

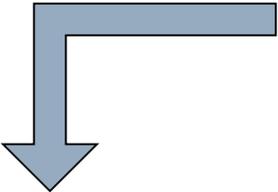
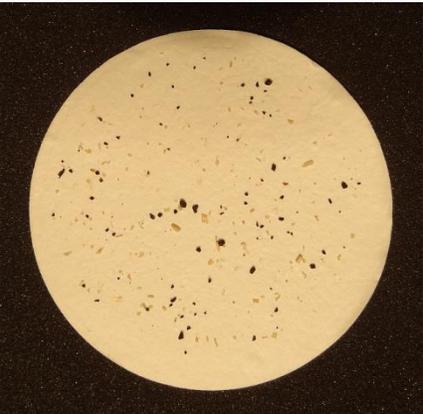
Detektion von Makroplastik und Müllansammlungen mittels Fernerkundung

Mathias Bochow,
Theres Kuester, Shanyu Zhou, Toni Schmidt

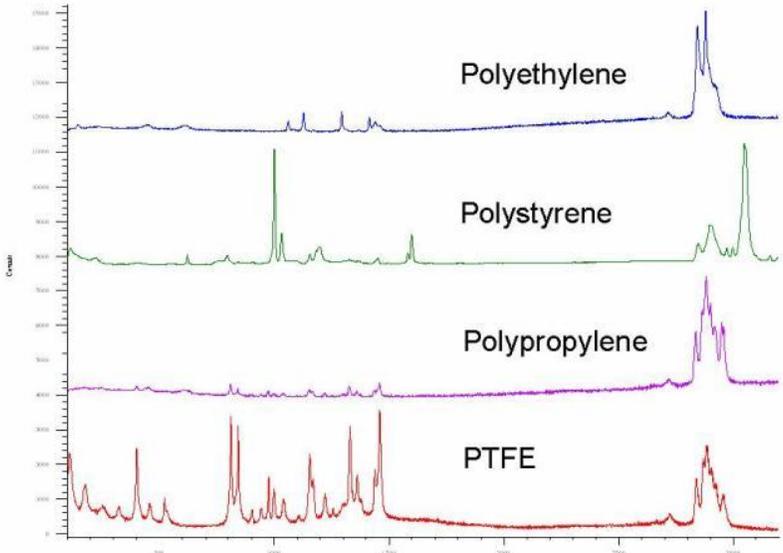
GFZ German Research Centre for Geosciences – Remote Sensing and Geoinformatics Section



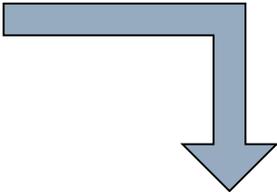
Laborspektroskopie zur Identifizierung von Mikroplastik



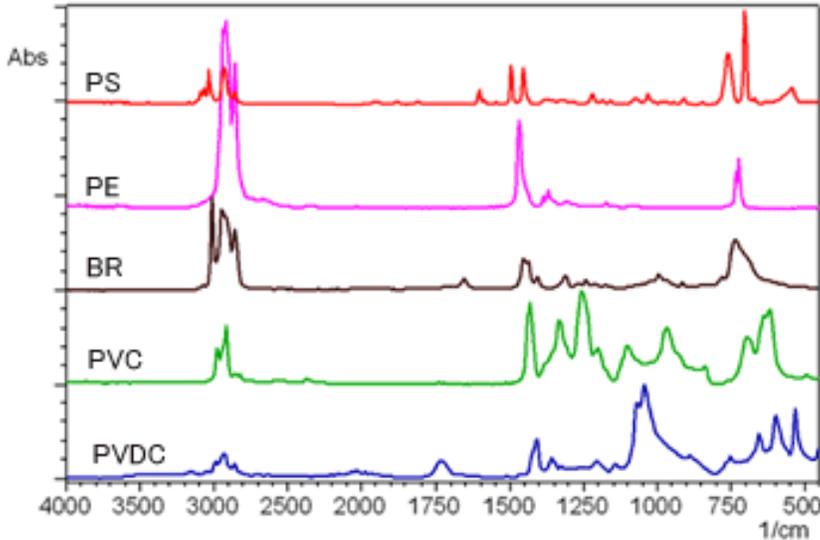
Raman Spektroskopie



www.ceriumlabs.com



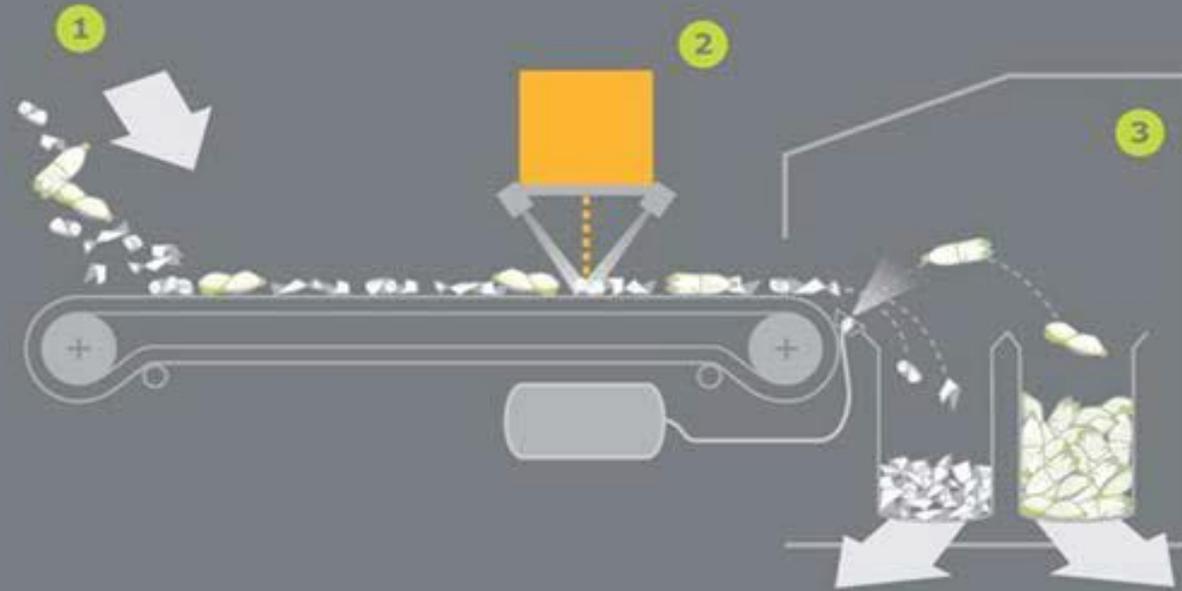
FT-IR Spektroskopie



www.shimadzu.com

Einsatzmöglichkeiten der NIR-Spektroskopie

Online-Identifizierung der Kunststoffsorte auf Förderbändern in der Recycling-Industrie



- 1 Feeding of unsorted material
- 2 Spectrometer scanner
- 3 Separation chamber

WRAP 2010, Gardner et al.

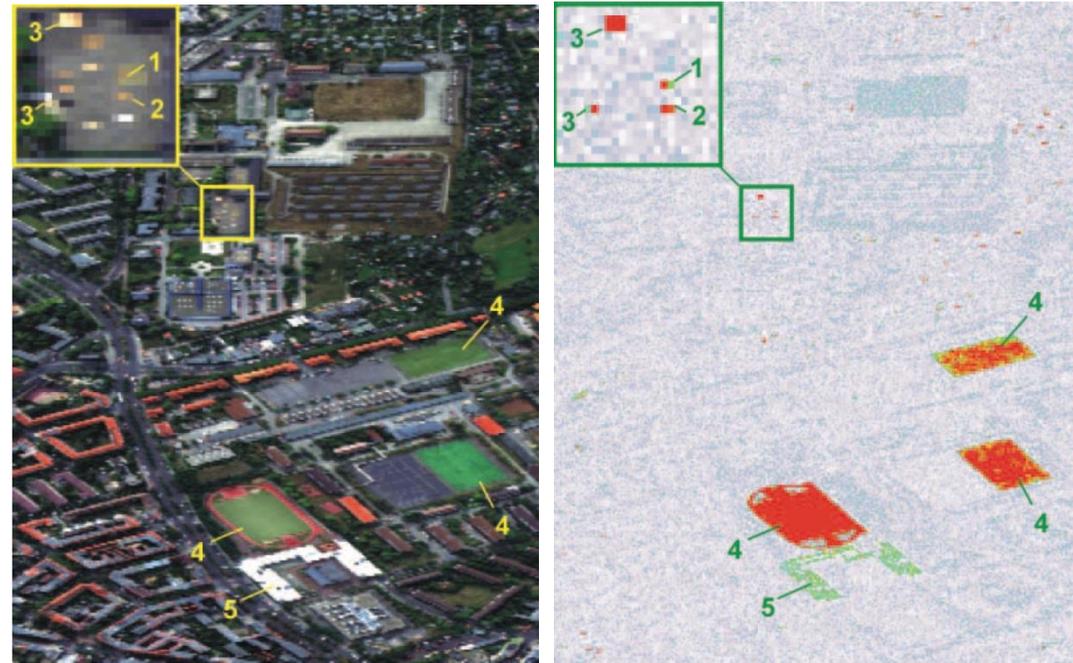
Einsatzmöglichkeiten der NIR-Spektroskopie II

