Soil Salinity Mapping and Hydrological Drought Indices Assessment in Arid Environments Based on Remote Sensing Techniques

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Overview

- Introduction
- Objectives
- Study area
- Methodological framework
- Findings
- Conclusions

Introduction

Remote Sensing Data

- Satellite images offer a large amount of data that could be analyzed
- Convenient source to perform several vegetation indices
- Spectral reflectance variabilities tend to differentiate between different vegetation characteristics based on crop water relationships

Spectral Vegetation Indices

- Spectral vegetation indices are mathematical combinations of different spectral bands mostly in the visible and near-infrared regions of the electromagnetic spectrum
- Vegetation activities can be measured comprehensively through semi-analytical methods of spectral band ratios

Introduction

Excessive irrigation

+

Poor drainage

→

Soil Salinization

Objectives

Spectral Vegetation Indices

Soil Salinity Indices

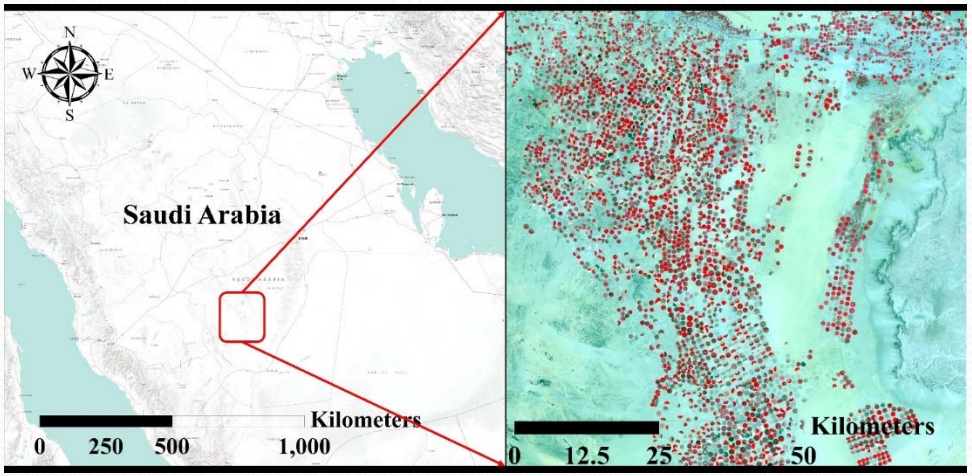
Regression Analysis

Find the correlation between Soil Salinity indices and Hydrological Drought Indices

Conservation of natural recourses

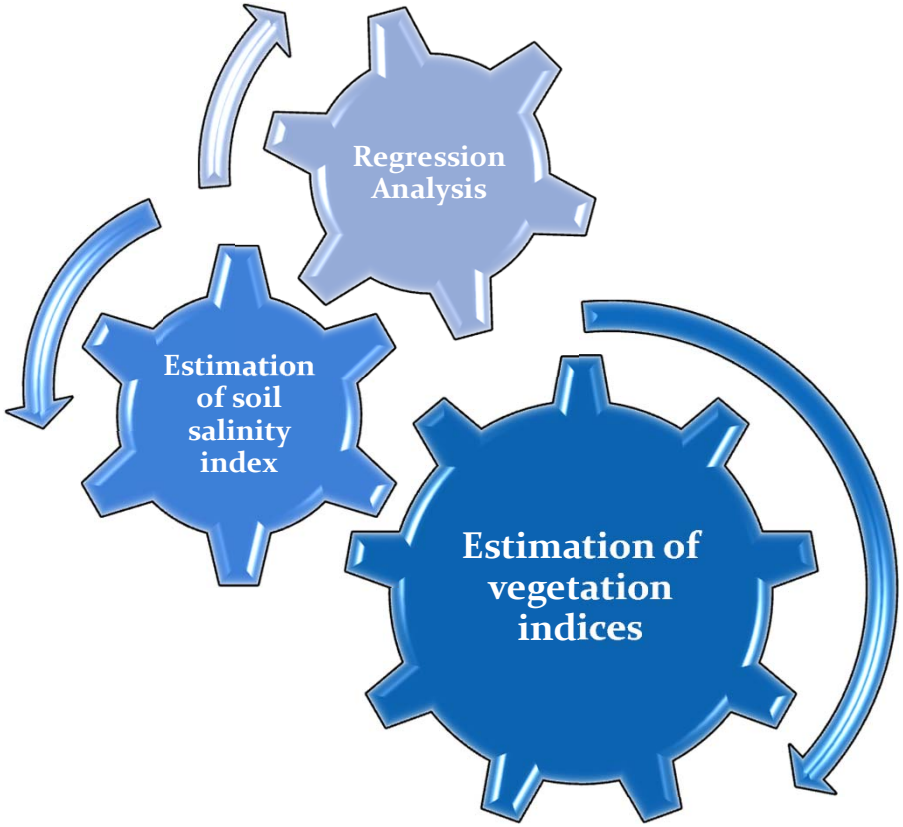
Study area

- Agriculture in Wadi Ad Dawasir area consists of technically highly developed farm enterprises that operate with modern pivot irrigation system.
- All year fodder consists of alfalfa, which is cut up to 10 times a year for food.
- The shallow alluvial aquifers could not sustain the high groundwater abstraction rates for a long time.
- The groundwater level declined dramatically in most areas from 120 to almost 400 m deep.



