Potentially useful remotely sensed drought indices

IMPORTANT NOTE!

This list of potentially useful remotely sensed drought indices was established in order to select suitable drought indices for the Drought Monitoring Framework and the study ASSESSING THE RELATION BETWEEN GROUNDWATER RECHARGE AND DROUGHT USING REMOTE SENSING AND HYDROLOGICAL MODELLING by T. Schults. This list was created in cooperation with other members of the project team of the Drought Monitoring Framework (DMF). As the focus of the Institute of Water Resources and Planning (IWRP) shifted towards different project in early 2019 this list was never fully finished and lacks scientific references. Because of this, the list cannot be published. The drought indices were selected subjectively at a conference meeting where the advantages and disadvantages were discussed with all team members.

Nr.	Name of index	Type of index	Used to monitor type of drought	Data input	Advantages	Disadvantages	Literature base	Formula / Bands		Source
1	**Standardized Precipitation index (SPI)**	Meteorology	Meteorological	P	- **Endorsed by WMO** - Various timescales - Used in research in Vietnam - Often used together with SPEI	- Only precipitation as input - **Deficient when accounting temperature component**	Yes			P = CHIRPS
2	**Drought Reconnaissance Index (DRI)**	Meteorology	Meteorological / Agricultural	P, T	- **Use of ET better representation of full water balance than SPI** - Various timescales	- Potential ET can be subject to error using only T - Monthly timescales may not react quickly enough to rapidly developing droughts	Yes			P = CHIRPS T = CFSR
3	**Palmer Drought Severity Index (PDSI)**	Meteorology	Meteorologica / Agricultural	P, T, AWC	- - Numerous papers on PDSI		Yes			P = CHIRPS T = CFSR AWC =

					- Incorporation of soil				
4	**Keetch–Byram Drought Index (KBDI)**	Meteorology	Meteorological / Agricultural	P, T	- Expresses moisture deficiency for an area and can easily be scaled to indicate the characteristics for a location	- Assumes a limit of available moisture and the necessity of certain climatic conditions for drought to develop, which may not be true for every location	Little		P = CHIRPS T = CFSR
5	**Weighted Anomaly Standardized Precipitation Index (WASP)**	Meteorology	Meteorological	P, T	- Using precipitation allows for simpler computations	- Does not work well in arid regions	Little		P = CHIRPS T = CFSR
6	**Crop Moisture Index (CMI)**	Meteorology	Agricultural	P, T	- The output is weighted, so it is possible to compare different climate regimes - Rapidly responds to changing conditions	- CMI may show false sense of recovery from drought events	Yes		P = CHIRPS T = CFSR
7	**Standardized Precipitation Evaporation Index (SPEI)**	Meteorology	Meteorological	P, T,	- Inclusion of temperature - Good in combination with SPI - Used in research in Vietnam	- Being a monthly index, rapidly developing drought situations may not be identified quickly	Yes		P = CHIRPS T = CFSR
8	**Soil Moisture Anomaly (SMA)**	Soil moisture	Agricultural	P, T, AWC	- Inclusion of temperature → full water balance - Considers moisture different layers of soil		Yes	$SMI = 1 - \frac{1}{1+(\frac{\theta}{\theta_{50}})^6}$ $SMA = \frac{SMI_t - \overline{SMI}}{\delta SMI}$	P = CHIRPS T = CFSR AWC =
9	**Evapotranspiration Deficit Index (ETDI)**	Soil moisture	Agricultural	SWAT	- Can be calculated with SWAT - Can easily be connected to groundwater study	-	Yes	$WS = \frac{PET - AET}{PET}$ $WSA_{i,j} = \frac{MWS_j - WS_{i,j}}{MWS_j - minWS_j} * 100, \quad if\ WS_{i,j} = MWS_j$	SWAT input