NIR-Sonde in Böden



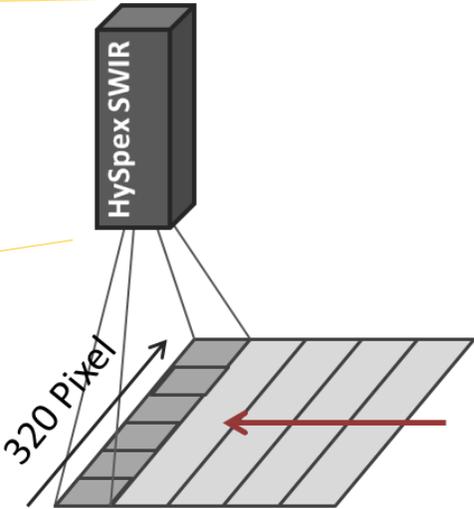
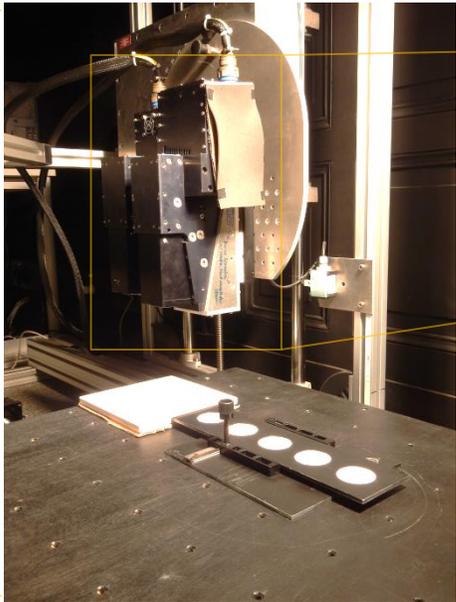
Quelle: BAM, Fachbereich Prozessanalytik

Flugzeug mit abbildendem NIR-Sensor



Quelle: Kühn et al. (2004), Int. J. of Remote Sensing 25(12)

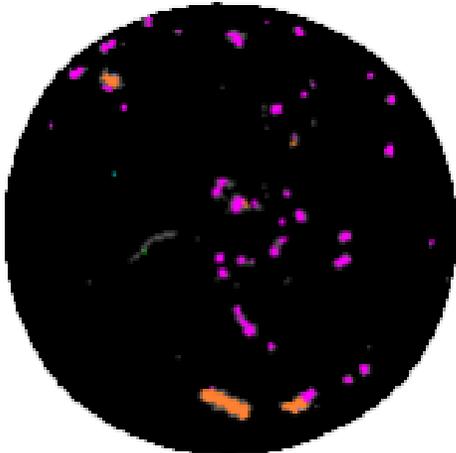
Einsatzmöglichkeiten der NIR-Spektroskopie III



Optisches Foto

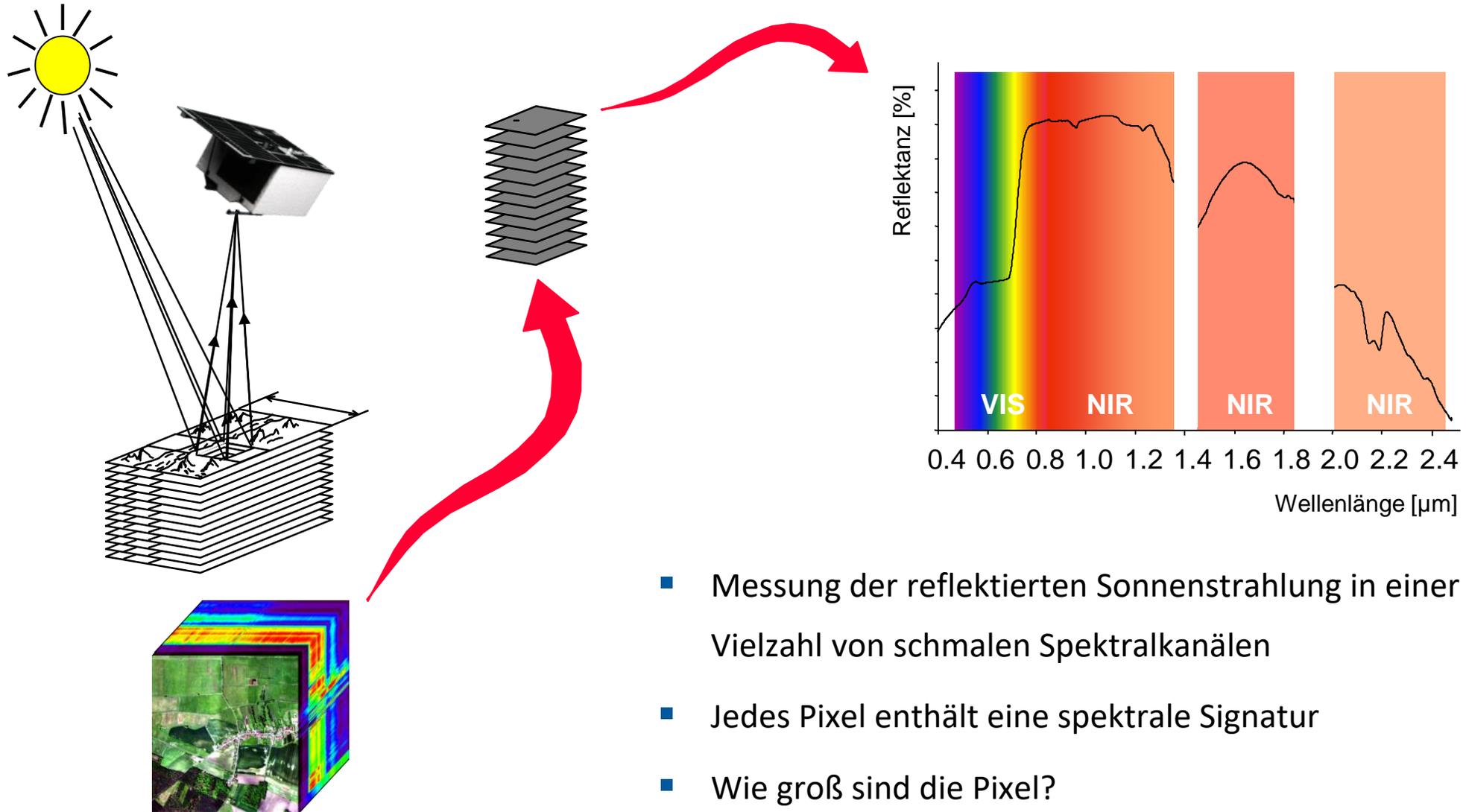


Klassifikationsergebnis

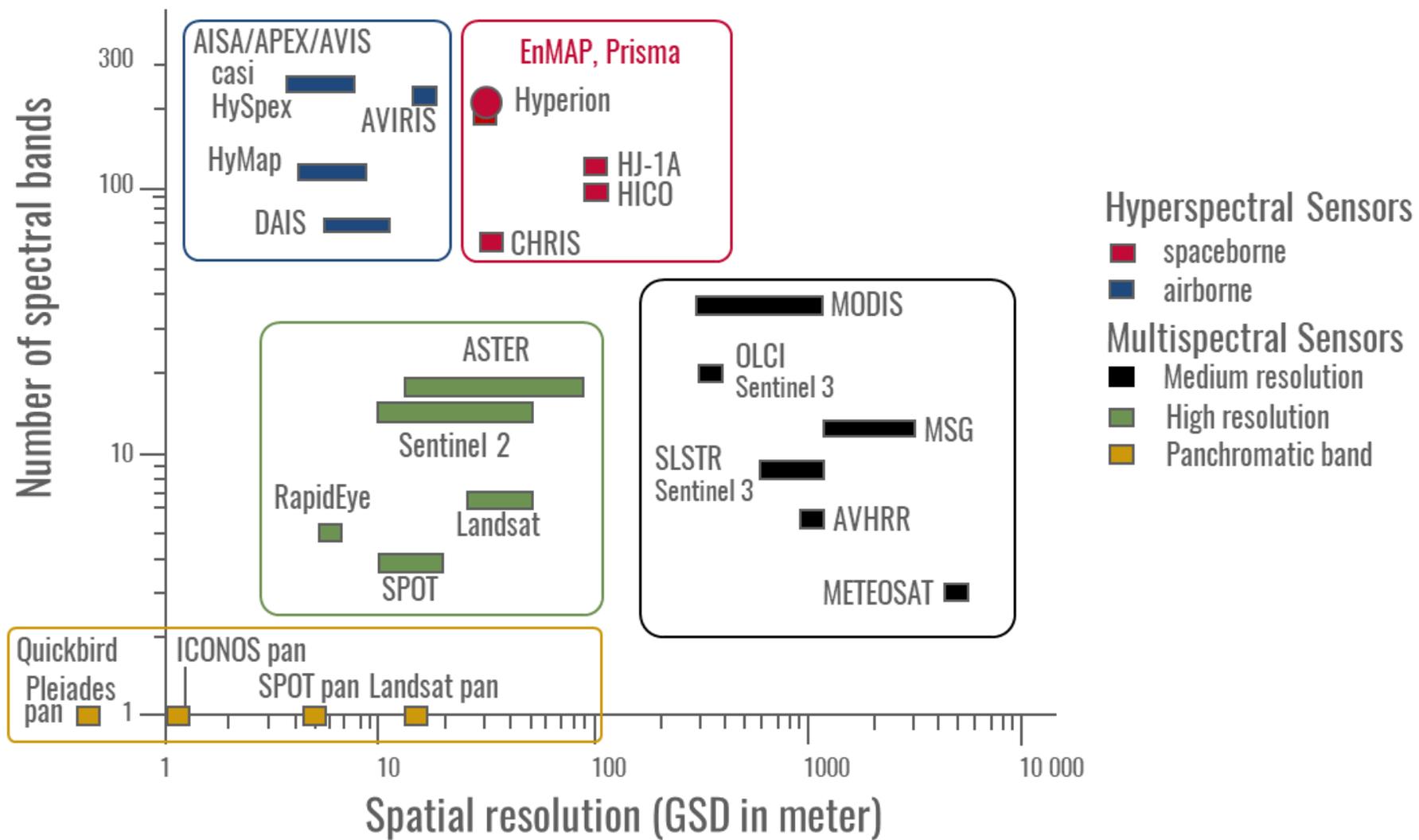


- Unclassified
- Natural organic
- PE
- PP

Hyperspektrale Fernerkundung = abbildende VIS-NIR-Spektroskopie von der Erdoberfläche