The location of the study area in false color composite

Methodological framework



Methodological framework

Estimation of vegetation indices

- *Water Supply Vegetation Index (WSVI)*
- *Soil Adjusted Vegetation Index (SAVI)*
- *Moisture Stress Index (MSI)*
- *Normalized Difference infrared Index (NDII)*

Estimation of soil salinity index

- *Brightness Index*
- *Normalized Difference Salinity Index*
- *Salinity Index SI-6*
- *Salinity Index SI-9*

Regression Analysis

- *Principle Component Analysis (PCA)*
- *Artificial Neural Network (ANN)*

Hydrological Drought Indices

Water Supply Vegetation Index (WSVI):

$$WSVI = NDVI/T_s$$

Soil Adjusted Vegetation Index (SAVI):

$$SAVI = \frac{(NIR - R)}{(NIR + R) * (1 + L)}$$

Moisture Stress Index (MSI):

$$MSI = \frac{SWIR_1}{NIR}$$

Normalized Difference Infrared Index (NDII):

$$NDII = \frac{(NIR - SWIR_1)}{(NIR + SWIR_1)}$$

Soil Salinity Indices

Normalized Difference Salinity Index:

$$NDSI = (R - NIR)/(R + NIR)$$

Brightness Index:

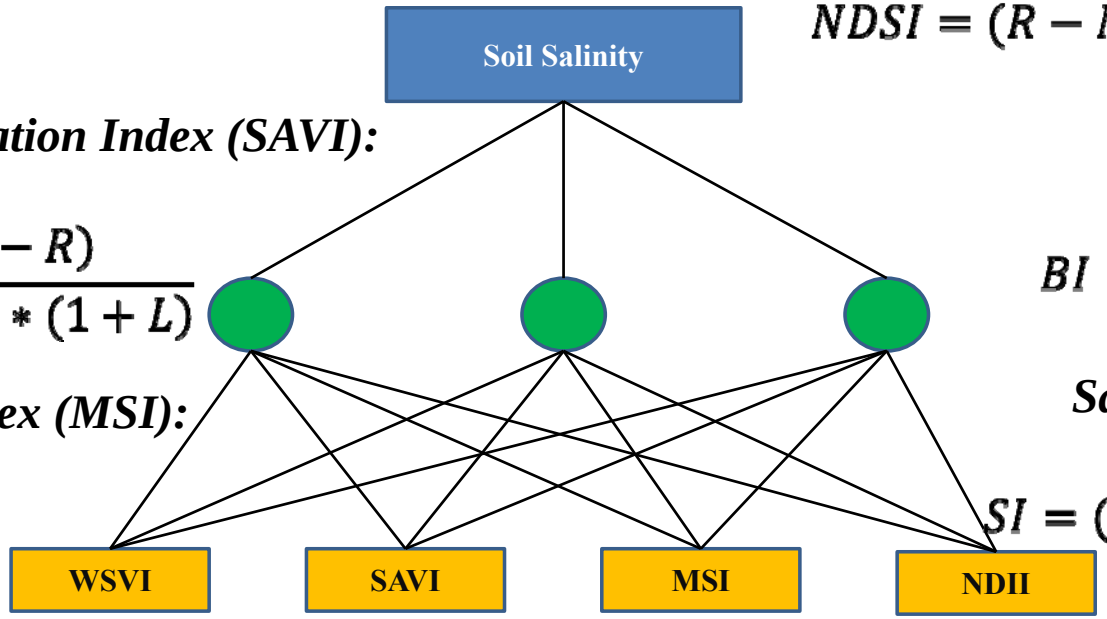
$$BI = \sqrt{(R^2 + NIR^2)}$$

Salinity Index SI-6:

$$SI = (B - R)/(B + R)$$

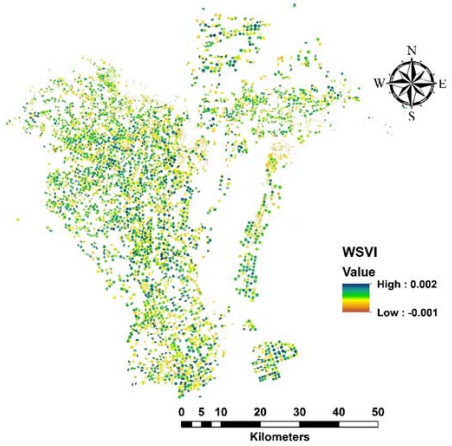
Salinity Index SI-9:

$$SI = (NIR \times R)/G$$

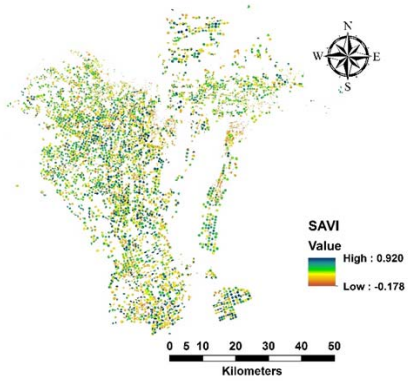


Artificial Neural Network (ANN)

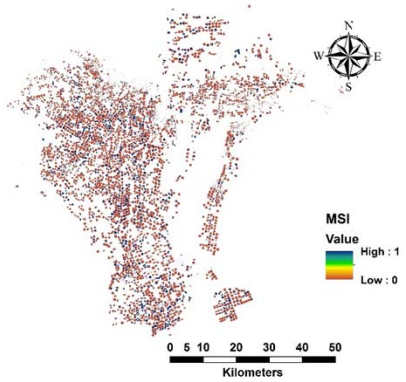
Findings



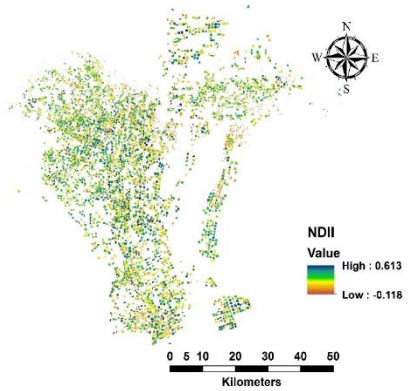
Water Supply Vegetation Index (WSVI)



Soil Adjusted Vegetation Index (SAVI)

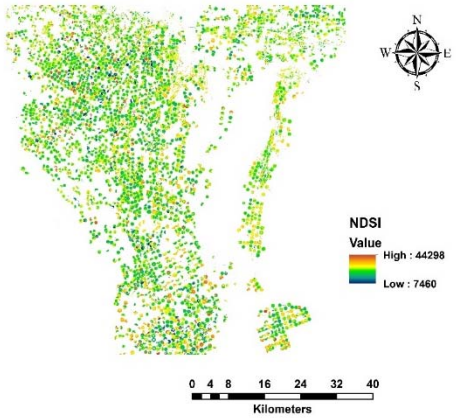


Moisture Stress Index (MSI)

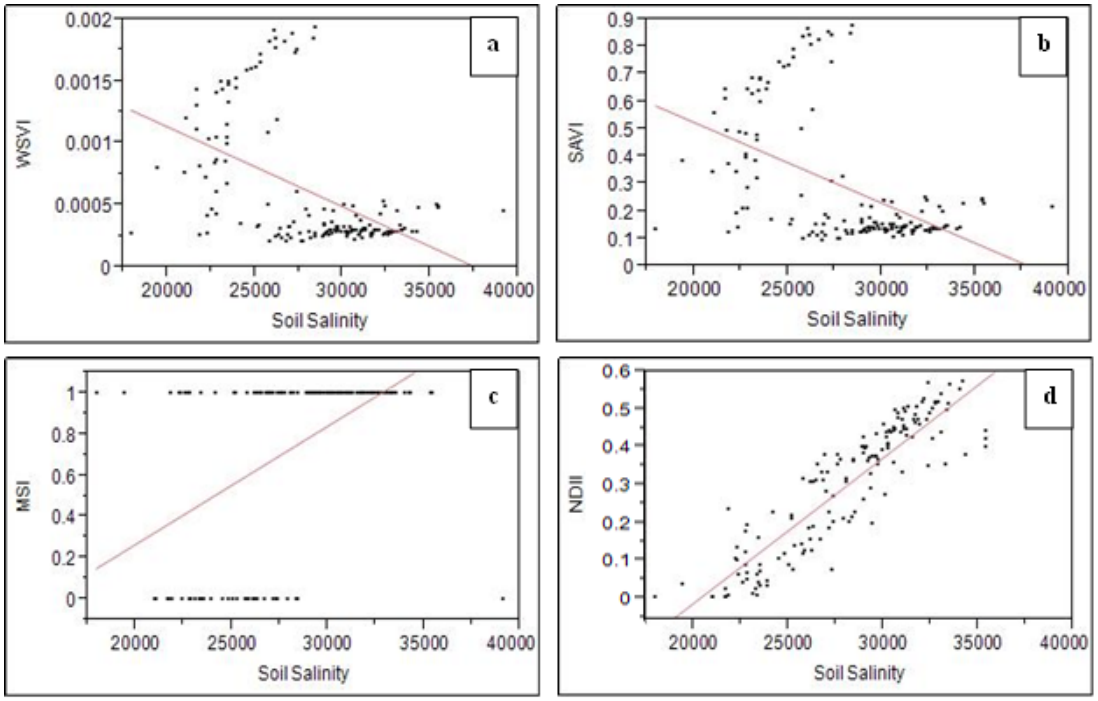


Normalized Difference infrared Index (NDII)

