OPTICAL REMOTE SENSING OF SALT LAKES FROM SPACE: CASE STUDY OF AIGUES-MORTES SALTED FIELD (SOUTH FRANCE)

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Abstract

Salt-lake are ecologically and culturally significant, their remote locations and rapid seasonal changes makes them hard to monitor with field method alone. This study explores the use of optical satellite data to track salt crust information, surface moisture, and vegetation dynamics. Focusing on selected parcels in the Salin d'Aigues-Mortes across 2023, we used spectral analysis and indices to detect seasonal patterns. SWIR bands proved critical for detecting water content and distinguishing between dry, wet and algae-covered surfaces. The combination of spectral indices, band-level reflectance and time-series analysis provides a robust approach to understanding salt-lake surface dynamics.

Context

Salt-lake information is important in ecological protection, water resource management, economic development, and tourism culture. This above information is closely related to the ecology of salt-lake area, and the salt production of different kinds (for industry, alimentation, and also in terms of rare earth element's exploitation).

Objectives

- Develop approaches to characterize salt lakes and its surrounding environments, using optical and techniques,
- The segmentation of salt-lake areas, the classification of the salt crystals states in different salted water fields,
- Establish the dynamic maps of salt lakes across years.

4 studies sites :

- **FRANCE**: Salin-de-Giraud and Salin d'Aigues-Mortes
- **SPAIN**: Salines de la Trinitat, the Elbro Delta
- **CHINA**: the Qarhan Salt Lake



Salins d'Aigues-Mortes (FR:艾格莫尔特盐湖)

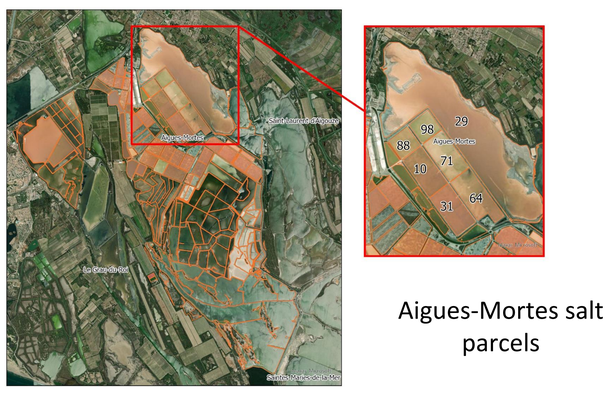


Studies sites localization

Data/ Methods

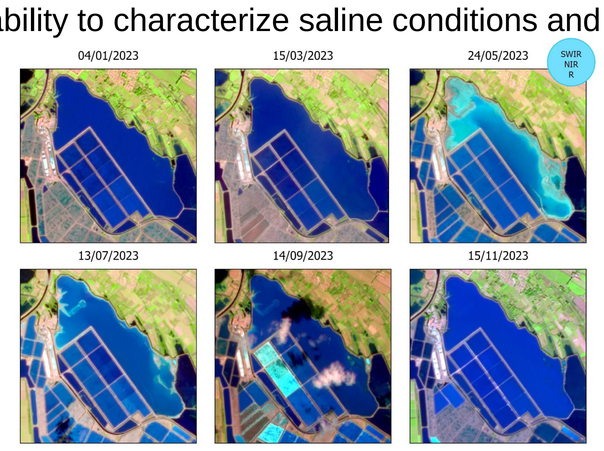
Six Sentinel-2 L2A images, acquired between January and November 2023 were processed.

Index	Formula
NDSI (Normalized Difference Salinity Index)	(1)(B11-B8)/(B11+B8) (2)(B4-B8)/(B4+B8)
NDWI (Normalized Difference Water Index)	(B8-B11)/(B8+B11)
SI (Salinity Index)	(B4+B11)/2
BI (Brightness Index)	Sqrt(B4*B4+B8*B5)

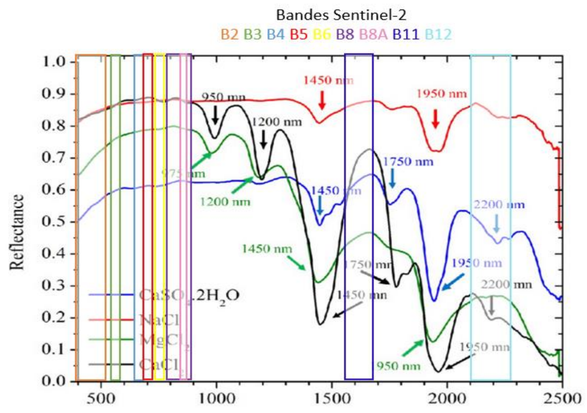


Aigues-Mortes salt parcels

- A parcel dataset of the saltpans was retrieved, corrected and completed, resulting in a total of 197 parcels. From these, 7 parcels (including one reservoir) were selected for preliminary analysis.
- Several salinity-related spectral indices from literature were tested in order to asses their ability to characterize saline conditions and monitor their evolution over time.