Räumliche vs spektrale Auflösung



Ziel: Aufspüren großer Müllansammlungen weltweit

Mülldeponie in Mumbai, Indien

Pal Pillai/AFP/Getty Images



“Garbage City”, Kairo, Ägypten

www.reddit.com

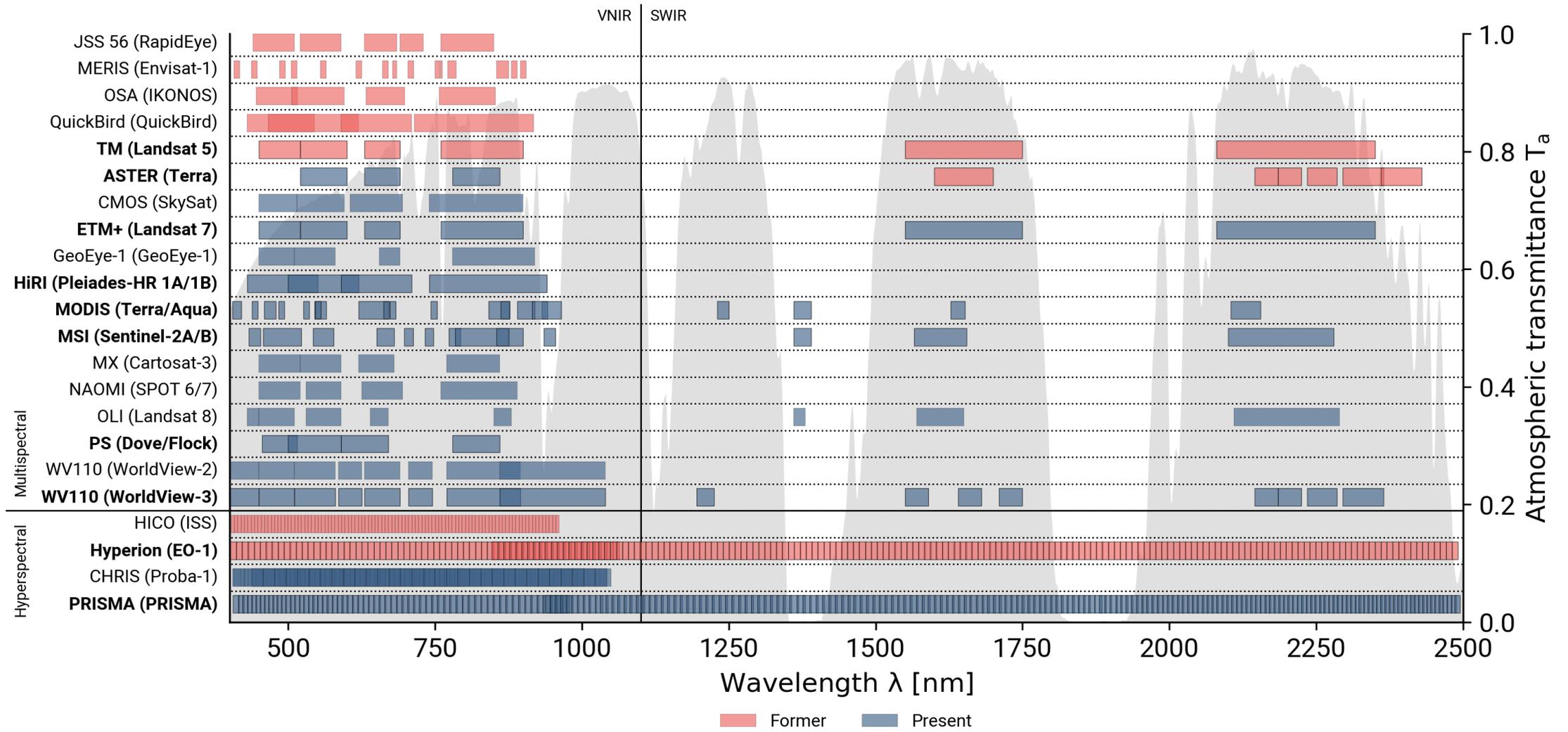


Illegale Müllablagerungen bei Jänickendorf, Brandenburg

www.muellrausch.de

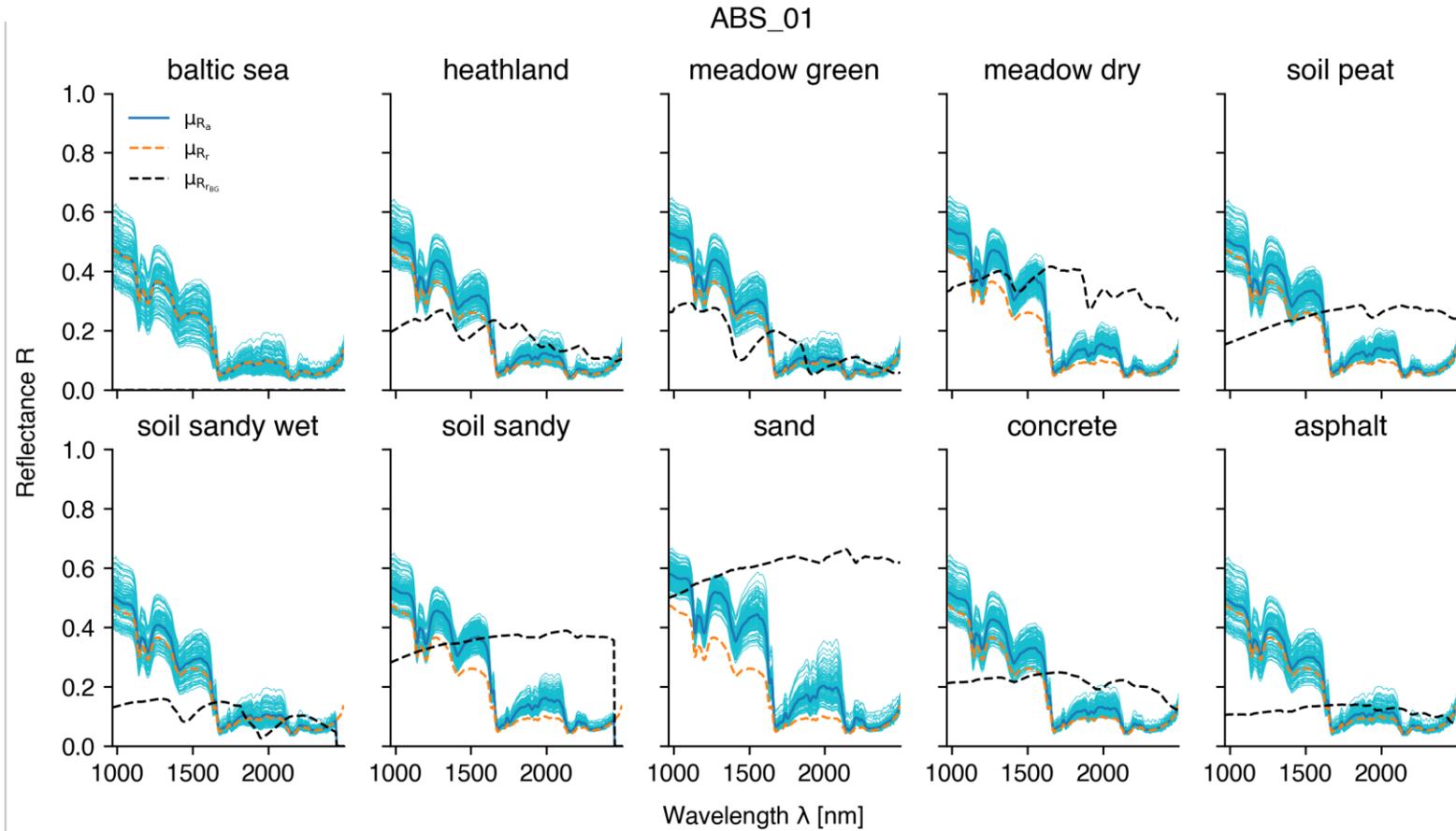
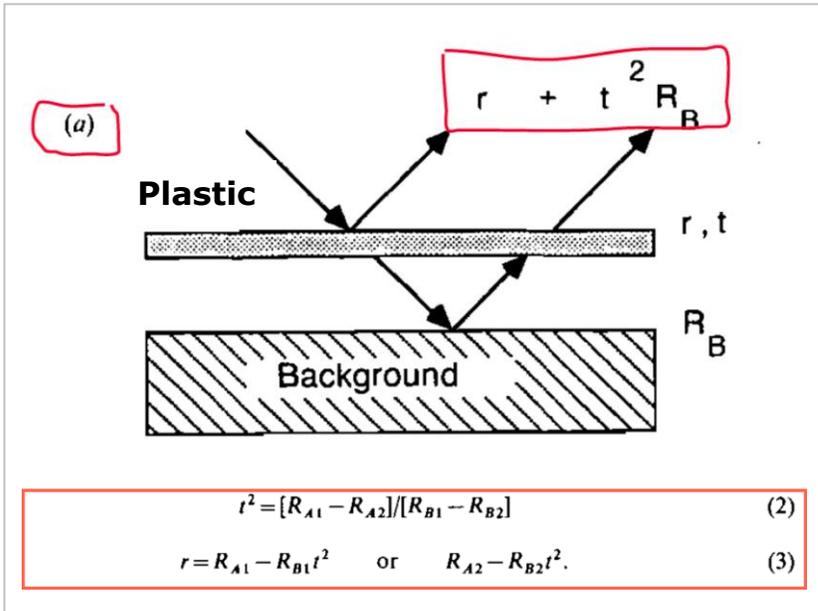


Satellitenstudie: Welche Satelliten eignen sich zur Kartierung von Plastikmüll?



