Partenariato

Consiglio Nazionale delle Ricerche - Istituto sull'Inquinamento Atmosferico (CNR-IIA), **Italia**

Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), **Italia**

Dipartimento di Biologia Ambientale, Sapienza Università di Roma, **Italia**

Consiglio Nazionale delle Ricerche - Istituto per la BioEconomia (CNR-IBE), **Italia**

Centro per la Ricerca Ecologica e le Applicazioni Forestali (CREAF), **Spagna**

Università di Creta – Museo di Storia Naturale di Creta (UoC - NHMC), **Grecia**

Società Ellenica per la Protezione della Natura (HSPN), **Grecia**

Remote sensing oriented nature based solutions towards a NEW LIFE FOR DRYLANDS

NewLife4Drylands

LIFE20 PRE/IT/000007
NewLife4Drylands

Francesca Assennato
Nicola Riitano
ISPRA GEO-DES

Il contributo del Programma LIFE alle priorità ambientali e climatiche della PAC: focus progetti su Impollinatori e Carbon farming. 11 Giugno 2024

6 CASI STUDIO

LIFE The Green Link, Spagna
(LIFE15 CCA/ES/000125)

LIFE PRIMED, Italia e Grecia
(LIFE17 NAT/GR/000511)

Alta Murgia, Italia (IT9120007)
Monti Asterousia, Grecia
(GR4310013)

NewLife4Drylands

OBIETTIVI

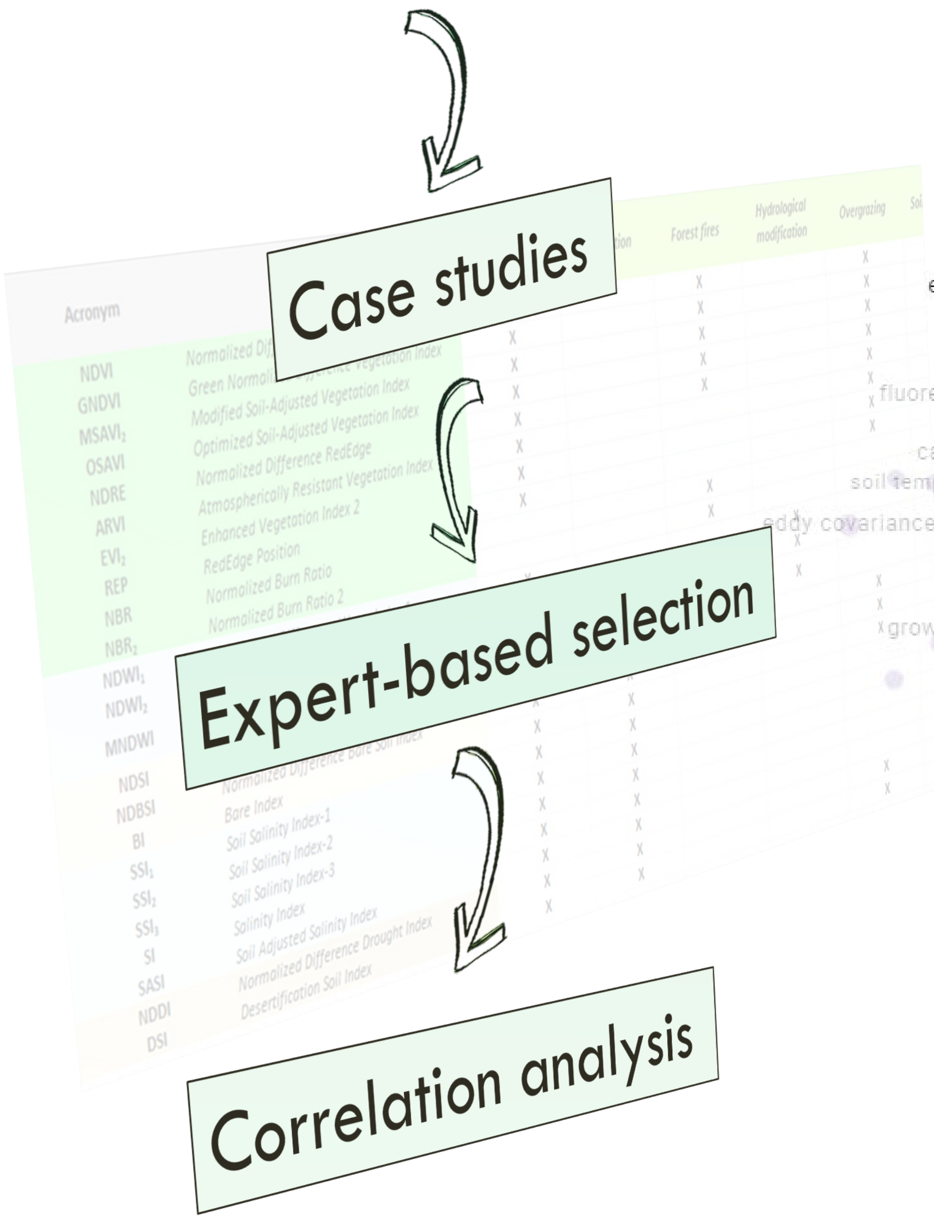
Fornire una base di conoscenza sulle attività di monitoraggio riguardanti l'identificazione dei processi di degrado e le successive pratiche di ripristino