								$WSA_{i,j} = \frac{MWS_j - WS_{i,j}}{maxMWS_j - MWS_j} * 100, \quad if\ WS_{i,j} > MWS_j$ $ETDI_j = 0.5ETDI_{j-1} + \frac{WSA_j}{50}$	
10	**Soil Moisture Deficit Index (SMDI)**	Soil moisture	Agricultural	SWAT	- Can be calculated with SWAT - Can easily be connected to groundwater study	-	Yes	$\mathrm{SD}_{i,j} = \frac{\mathrm{SW}_{i,j} - \mathrm{MSW}_j}{\mathrm{MSW}_j - \min SW_j} \times 100, \mathrm{if} \mathrm{SW}_{i,j} = \mathrm{MSW}_j$ $\mathrm{SD}_{i,j} = \frac{\mathrm{SW}_{i,j} - \mathrm{MSW}_j}{\max SW_j - \mathrm{MSW}_j} \times 100, \mathrm{if} \mathrm{SW}_{i,j} > \mathrm{MSW}_j$ $\sum_{t=1}^{j} Z_t = -100t - 100$ $\mathrm{SMDI}_j = \frac{\sum_{t=1}^{j} \mathrm{SD}_t}{25t+25}$ $\mathrm{SMDI}_1 = \frac{\mathrm{SD}_1}{50}$ $\mathrm{SMDI}_j = \mathrm{SMDI}_{j-1} + \Delta\mathrm{SMDI}_j$	SWAT input
11	**Kappa Water Balance Index (K)**	Soil moisture	Agricultural / Hydrological	PET, ETA	- Used in research in Vietnam		No	$K = \frac{ET}{P}$	
12	**Palmer Hydrological Drought Severity Index (PHDI)**	Hydrology	Hydrological	P, T, AWC	- Total water system to be considered	- Impact of human influences are not considered	Yes		
13	**Enhanced Vegetation Index (EVI)**	Remote sensing	Agricultural	Sat	- High resolution - Good spatial coverage	- Stress to plant canopies can be caused by other than drought - Short time of record so not good for long term monitoring (Handbook) - Limitations for real time monitoring of drought due to lag time in		$EVI = G * \frac{(NIR - RED)}{(NIR + C1 * RED - C2 * BLUE + L)}$ NIR = Near infrared RED = Red light BLUE = Blue light C1 = C2 = G = L = Canopy background adjustment	

						vegetation (Patel et al 2011)			
14	**Evaporative Stress Index (ESI)**	Remote sensing	All	Sat, PET	- High resolution - Good spatial coverage	- Cloud cover can contaminate results			
15	**Normalized Difference Vegetation Index (NDVI)**	Remote sensing	Agricultural	Sat	- High resolution - Good spatial coverage - Most widely used Veg index	- Data processing is vital to NDVI, robust system is needed - Sensitive to soil color - Atmospheric influnces - Saturate in high biomass conditions - Requires significant processing - Limitations for monitoring drought due to lag in time veg respons (Patel)	Yes	$NDVI = \frac{(NIR-VIS)}{(NIR+VIS)}$ NDVI = Normalized Difference Vegetation Index NIR = Near-infrared light VIS = Visible light	
16	**Temperature Condition Index (TCI)**	Remote sensing	Agricultural	Sat	- High resolution - Good spatial coverage - Takes temperature into account - Can be used in combination with NDVI to provide a combined veg and moist ass addressing limitations in the lag of drought and veg respons	- Cloud cover can contaminate results - Used in conjunction with NDVI and VCI	Yes	$TCI = \frac{(BT_{max}-BT)}{(BT_{max}-BT_{min})}$ TCI = Temperature Condition Index BT = Brightness temperature	
17	**Vegetation Condition Index (VCI)**	Remote sensing	Agricultural	Sat	- High resolution - Good spatial coverage	- Cloud cover can contaminate results - Used in conjunction with NDVI and VCI	Yes	$VCI = \frac{(NDVI-NDVI_{min})}{(NDVI_{max}-NDVI_{min})}$ VCI = Vegetation Condition Index	