Satellitenstudie: Welche Satelliten eignen sich zur Kartierung von Plastikmüll?

- 53 Proben von 5 Plastikarten: PE, PP, PET, PS und PVC
- Labormessung mit VNIR-Spektrometer
- 10 Untergründe
- $8338 * 10 = 83380$ Spektren



Nachfolgende Schritte:

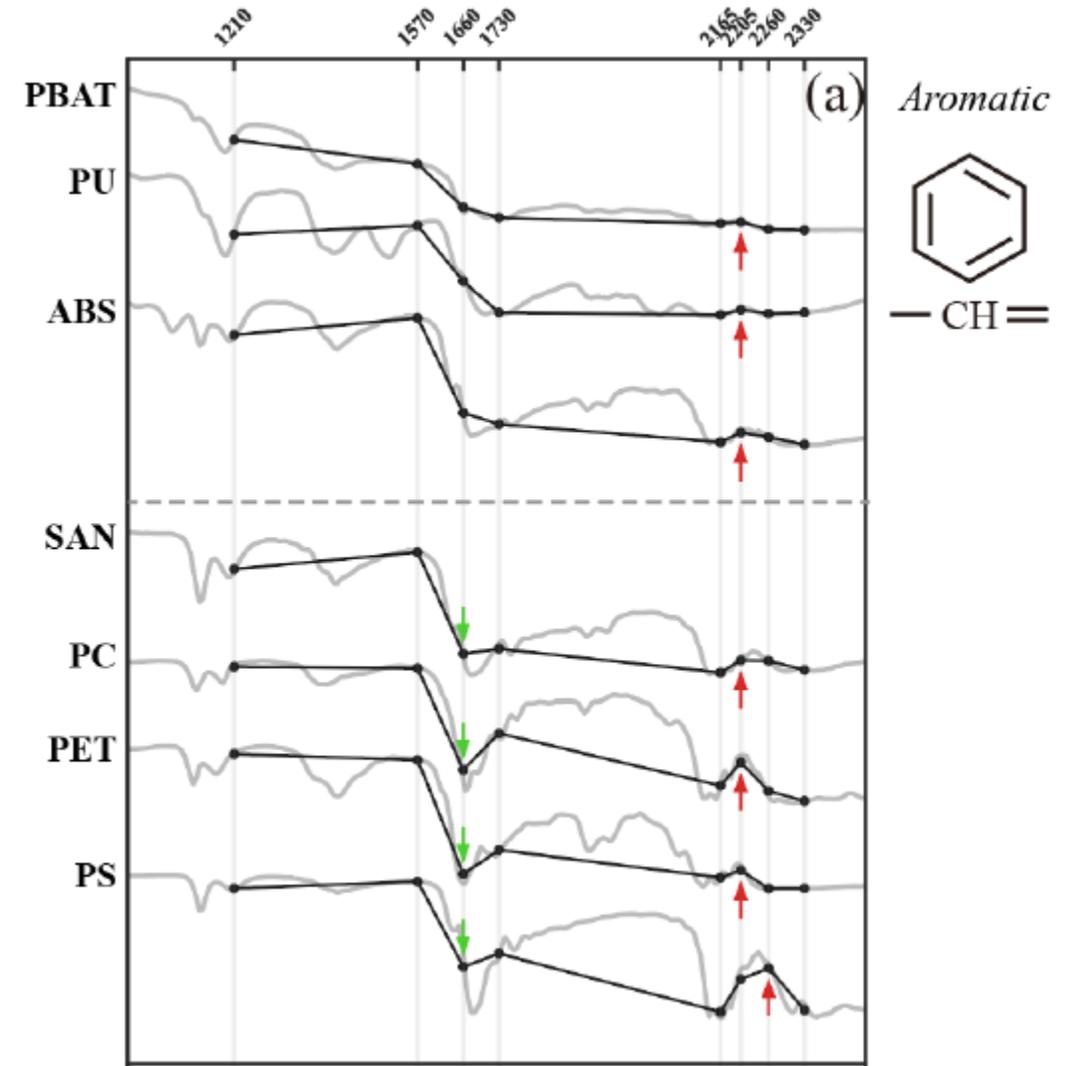
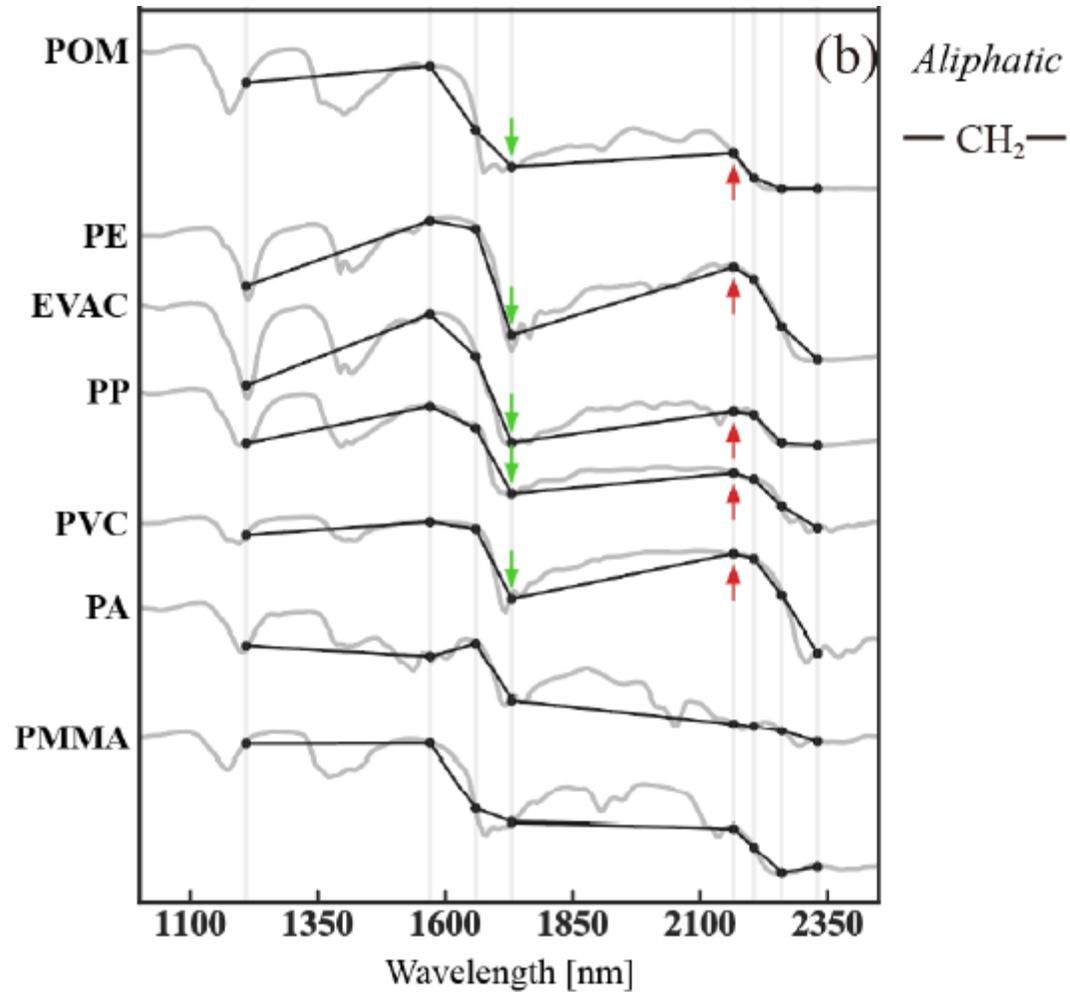
- Sensorsimulation
- Machine Learning Klassifikation