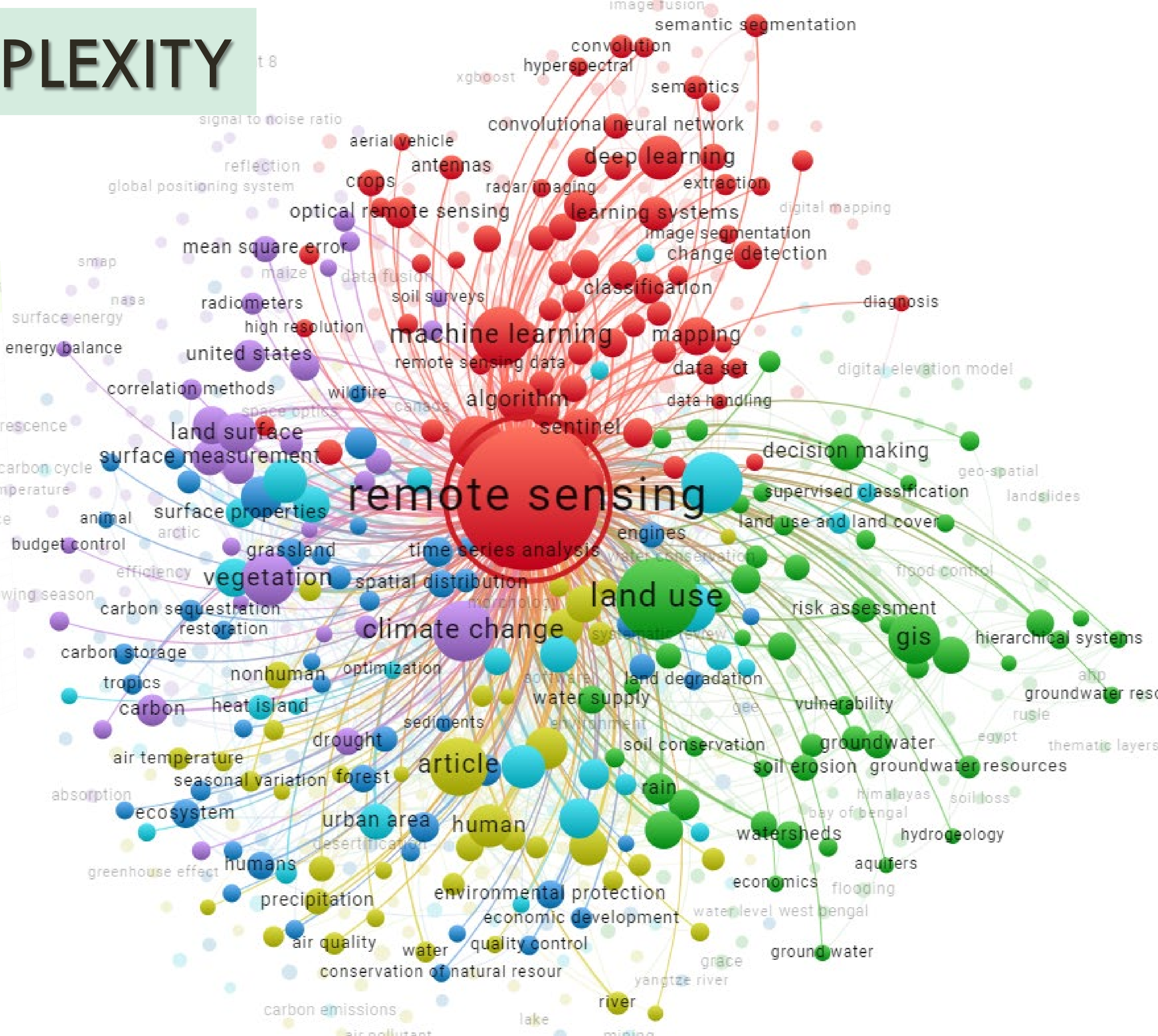
Riassumere la complessità e l'elevato numero di variabili