Findings

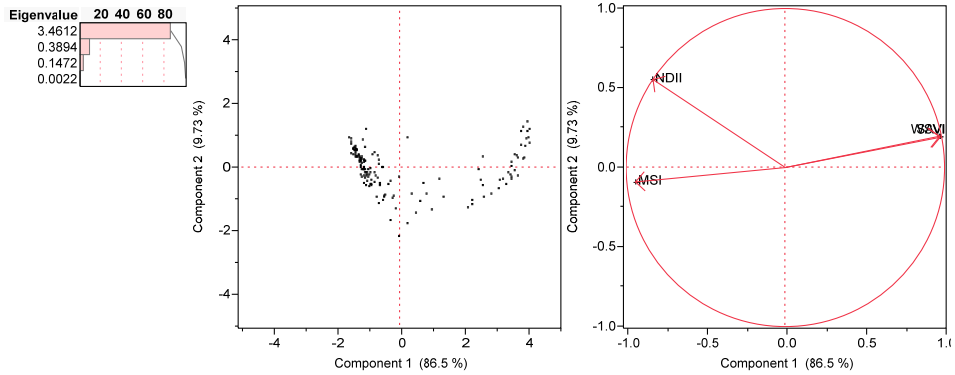


Normalized Difference Salinity Index



Regression analyzes of NDSI (ppm) against hydrological drought indices

Findings

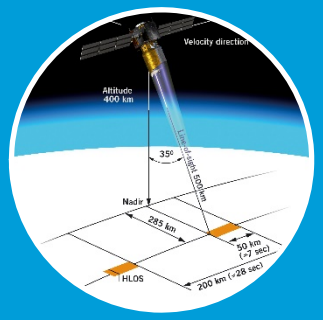


Principle Component Analysis

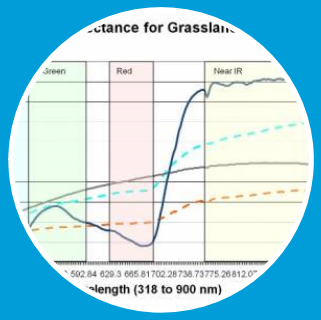
		Training Measures	Validation Measures
NDII	RSquare	0.7574526	0.6698156
	RMSE	**0.0999530**	0.0972931
	Mean Abs Dev	0.0571881	0.0436599
	-LogLikelihood	-88.411680	-45.554430
	SSE	0.9990600	0.4732975
	Sum Freq	100	50
MSI	RSquare	0.3032101	0.0893892
	RMSE	0.2388872	0.1869959
	Mean Abs Dev	0.1203075	0.0628425
	-LogLikelihood	-1.2825260	-12.886510
	SSE	5.7067096	1.7483727
	Sum Freq	100	50
SAVI	RSquare	0.7565419	0.6698155
	RMSE	0.1499295	0.1459397
	Mean Abs Dev	0.0857822	0.0654899
	-LogLikelihood	-47.865170	-25.28115
	SSE	2.2478847	1.0649203
	Sum Freq	100	50
WSVI	RSquare	0.7533827	0.6619429
	RMSE	0.0003280	0.0003226
	Mean Abs Dev	0.0001876	0.0001451
	-LogLikelihood	-660.35100	-331.01460
	SSE	1.08E-05	5.20E-06
	Sum Freq	100	50

Neural Network Analysis

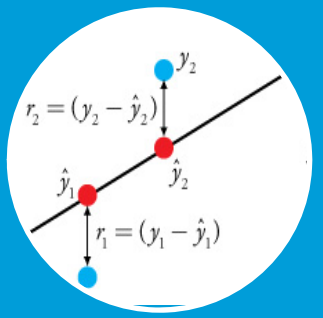
Conclusion & Recommendations



Remote Sensing techniques were satisfactorily implemented and interpreted in term of soil salinity mapping in consort with hydrological drought indices



Normalized Difference Infrared Index was statistically proved to be the Normalized Difference Salinity Index profound, followed by Soil Adjusted Vegetation Index and Water Shortage Vegetation Index respectively



Principal Component Analysis and Artificial Neural Network Analysis are complementary tools to understand the regression pattern of the hydrological drought indices in the designated study area

Thanks for your attention