Satellitenstudie: (Macro) F1-Scores des Random Forests Klassifizierers

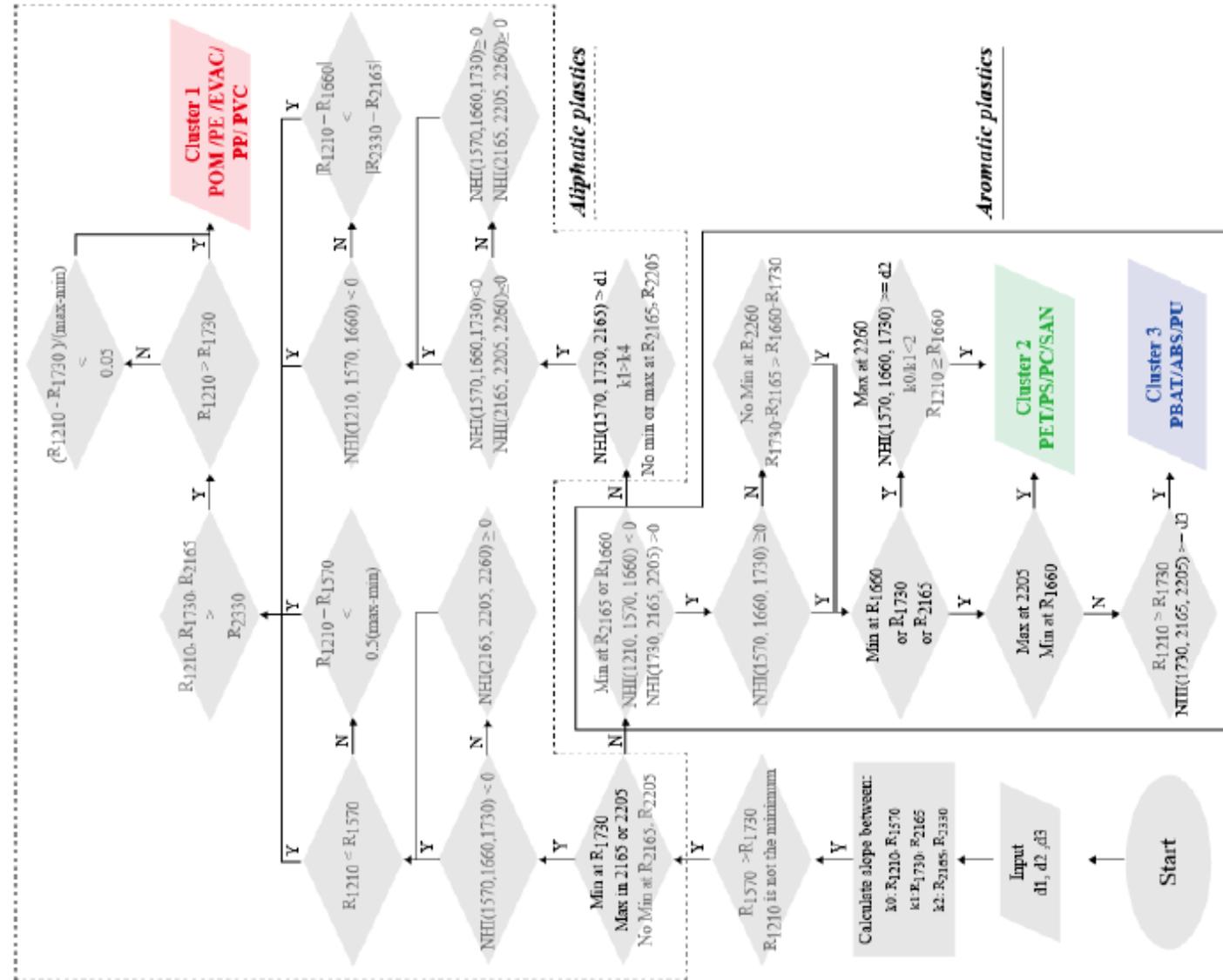
A	HiRI (Pleiades-HR 1A/1B)	.30	.26	.21	.14	.23	.18	.19	.14	.25	.18	.21
	PS (Dove/Flock)	.27	.24	.22	.18	.22	.25	.20	.18	.26	.18	.22
	ASTER (Terra)	.42	.45	.43	.44	.47	.39	.38	.37	.43	.56	.43
B	MODIS (Terra/Aqua)	.32	.37	.36	.29	.30	.32	.29	.21	.35	.27	.31
	MSI (Sentinel-2A/B)	.30	.29	.21	.25	.29	.32	.21	.21	.32	.21	.26
	TM/ETM+ (Landsat 5/7)	.32	.33	.25	.26	.23	.30	.22	.22	.28	.22	.26
C	WV110 (WorldView-3)	.37	.47	.50	.56	.55	.43	.52	.46	.45	.51	.48
	Hyperion (EO-1)	.74	.86	.85	.84	.84	.82	.83	.82	.84	.83	.83
	PRISMA (PRISMA)	.79	.86	.87	.87	.87	.87	.83	.86	.86	.88	.86
	Mean	.43	.46	.43	.43	.44	.43	.41	.39	.45	.43	
		Baltic Sea	Heathland	Green meadow	Dry meadow	Peat soil	Wet sandy soil	Sandy soil	Sand	Asphalt	Concrete	Mean

A	HiRI (Pleiades-HR 1A/1B)	.29	.21	.22	.04	.28	.21
	PS (Dove/Flock)	.30	.25	.16	.06	.32	.22
	ASTER (Terra)	.41	.36	.22	.56	.61	.43
B	MODIS (Terra/Aqua)	.33	.35	.20	.13	.52	.31
	MSI (Sentinel-2A/B)	.30	.24	.18	.16	.42	.26
	TM/ETM+ (Landsat 5/7)	.29	.23	.17	.26	.37	.26
C	WV110 (WorldView-3)	.51	.56	.22	.54	.58	.48
	Hyperion (EO-1)	.90	.84	.84	.85	.70	.83
	PRISMA (PRISMA)	.91	.87	.88	.87	.75	.86
	Mean	.47	.44	.35	.39	.50	
		PE	PET	PP	PS	PVC	Mean

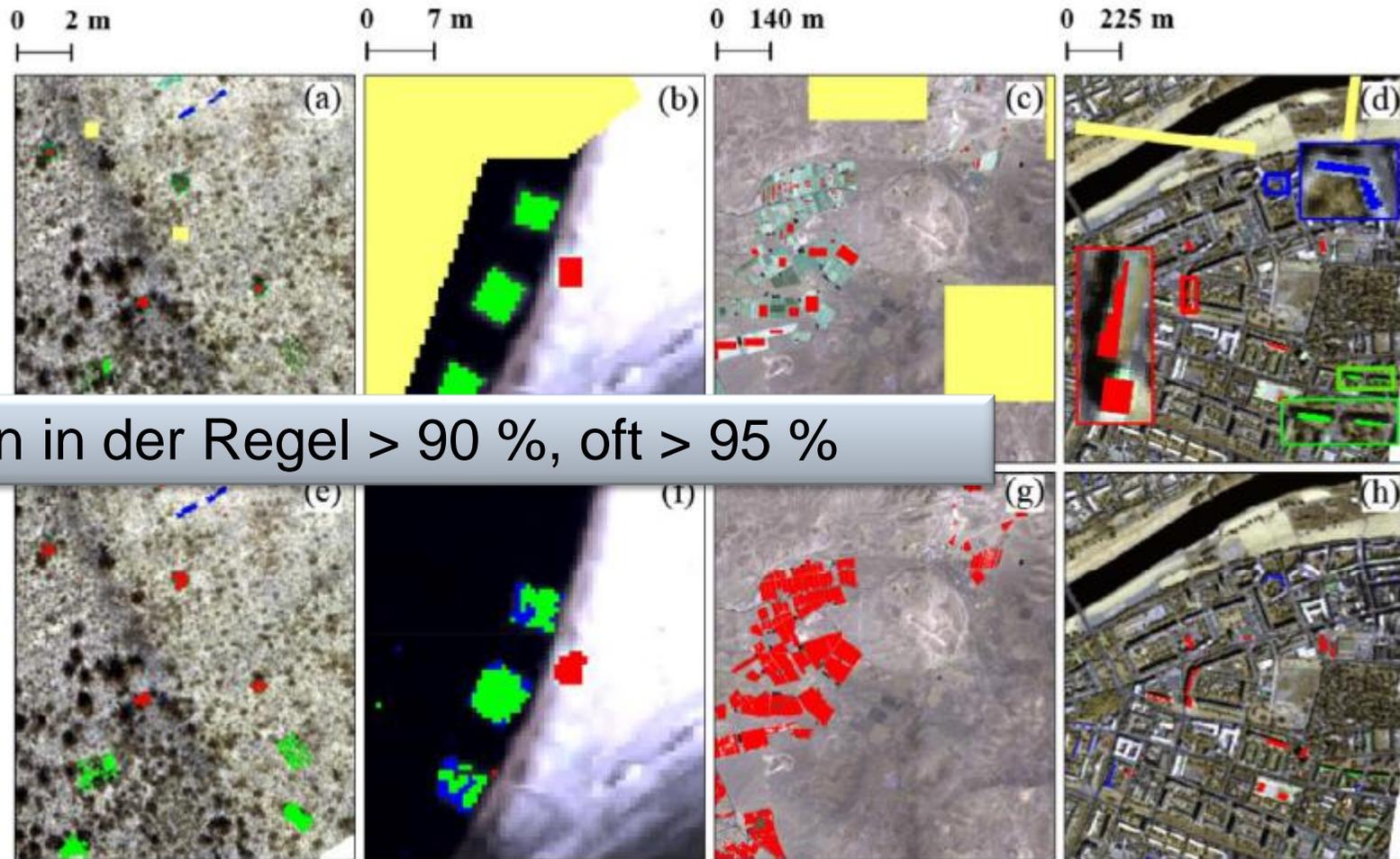
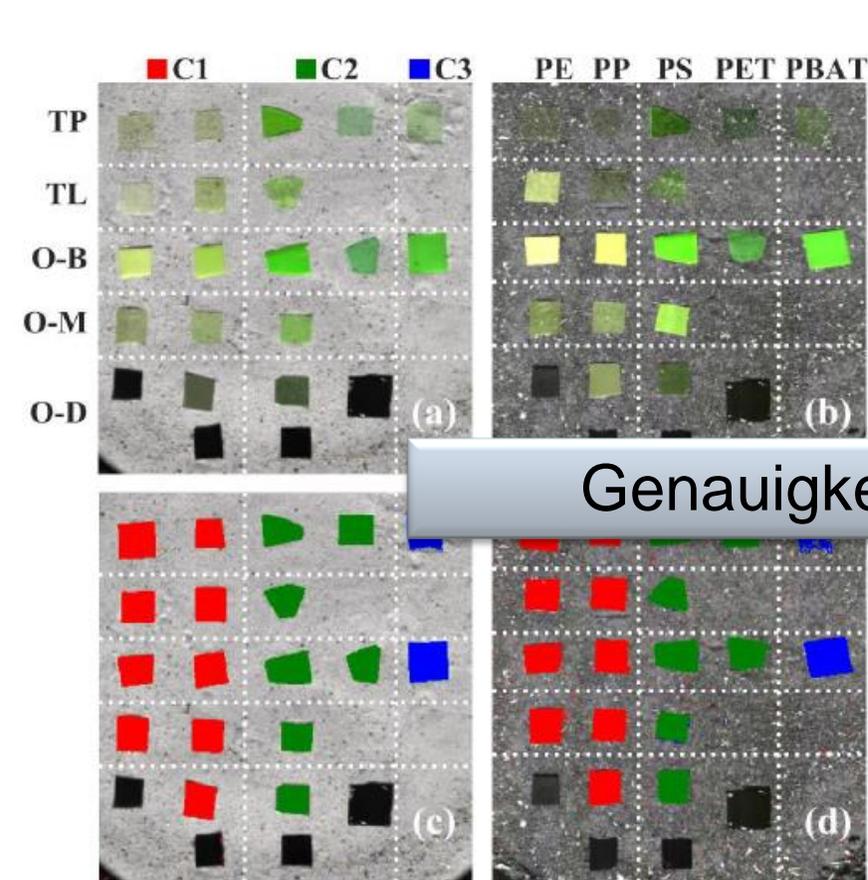
WorldView-3: Unterscheidung von aliphatischen und aromatischen Kohlenwasserstoffen