18	**Vegetation Health Index (VHI)**	Remote sensing	Agricultural	Sat	- High resolution - Good spatial coverage - As a composite of VCI and TCI, VHI is more robust		Yes	$VHI = \propto VCI + 1\ (1-\propto)TCI$ VHI = Vegetation Health Index VCI = Vegetation Condition Index TCI = Temperature Condition Index α = relative contribution of VCI and TCI in VHI	
29	**Normalized Difference Water Index and Land Surface Water Index (LSWI)**	Remote sensing	Agricultural	Sat	- High resolution - Good spatial coverage - **Clear picture of soil moisture and the consequent water stress** - Combination of indexes looking at different signals for drought - Scattering effects aerosols are weak - Less sensitive to atmosphere than NDVI	- Stress to plant canopies can be caused by other than drought - **Complementary to, not a subsititue to NDVI**	Yes	$NDWI = \frac{(Xnir-Xswir)}{(Xnir+Xswir)}$ Xnir = near infrared light Xswir= short wave infrared light	
20	**Global Integrated Drought Monitoring and Prediction System (GIDMaPS)**	Composite	All	OMod	- Excellent for areas lacking observations - Easy to use - No input of user	- Grid sizes may not represent all areas and climate regimes equally	Little		
21	**Multivariate Standardized Drought Index (MSDI)**	Composite	All	OMod	- Excellent for areas lacking observations - Easy to use - No input of user needed - Individual indices can be obtained from MSDI	- Grid sizes may not represent all areas and climate regimes equally	Little		
22	**Global Vegetation Moisture Index (GVMI)**	Remote sensing	Agricultural	Sat	-	-	Yes	$GVMI = \frac{(NIR+0.1)-(SWIR+0.02)}{(NIR+0.1)+(SWIR+0.02)}$ NIR = near infrared (780:1400) SWIR = short wave infrared (1400:3000) https://www.indexdatabase.de/db/i-single.php?id=372	Many sensors

23	**Adjusted transformed soil-adjusted VI** (VI)				-	-	Little	$ATSAVI = \frac{NIR - a*RED - b}{a*NIR + RED - a*b + X(1+a^2)}$ X=0.08 a=1.22 b=0.03	
24	**Aerosol free vegetation index (AFRI1600/AFRI2100)**				-	-	Little	$AFRI1600 = (NIR - 0.66\frac{1600nm}{NIR+0.66*1600nm})$ $AFRI2100 = (NIR - 0.5\frac{2100nm}{NIR+0.56*2100nm})$	
25	**Ashburn Vegetation Index (AVI)**				-	-	Little	$AVI = 2\,[800:1100] - [600:700]$	
26	**Atmospherically Resistant Vegetation Index (ARVI)**				-	-	Yes	$ARVI = \frac{NIR - RED - \gamma(RED - BLUE)}{NIR + RED - \gamma(RED - BLUE)}$ Y =	
27	**Atmospherically Resistant Vegetation Index 2 (ARVI2)**				-	-	Little	$ARVI2 = -0.18 + 1.17(\frac{NIR - RED}{NIR + RED})$	
28	**Blue-wide dynamic range vegetation index (BWDRVI)**				-	-	No	$BWDRVI = \frac{0.1 * NIR - BLUE}{0.1 * NIR + BLUE}$	
29	**CASI NDVI**				-	-	No	$CASI\ NDVI = \frac{([770:780] + [784:790]) - ([655:665] + [676:685])}{([770:780] + [784:790]) + ([655:665] + [676:685])}$	
30	**Corrected Transformed Vegetation Index (CTVI)**				-	-	No	$CTVI = \frac{NDVI + 0{,}5}{\lvert NDVI \rvert + 0{,}5} * \sqrt{\lvert NDVI \rvert + 0{,}5}$	
31	**Enhanced Vegetation Index 2 (EVI2)**				-	-	No	$EVI2 = 2{,}4 * \frac{NIR - RED}{NIR + RED + 1}$	
32	**Green Atmospherically Resistant Vegetation Index (GARI)**				-	-	No	$GARI = \frac{NDVI + 0{,}5}{\lvert NDVI \rvert + 0{,}5}$	
33	**Green Normalized Difference Vegetation Index (GNDVI)**				-	-	Yes	$GNDVI = \frac{NIR - [540:570]}{NIR + [540:570]}$	
34	**Green Optimized Soil Adjusted Vegetation Index (GOSAVI)**				-	-	No	$GOSAVI = \frac{NIR - G}{NIR + G + Y}$ G =	