Supportare il processo decisionale nelle attività di restauro

Da utilizzare in combinazione con il protocollo

SUMMARIZING COMPLEXITY





MATCHING OF EACH SELECTED INDEX/INDICATOR WITH THE DEGRADATION PROCESSES IN EACH PILOT SITE

Indices			Degradation processes												
Type	Acronym	Description	*Landscape modification*	*Aridification*	*Forest fires*	*Hydrological modification*	*Overgrazing*	*Soil salinization*	*Soil organic matter decline*	*Soil erosion by water and wind*	*Decline in vegetation community functioning*	*Decline in vegetation cover/biomass*	*Habitat loss*	*Increase in invasive species*	*Trees encroachment*
Vegetation Indices	NDVI	*Normalized Difference Vegetation Index*	X		X		X				X	X	X	X	X
	GNDVI	*Green Normalized Difference Vegetation Index*	X		X		X				X	X	X	X	X
	$MSAVI_2$	*Modified Soil-Adjusted Vegetation Index*	X		X		X				X	X	X	X	X
	OSAVI	*Optimized Soil-Adjusted Vegetation Index*	X		X		X				X	X	X	X	X
	NDRE	*Normalized Difference RedEdge*	X		X		X				X	X	X		
	ARVI	*Atmospherically Resistant Vegetation Index*	X				X				X	X	X		X
	EVI_2	*Enhanced Vegetation Index 2*	X				X				X	X	X		X
	REP	*RedEdge Position*	X				X				X	X	X		
	NBR	*Normalized Burn Ratio*			X										
	NBR_2	*Normalized Burn Ratio 2*			X										
Water Indices	$NDWI_1$	*Normalized Difference Water Index 1*	X			X						X			
	$NDWI_2$	*Normalized Difference Water Index 2*	X			X									
	MNDWI	*Modified Normalized Difference Water Index*	X			X									
Soil Indices	NDSI	*Normalized Difference Soil Index*	X	X			X	X	X				X		
	NDBSI	*Normalized Difference Bare Soil Index*	X	X			X	X	X				X		
	BI	*Bare Index*	X	X			X	X	X				X		
Soil Salinity Indices	SSI_1	*Soil Salinity Index-1*	X	X				X							
	SSI_2	*Soil Salinity Index-2*	X	X				X							
	SSI_3	*Soil Salinity Index-3*	X	X				X							
	SI	*Salinity Index*	X	X				X							
	SASI	*Soil Adjusted Salinity Index*	X	X				X					X		
Drought/Dryness Indices	NDDI	*Normalized Difference Drought Index*	X	X			X	X	X				X		
	DSI	*Desertification Soil Index*	X	X			X	X	X				X		

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INSIGHT OF SELECTED REMOTE SENSING INDICATORS

List of Indices/Indicators from Remote Sensed (RS) data useful for assessing soil degradation/desertification status in the NL4DL study sites

Indices (R is the reflectance at the wavelengths (nm) denoted by the subscripts)