Entscheidungsbaum-Klassifizierer für Plastik in WorldView-3 Daten



Validierung anhand eines Laborversuchs und Flugzeugaufnahmen



Genauigkeiten in der Regel > 90 %, oft > 95 %

Laborexperiment Plastik auf Sand und Boden.

Sensor: HySpex, resampled auf WV-3

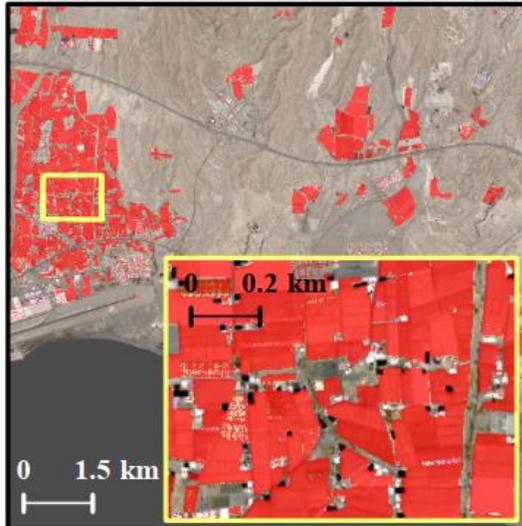
■ Background ■ Cluster 1 ■ Cluster 2 ■ Cluster 3

(a, b) Feldexperimente in Thyrow und am Seddiner See, (c) Gewächshäuser in Almeria, Spanien, (d) Dresden.

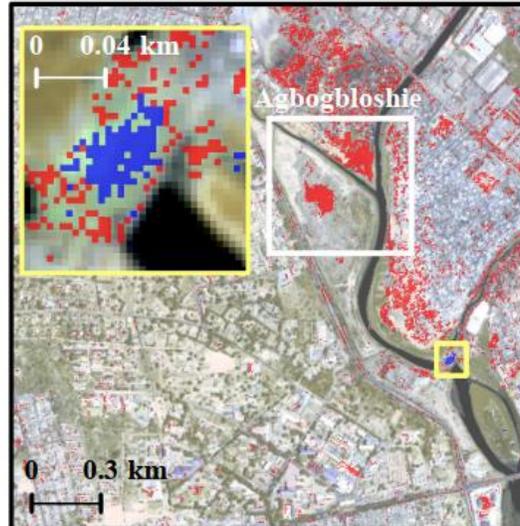
Flugzeugaufnahmen mit HySpex und HyMap, resampled auf WV-3

Validierung mit echten WorldView-3 Satellitenbildern

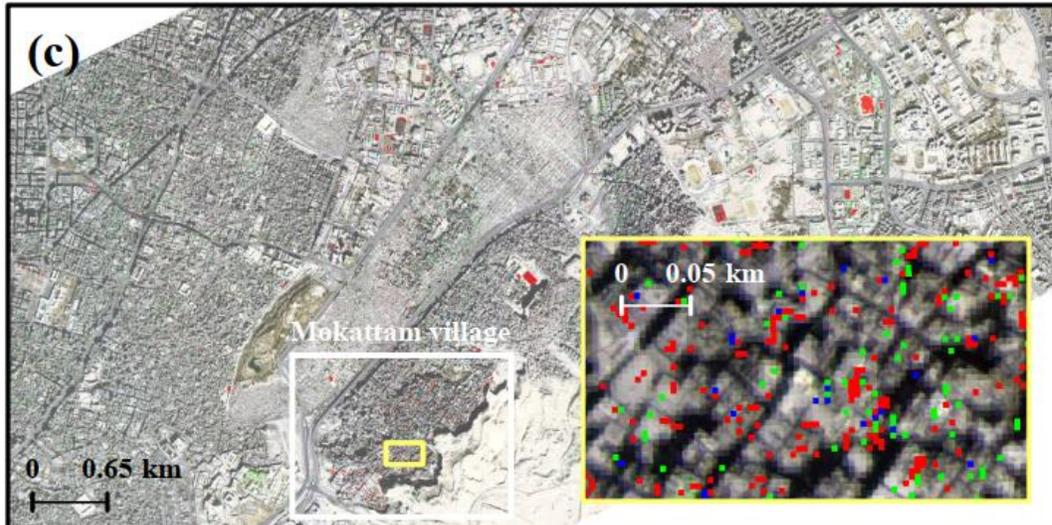
(a)



(b)



(c)



Zhou S., T Kuester, M Bochow, N Bohn, M Brell, H Kaufmann (2021): **A knowledge-based, validated classifier for the identification of aliphatic and aromatic plastics by WorldView-3 satellite data**, *Remote Sensing of Environment*, Volume 264, 2021, 112598, ISSN 0034-4257, <https://doi.org/10.1016/j.rse.2021.112598>

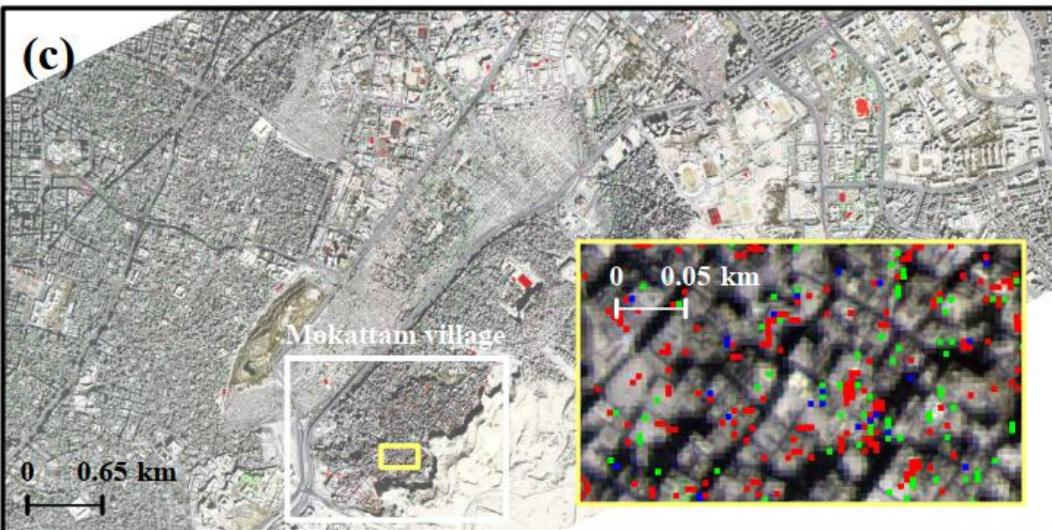
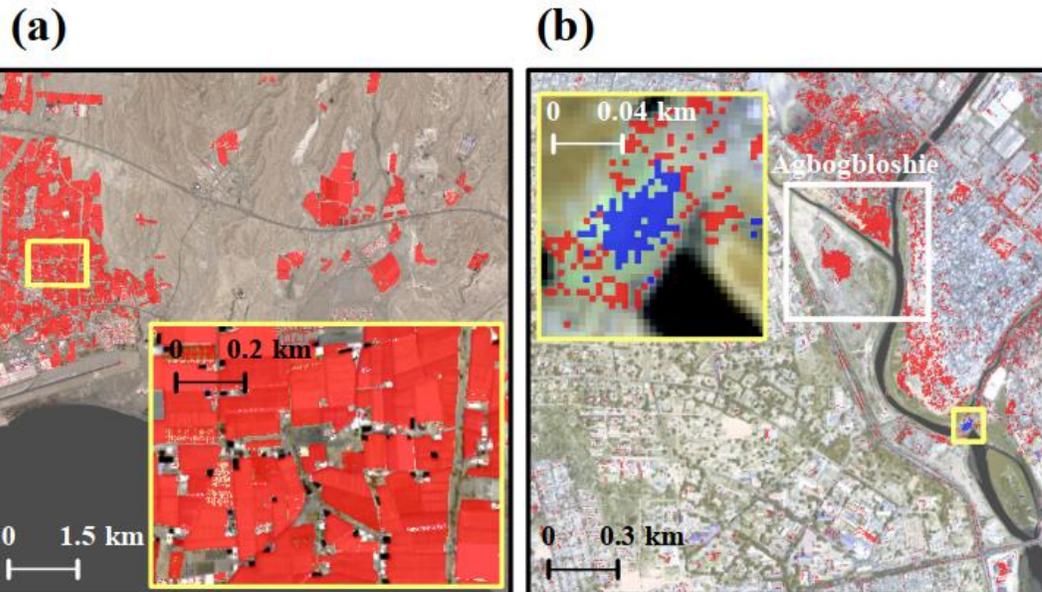
- Klasse 1 (C1)
- Klasse 2 (C2)
- Klasse 3 (C3)