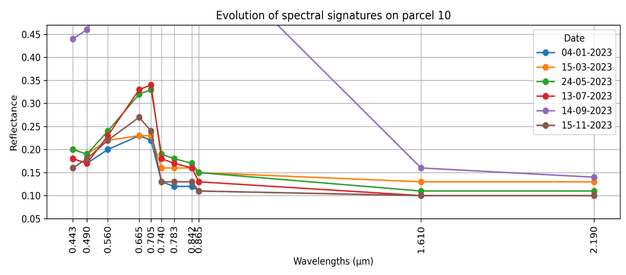
Aigues-Mortes parcels – SWIR visualization

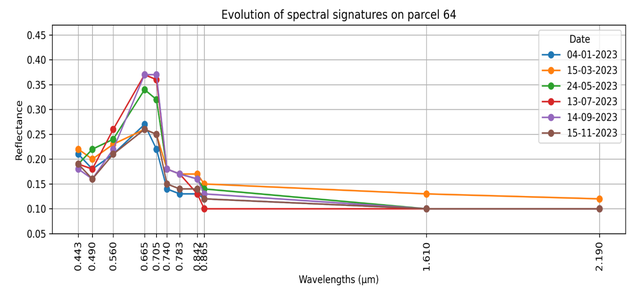


Wavelength (nm) (modified from : Moreira et al., 2014)

Results

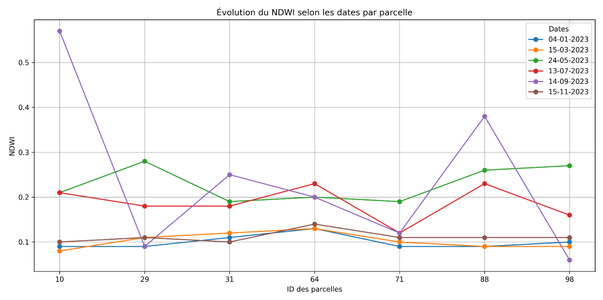
➢ **Temporal evolution of spectral signatures**.

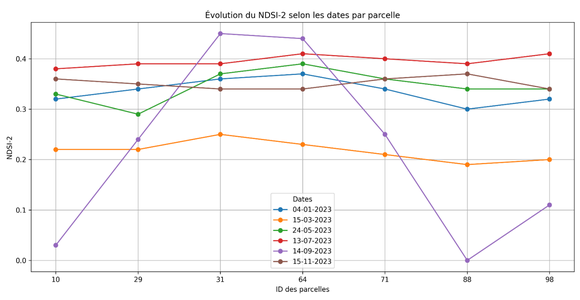




- Between March and November 2023, reflectance spectra show typical vegetation signals (e.g., algae), with NIR peaks from May to July.
- March shows flat reflectance in the visible range, suggesting water presence.
- Persistently low SWIR reflectance (1.61 – 2.19 µm) throughout the period indicates ongoing free water on the parcels.

➢ **Temporal evolution of indices**





- NDWI peaks in May (0.18 - 0.28) reflect maximum moisture and growth, while NDSI dips, indicating reduced salinity.
- March and September show anomalies, possibly from early growth, irrigation or halophytes.
- While July and winter months mark dry, saline conditions with high NDSI and low NDWI.
- Spatially, parcels like 88 fluctuating, suggesting, localized management or variability.

Discussion

- **Spectral & Temporal Trends**

NIR peaks indicate algae growth, SWIR & NIR remain low persistent dryness.

- **Salt crust spectral behavior**

Dry salt, high reflectance wet/dry salt, lower reflectance (e.g., SWIR).

- **NDWI & NDSI insights**

Low NDWI and high NDSI = dry or saline zone.
Seasonal and spatial trends revels salinity stress.

Conclusion and future work

- These initial results highlight clear seasonal trends linked to algae and salinity through drying parcels. However, water color, chemical composition, surface crystals and grain size may also influence reflectance.
- **Perspectives** : collecting field data and hyperspectral imagery Prisma, EnMap and if possible Gaofen 5-01A-ASHI to gain a comprehensive understanding of the salt flat's surface conditions (salt chemistry composition…) and dynamics.

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Dragon 6 95458

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