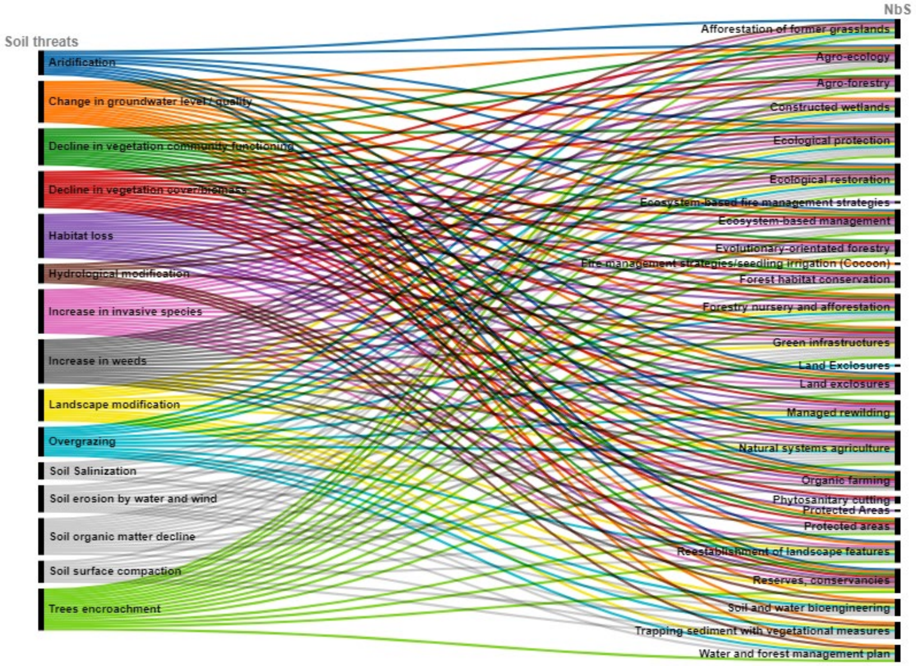
Type	Acronym	Description	Generic Formula	Formula by Sentinel-2 bands	Reference	Application	By RS data	Degradation Processes in NL4DL study sites	By CNR-IIA
	NDVI	Normalized Difference Vegetation Index	$\frac{R_{800}-R_{670}}{R_{800}+R_{670}}$	$\frac{NIR-Red}{NIR+Red}$	Rouse et al. (1974); Zarco-Tejada et al. (2001)				
	GNDVI	Green Normalized Difference Vegetation Index	$\frac{R_{800}-R_{550}}{R_{800}+R_{550}}$	$\frac{NIR-Green}{NIR+Green}$	Gitelson et al. (1996)				
	$MSAVI_2$	Modified Soil-Adjusted Vegetation Index	$\frac{2R_{800}+1-\sqrt{(2R_{800}+1)^2-8(R_{800}-R_{670})}}{2}$	$\frac{2*NIR+1-\sqrt{(2*NIR+1)^2-8*(NIR-Red)}}{2}$	Qi et al. (1995)				
	OSAVI	Optimized Soil-Adjusted Vegetation Index	$(1+0.16)\frac{R_{800}-R_{670}}{R_{800}+R_{670}+0.16}$	$(1+0.16)\frac{NIR-Red}{NIR+Red+0.16}$	Rondeaux et al. (1996)				
	NDRE	Normalized Difference RedEdge	$\frac{R_{860}-R_{700}}{R_{860}+R_{700}}$	$\frac{NIR_{narrow}-RedEdge1}{NIR_{narrow}+RedEdge1}$	Zhang et al. (2019)	presence and activity of green vegetation		Decline in Biodiversity; Decline in Biomass; Decline in vegetation community functioning; Decline in vegetation cover	
Vegetation Indices	ARVI	Atmospherically Resistant Vegetation Index	$\frac{R_{800}-[R_{670}-(R_{450}-R_{670})]}{R_{800}+[R_{670}-(R_{450}-R_{670})]}$	$\frac{NIR-[Red-(Blue-Red)]}{NIR+[Red-(Blue-Red)]}$	Bannari et al. (1995)		Yes		Yes
	EVI_2	Enhanced Vegetation Index 2	$2.5\frac{R_{800}-R_{670}}{R_{800}+2.4R_{670}+1}$	$2.5\frac{NIR-Red}{NIR+2.4Red+1}$	Jiang et al. (2008)				
	REP	RedEdge Position	$705+35\frac{\left(\frac{R670+R780}{2}\right)-R700}{R740+R700}$	$705+35\frac{\left(\frac{Red+REdEdge3}{2}\right)-RedEdge1}{RedEdge2+RedEdge1}$	Main et al. (2011)				
	NBR	Normalized Burn Ratio	$\frac{R_{860}-R_{2200}}{R_{860}+R_{2200}}$	$\frac{NIR_{narrow}-SWIR2}{NIR_{narrow}+SWIR2}$	Key et al. (2002)	Burned areas detection		Forest fires	
	NBR_2	Normalized Burn Ratio 2	$\frac{R_{1600}-R_{2200}}{R_{1600}+R_{2200}}$	$\frac{SWIR1-SWIR2}{SWIR1+SWIR2}$	Key et al. (2002)				