(a) Almeria, Spanien

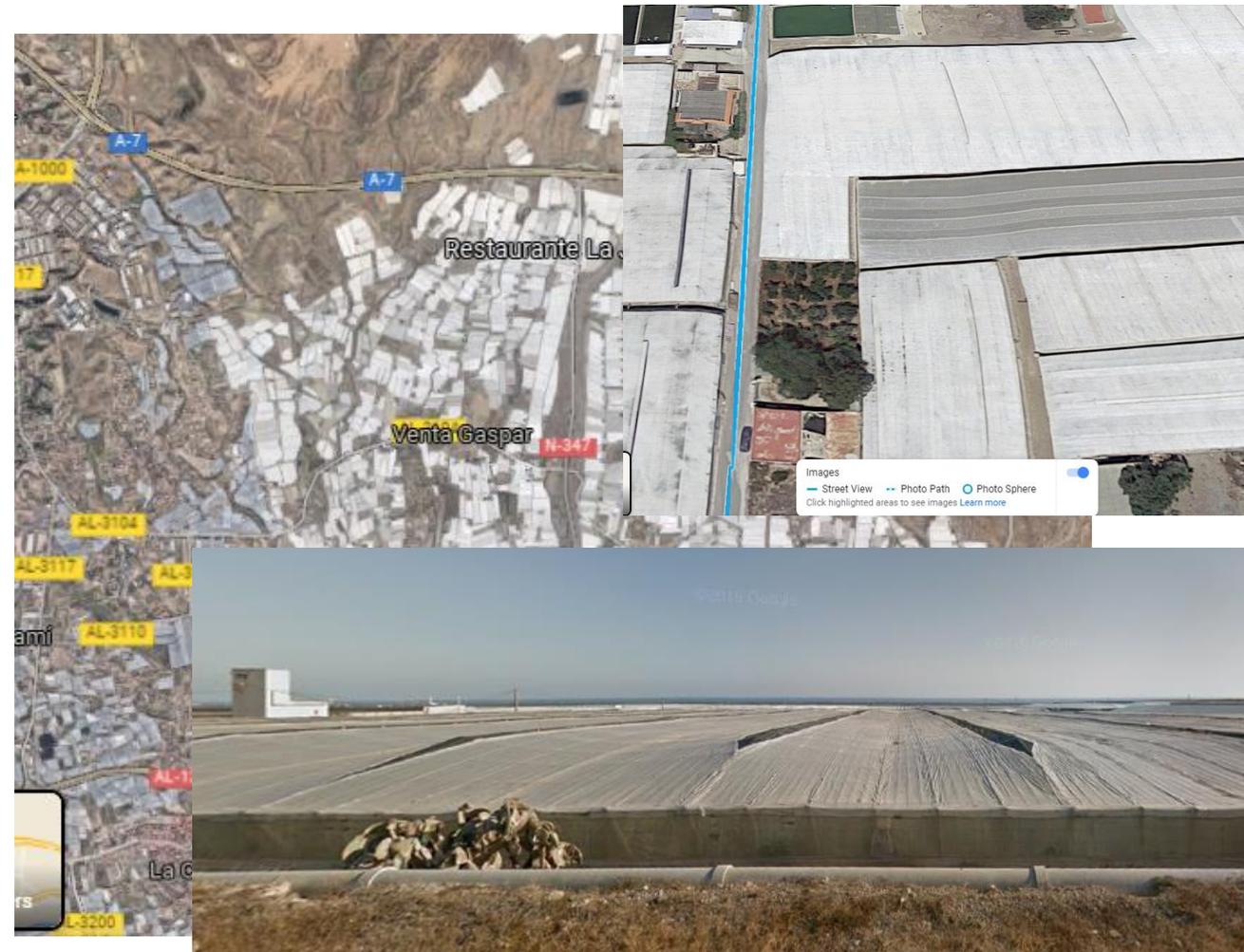
(b) Accra, Ghana

(c) "Garbage City" in Kairo, Ägypten

Validierung mit echten WorldView-3 Satellitenbilder: Almeria, Spanien



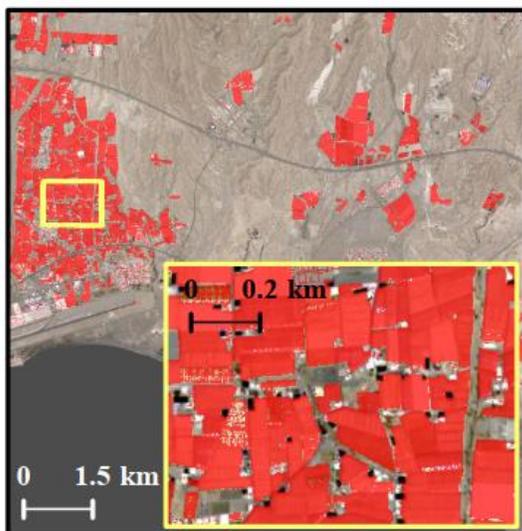
-  Klasse 1 (C1)
-  Klasse 2 (C2)
-  Klasse 3 (C3)



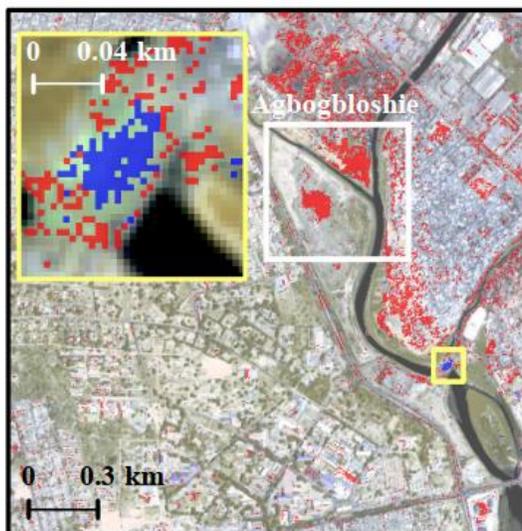
(a) Gewächshäuser in Almeria, Spanien
Sensor: WV-3