								Y = 0,16	
35	**Green Soil Adjusted Vegetation Index (GSAVI)**				-	-	No	$GSAVI = \frac{NIR - G}{NIR + G + Y}(1 + L)$ Y = L =	
36	**Misra Green Vegetation Index (MGVI)**				-	-	Little	$MGVI = -0{,}386[500:600] - 0{,}530[600:700] + 0{,}535[700:800] + 0{,}532[800{:}1100]$	
37	**Normalized Difference MIR/NIR Normalized Difference Vegetation Index (in case of atmospheric disturbances)**				-	-	Yes	$NDMIRNIRDVI? = \frac{MIR - NIR}{MIR + NIR}$	
38	**Normalized Difference Vegetation Index 690-710**				-	-	No	$NDVI690 - 710 = \frac{NIR - [690:710]}{NIR + [690:710]}$	
39	**Normalized Difference Vegetation Index C**				-	-	No	$NDVIc = \frac{NIR - RED}{NIR + RED} * (1 - \frac{SWIR - SWIR_{min}}{SWIR_{max} - SWIR_{min}})$	
40###	**Optimized Soil Adjusted Vegetation Indexx (OSAVI**				-	-	Yes	$OSAVI = (1 + Y)\frac{800nm - 670nm}{800nm + 670nm + Y}$	Y?
	Soil Adjusted Vegetation index (SAVI)				-	-	Yes	$SAVI = \frac{800nm - 670nm}{800nm + 670nm + L}(1 + L)$ L = 0.5	
40	**Soil and Atmospherically Resistant Vegetation Index**				-	-	Yes	$SARVI = (1 + L)\frac{800nm - \left(Rr - \gamma(RB - Rr)\right)}{800nm + -\left(Rr - \gamma(RB - Rr)\right) + L}$	
41	**Soil and Atmospherically Resistant Vegetation Index 2**				-	-	Little	$SARVI2 = 2{,}5\frac{NIR - RED}{1 + NIR + 6 * RED - 7{,}5 * BLUE}$	

42	**Soil and Atmospherically Resistant Vegetation Index 3**				-	-	No	$SARVI3 = (1 + 0{,}5)\frac{833nm - 658nm}{833nm + 658nm + 0{,}5}$	
43	**Tasseled Cap – Green Vegetation Index MSS**				-	-	Little	$TCGVI = -0{,}899[500:600] + 0{,}248[600:700] + 0{,}076[700:800] - 0.041[800:1100]$	
44	**Tasseled Cap – Vegetation**				-	-	Yes	$TCVEG = -0{,}2848[450:520] - 0{,}2435[520:600] - 0{,}5436[630:690] + 0{,}7243[760:900] + 0{,}084[1550:1750]$	
45	**Transformed Soil Adjusted Vegetation Index (TSAVI)**				-	-	Yes	$TSAVI = \frac{B(NIR - B * R - A)}{RED + B(NIR - A) + X(1 + B^2)}$	
46	**Transformed Soil Adjusted Vegetation Index (TSAVI2)**				-	-	Little	$TSAVI2 = \frac{a * NIR - a * RED - b}{RED + a * NIR - a * b}$	
47	**Triangular Vegetation Index (TVI)**				-	-	Yes	$TVI = 0{,}5(120(750nm - 550nm) - 200(670nm - 550)$	
48	**Wide Dynamic Range Vegetation Index (WDRVI)**				-	-	Little	$WDRVI = \frac{0.1 * NIR - RED}{0.1 * NIR + RED}$	