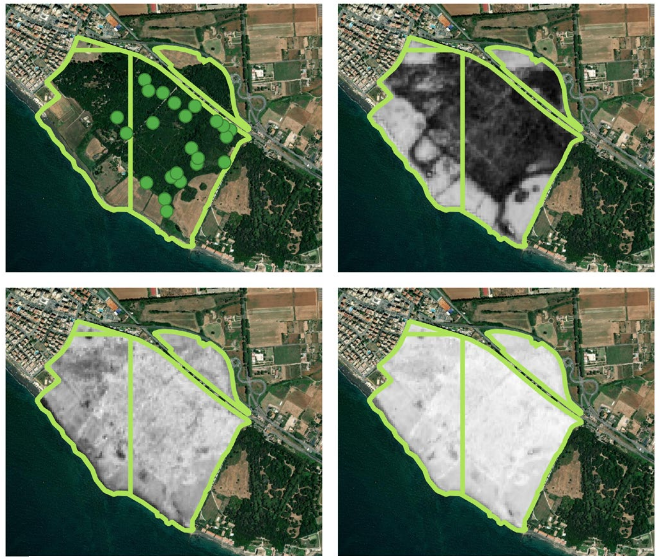
Water Indices	**$NDWI_1$**	**Normalized Difference Water Index 1**	$\frac{R_{800} - R_{2130}}{R_{800} + R_{2130}}$	$\frac{NIR - SWIR2}{NIR + SWIR2}$	Gao, 1996	water content of leaves	Yes	Decline in vegetation	Yes
	$NDWI_2$	**Normalized Difference Water Index 2**	$\frac{R_{550} - R_{800}}{R_{550} + R_{800}}$	$\frac{Green - NIR}{Green + NIR}$	McFeeters (1996)	water content in water bodies		Hydrological modifications	
	MNDWI	**Modified Normalized Difference Water Index**	$\frac{R_{550} - R_{2130}}{R_{550} + R_{2130}}$	$\frac{Green - SWIR2}{Green + SWIR2}$	Xu (2006)				
Soil Indices	**NDSI**	Normalized Difference Soil Index	$\frac{R_{1650} - R_{560}}{R_{1650} + R_{560}}$	$\frac{SWIR1 - Green}{SWIR1 + Green}$	Deng et al. (2015)	identify areas where soils are dominant	Yes	Soil quality degradation	Yes
	NDBSI	Normalized Difference Bare Soil Index	$\frac{R_{1650} - R_{860}}{R_{1650} + R_{860} + 0.001}$	$\frac{SWIR1 - NIRnarrow}{SWIR1 + NIRnarrow + 0.001}$					
	BI	Bare Index	$\frac{(R_{1650} + R_{670}) - (R_{800} + R_{450})}{(R_{1650} + R_{670}) + (R_{800} + R_{450})}$	$\frac{(SWIR1 + Red) - (NIR + Blue)}{(SWIR1 + Red) + (NIR + Blue)}$	Chen et al. (2004)				
Soil Salinity Indices	**SSI_1**	**Soil Salinity Index-1**	$\sqrt{R_{[520:600]} * R_{[630:690]}}$	$\sqrt{Green * Red}$	Khan et al. (2001); Yahiaoui et al. (2015)	identification of degree of soil salinization	Yes	Soil Salinization	Yes
	SSI_2	**Soil Salinity Index-2**	$2 * R_{[520:600]} - (R_{[630:690]} + R_{[770:900]})$	$2 * Green - (Red + NIR)$	Douaoui and Lepinard (2010); Yahiaoui et al. (2015)				
	SSI_3	**Soil Salinity Index-3**	$\sqrt{R^2_{[630:690]} + R^2_{[520:600]}}$	$\sqrt{Red^2 + Green^2}$	Douaoui et al. (2006); Yahiaoui et al. (2015)				
	SI	**Salinity Index**	$\frac{R_{[530:590]} * R_{[640:670]}}{R_{[450:510]}}$	$\frac{Green * Red}{Blue}$	Elhag et al. (2016)				
	SASI	**Soil Adjusted Salinity Index**	$\frac{R_{[630:690]}}{100 * R^2_{[450:520]}}$	$\frac{Red}{100 * Blue^2}$	Yahiaoui et al. (2015)				
Drought/Dryness Indices	**NDDI**	**Normalized Difference Drought Index**	$\frac{NDVI - NDWI_1}{NDVI + NDWI_1}$		Gu et al. (2007); Renza et al. (2010)	assessing drought	Yes	Aridification	Yes
	DSI	**Desertification Soil Index**	$\frac{R_{1648} - R_{498}}{R_{1648} - R_{2203} + 0.2}$	$\frac{SWIR1 - Blue}{SWIR1 - SWIR2 + 0.2}$	Wu et al. (2010)	highlight the higher reflectance of desertification soil as			