Validierung mit echten WorldView-3 Satellitenbilder: Accra, Ghana

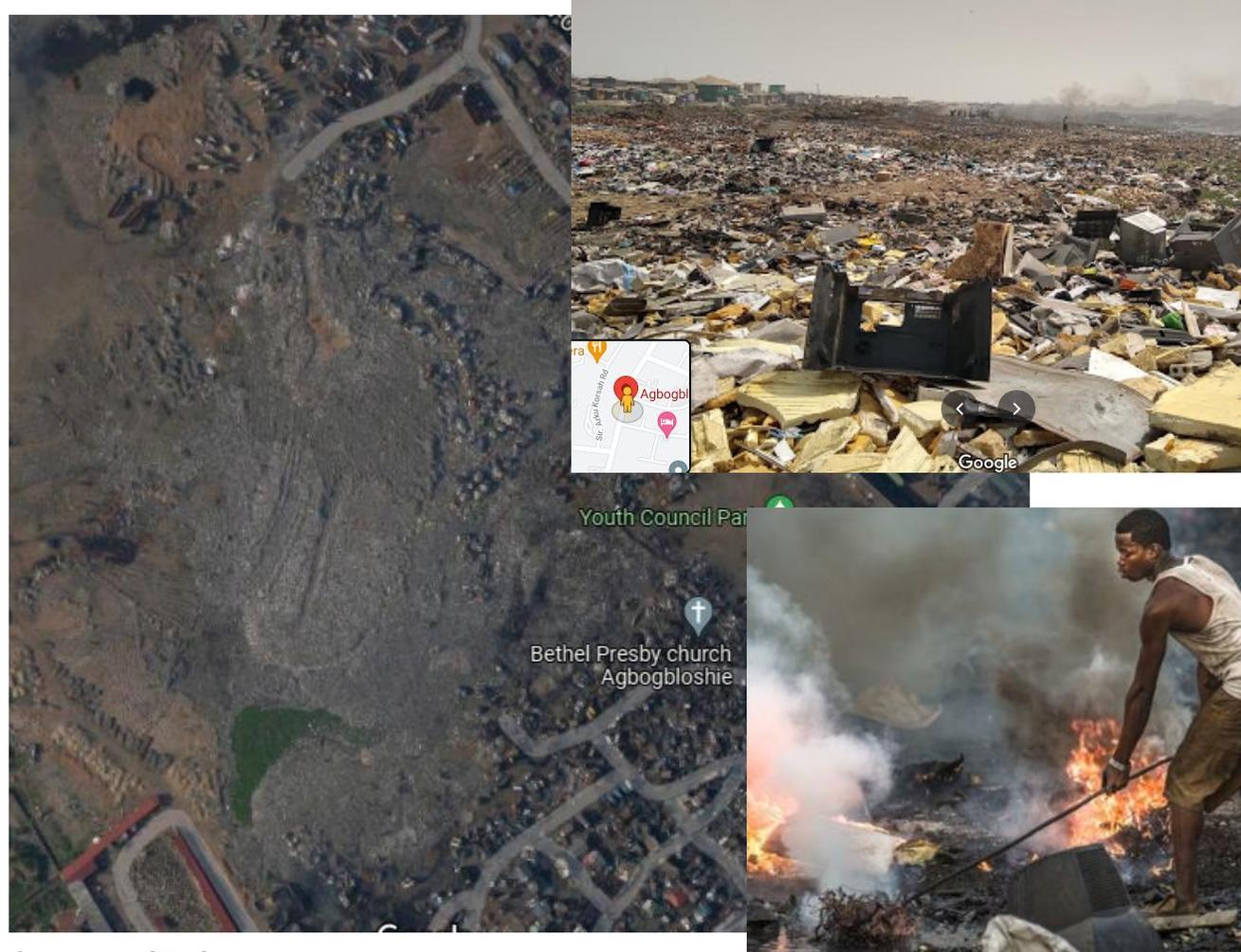
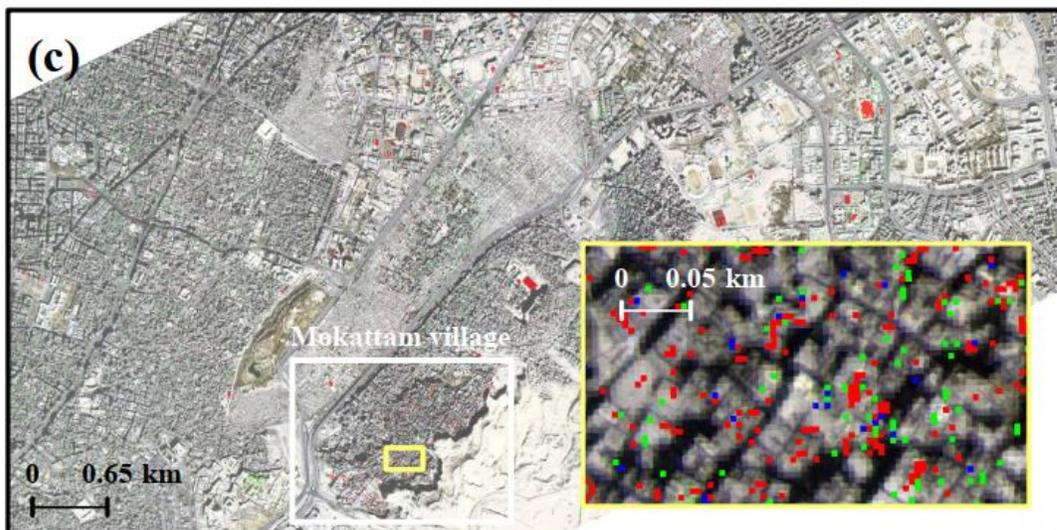
(a)



(b)



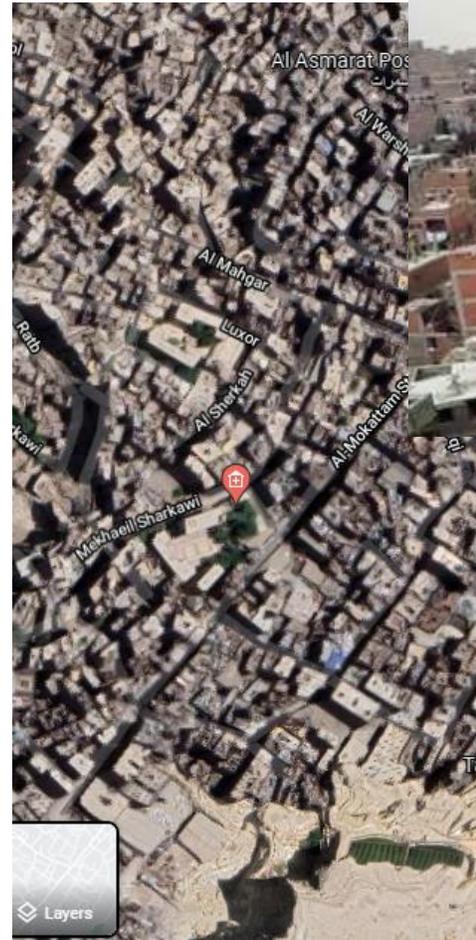
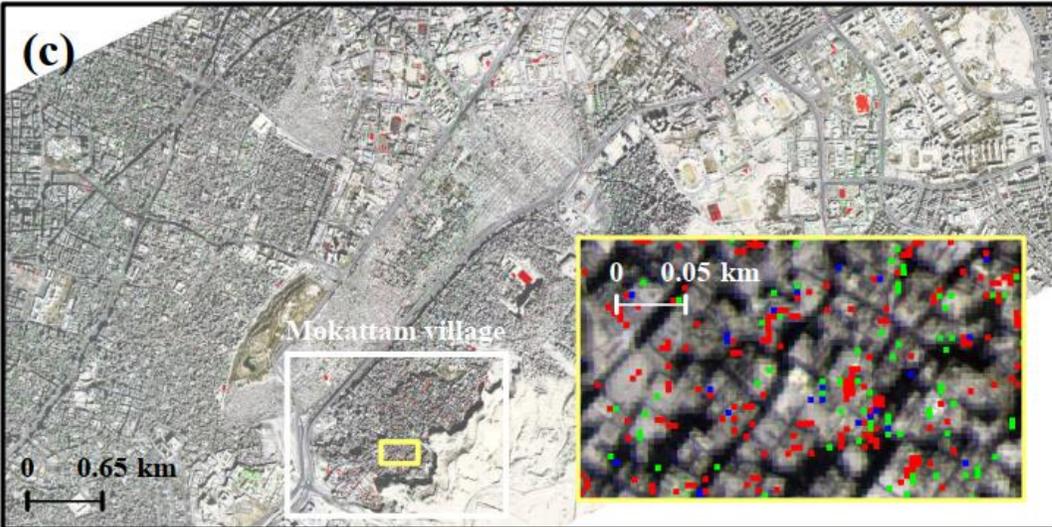
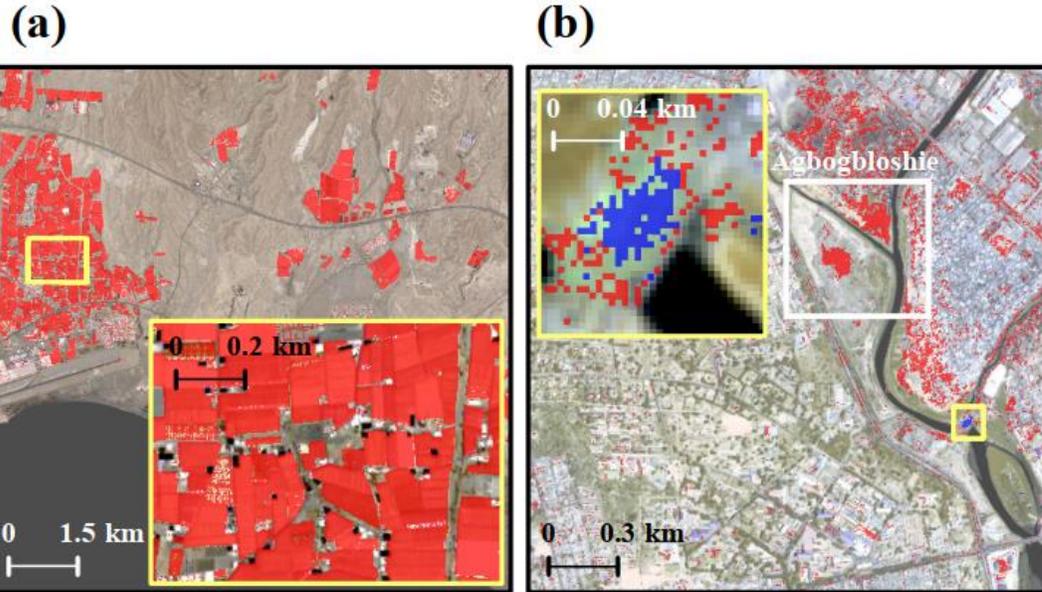
(c)



- Klasse 1 (C1)
- Klasse 2 (C2)
- Klasse 3 (C3)

(b) Elektroschrott in Agbogbloshie, Accra, Ghana
Sensor: WV-3

Validierung mit echten WorldView-3 Satellitenbilder: Kairo, Ägypten



-  Klasse 1 (C1)
-  Klasse 2 (C2)
-  Klasse 3 (C3)

(c) "Garbage City" in Kairo, Ägypten.
Sensor: WV-3

Detektion von Makroplastik und Müllansammlungen mittels Fernerkundung

KONTAKT:

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MATHIAS.BOCHOW@GFZ-POTSDAM.DE

Eine Initiative des Bundesministeriums
für Bildung und Forschung

Plastik
in der **Umwelt**

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