
10 weight levels

ETM +
RGB=432

NDVI



ETM +
RGB=543



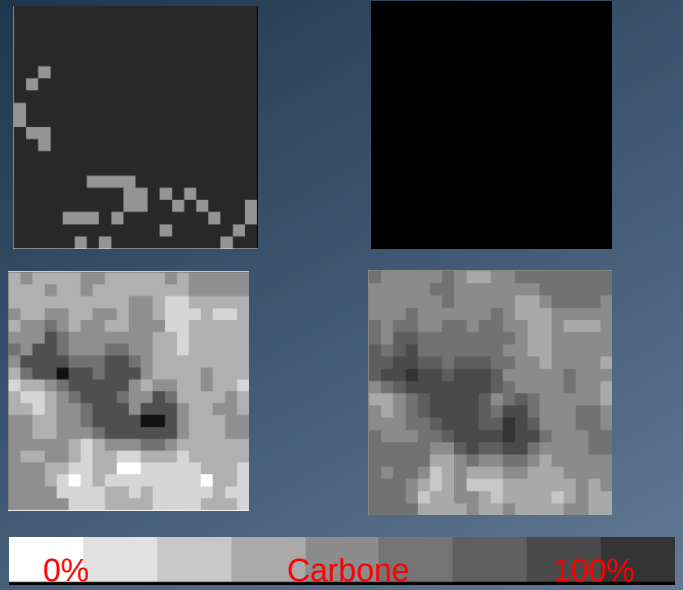
Comparison

Hyperspectral data

Multispectral Data

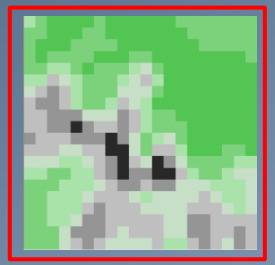
Light charcoal

Dark Charcoal



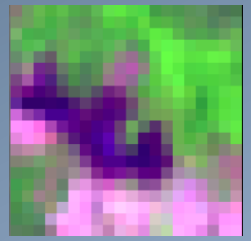
5 end members
10 weight levels

ETM + RGB=432

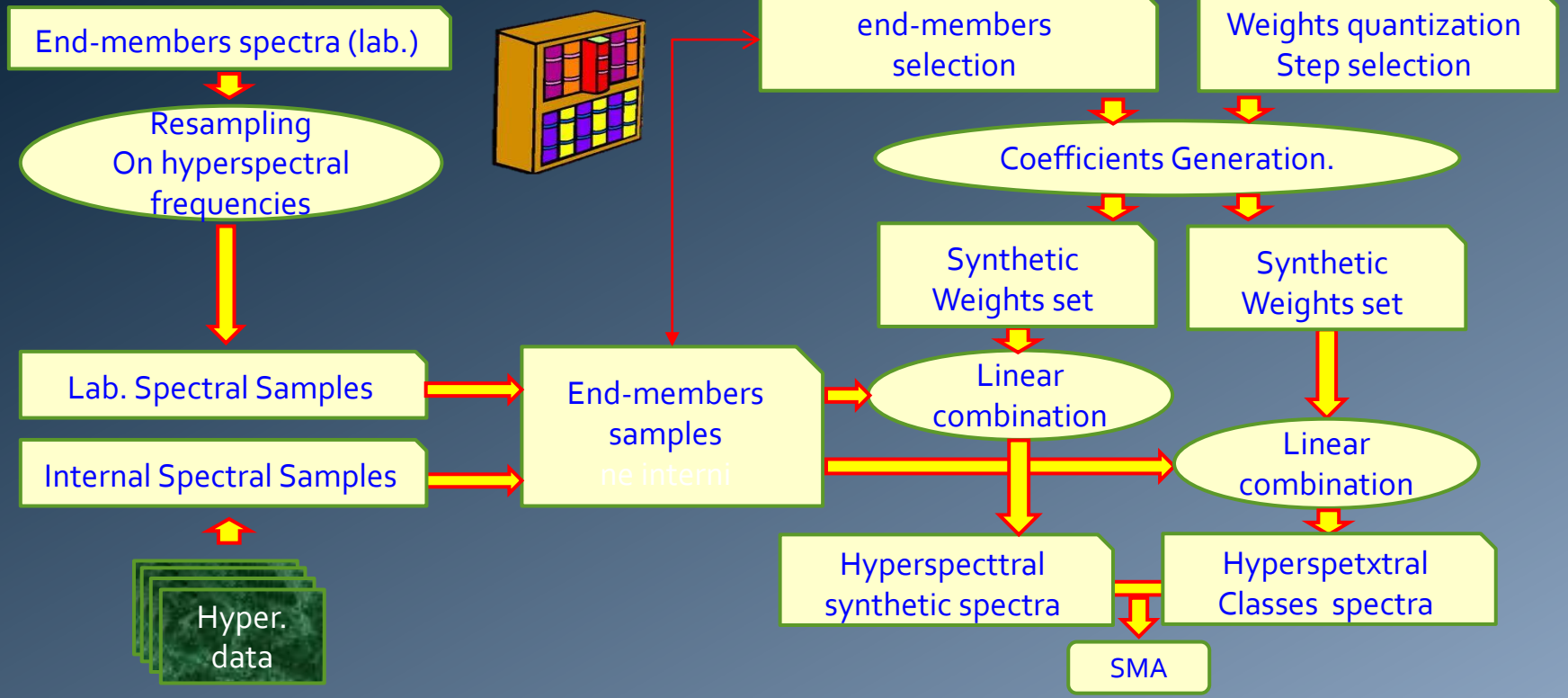


NDVI

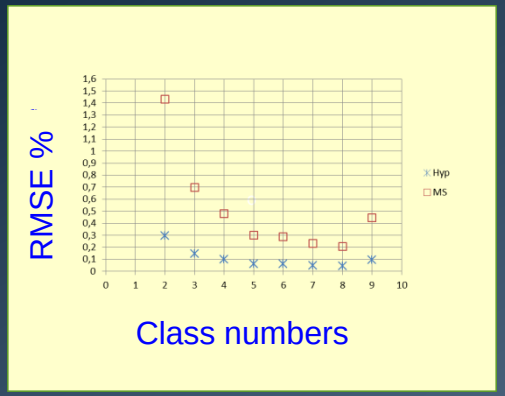
ETM + RGB=543



Comparison (Synthetic Data)



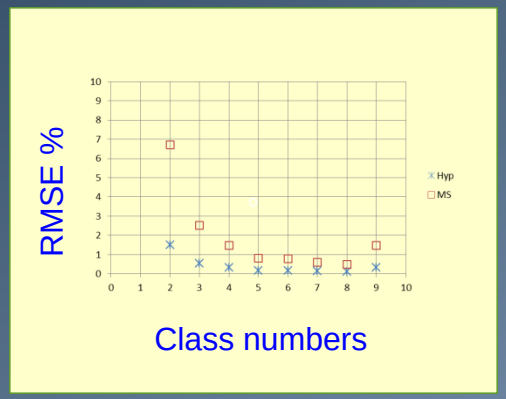
Comparison (Synthetic Data)



3 End-members

- Bare Soil:
- Green Leaf
- Brown Charcoil

44 combinations



5 End-members

- Bare Soil
- Green Leaf
- Brown Leaf
- Light Charcoil
- Brown Charcoil

495 combinations

Conclusions

- ***SMA procedure works correctly on both hyperspectral and multispectral data***
- ***The estimation is plausible for the most part of the acquired scene***
- ***The SMA estimations are aligned with those offered by other common techniques such as NDVI e NBR, but give more information with respect to these last one***
- ***A qualitative comparison shows slightly better performances of the hyperspectral data with respect to the multispectral ones***
- ***A quantitative raw comparison performed on a synthetic scene shows lower errors in results obtained with hyperspectral data.***

Work in progress

- ***Quantitative comparison based on ground truth***


THANKS!