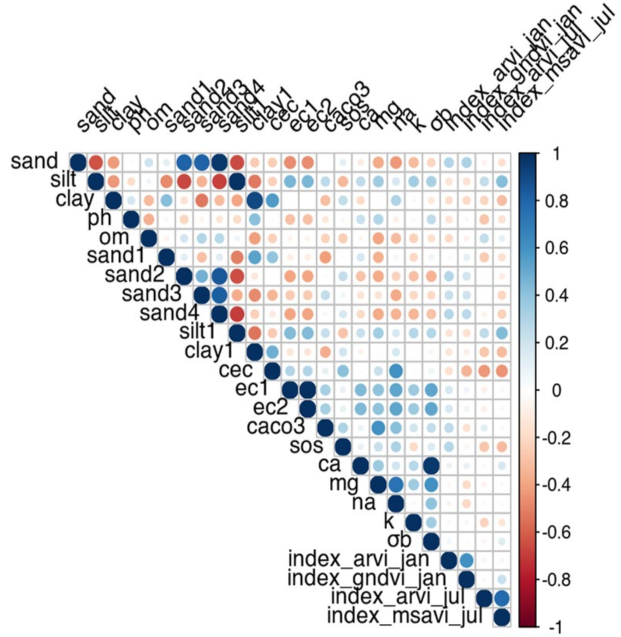
Expert-Based Connections

Correlation Analysis

Acronym	Description	Landscape modification	Aridification	Forest fires	Hydrological modification	Overgrazing	Soi
NDVI	*Normalized Difference Vegetation Index*	X		X		X	
GNDVI	*Green Normalized Difference Vegetation Index*	X		X		X	
$MSAVI_2$	*Modified Soil-Adjusted Vegetation Index*	X		X		X	
OSAVI	*Optimized Soil-Adjusted Vegetation Index*	X		X		X	
NDRE	*Normalized Difference RedEdge*	X		X		X	
ARVI	*Atmospherically Resistant Vegetation Index*	X				X	
EVI_2	*Enhanced Vegetation Index 2*	X				X	
REP	*RedEdge Position*	X				X	
NBR	*Normalized Burn Ratio*			X			
NBR_2	*Normalized Burn Ratio 2*			X			
$NDWI_1$	*Normalized Difference Water Index 1*	X			X		
$NDWI_2$	*Normalized Difference Water Index 2*	X			X		
MNDWI	*Modified Normalized Difference Water Index*	X			X		
NDSI	*Normalized Difference Soil Index*	X	X			X	
NDBSI	*Normalized Difference Bare Soil Index*	X	X			X	
BI	*Bare Index*	X	X			X	
SSI_1	*Soil Salinity Index-1*	X	X				
SSI_2	*Soil Salinity Index-2*	X	X				
SSI_3	*Soil Salinity Index-3*	X	X				
SI	*Salinity Index*	X	X				
SASI	*Soil Adjusted Salinity Index*	X	X				
NDDI	*Normalized Difference Drought Index*	X	X			X	
DSI	*Desertification Soil Index*	X	X			X	







Features

Identification of the Land Degradation Processes

Expert Based selection of Indicator

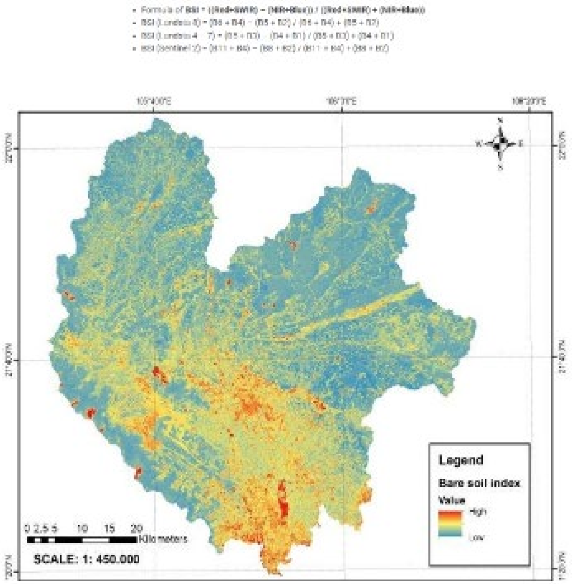
instructions to calculate with Sentinel 2 - integrated EO Browser

Guided **procedure** to the assessment of trend and status through selected and ad-hoc **remote sensing** and in-situ **indicators**

Nature-Based Solutions that fits with the selected degradation process can be selected and further monitored

BI – Bare Index

Bare Index or Bare Soil Index (BSI) are a numerical indicators that combines blue, red, near infrared and short wave infrared spectral bands to capture soil variations. These spectral bands are rather used in a normalized manner than their simple formula. The short wave infrared and the red spectral bands are used to quantify the soil mineral composition, while the blue and the near infrared spectral bands are used to enhance the presence of vegetation



Generic Formula (R is the reflectance at the wavelengths (nm) denoted by the subscripts):

$$\frac{(R_{1650} + R_{670}) - (R_{800} + R_{450})}{(R_{1650} + R_{670}) + (R_{800} + R_{450})}$$

Formula by Sentinel-2 bands:

$$\frac{(SWIR1 + Red) - (NIR + Blue)}{(SWIR1 + Red) + (NIR + Blue)}$$

References:

Loi, Duong & Chou, Tien-Yin & Fang, Yao-Min. (2017). Integration of GIS and Remote Sensing for Evaluating Forest Canopy Density Index in Thai Nguyen Province, Vietnam. International Journal of Environmental Science and Development. 8. 539-542. 10.18178/ijesd.2017.8.8.1012.

NDRE – Normalized Difference RedEdge

NDRE Normalized Difference Red Edge

Normalized difference red edge index (NDRE) is a method of measuring the amount of chlorophyll in the plants. The best timing to apply NDRE is mid-to-late growing season when the plants are mature and ready to be harvested. At this point, other indices would be less effective to use.

It is represented by a certain value calculated using a combination of a Near-InfraRed (NIR) band and the RedEdge range between visible Red and NIR

Generic Formula (R is the reflectance at the wavelengths (nm) denoted by the subscripts):

$$\frac{R_{860} - R_{700}}{R_{860} + R_{700}}$$

Formula by Sentinel-2 bands:

$$\frac{NIR_{narrow} - RedEdge1}{NIR_{narrow} + RedEdge1}$$

Since chlorophyll is crucial to the process of photosynthesis, its quantity is an important indicator of the plant's health. On EOSDA Crop Monitoring, we're using a standard scale of -1 to 1 for the NDRE index. It's important to know how to correctly interpret the values:

- -1 to 0.2 indicate bare soil or a developing crop;
- 0.2 to 0.6 can be interpreted as either an unhealthy plant or a crop that is not mature yet;
- 0.6 to 1 are good values indicating healthy, mature, ripening crops.

source: EOS Data Analytics

References:

- Zhang, K., Ge, X., Shen, P., Li, W., Liu, X., Cao, Q., ... & Tian, Y. (2019). Predicting rice grain yield based on dynamic changes in vegetation indexes during early to mid-growth stages. *Remote sensing*, *11*(4), 387.

THANK YOU!

NewLife4Drylands

WEB TOOL LINK

www.newlife4drylands.eu/en/outcomes

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