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10th -12th of November 2021

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Progress in the remote sensing of groundwater-dependent ecosystems in arid and semi-arid environments

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Introduction

- Remote sensing of groundwater-dependent ecosystems (GDEs) has increased substantially in recent years.

- Of significant prominence is the delineation and mapping of groundwater
  - depend vegetation,
  - species diversity, and
  - water quality in these ecosystems

  } arid and semi-arid environments.

- GDEs provide the ecological services such as habitat for variety of fauna, carbon sequestration and water purification.

Introduction (continued)

- Thus, the recent technological advancements + free and open access to new imagery with improved sensing characteristics has resulted in a numerous application on GDEs assessment and monitoring
  - at varying scales,
  - essentially in the light of global climate change and variability.

- Hence, the purpose of this study is to provide a detailed scientific research progress in the use of remote sensing of GDEs.

Objectives

1. To provides comprehensive overview of remote sensing applications in GDEs.

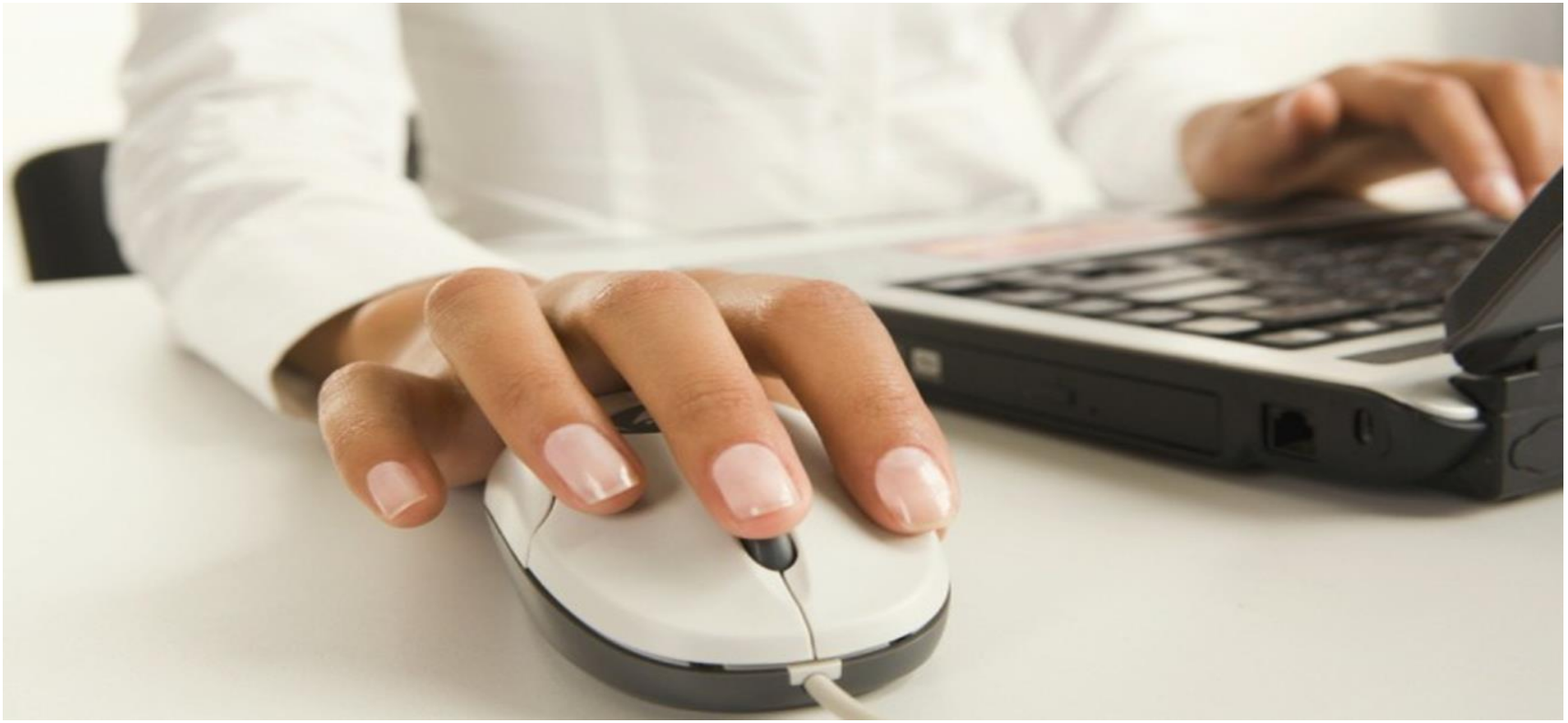
2. Provides the application of remote sensing in GDEs
   - available remote sensing sensors and
   - algorithms in identifying, delineating and mapping GDEs.

Objectives (Continued)

3. Seasonal and long term monitoring of GDEs, with the role of climate variability.

4. Explore the challenges associated with application of remotely sensed data in GDEs and future prospects in identifying, delineating and mapping GDEs.

Methods



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Eligibility criteria

- Journals
- Articles
- Dissertations

2000 to 2021

Search

Articles	• Ecology • Remote sensing • Water
Search engines	• Google Scholar • SCOPUS
Keywords	Level 1: ‘remote sensing’, ‘groundwater-dependent ecosystems’, ‘arid and semi-arid environments’ (18 257) Level 2: ‘multispectral sensors’ and ‘hyperspectral sensors’ (1 344) Level 3: ‘identification’ and ‘delineation’ **(144)**

Results

Results (Continued)

- There is progress in the use of remote sensing in GDEs

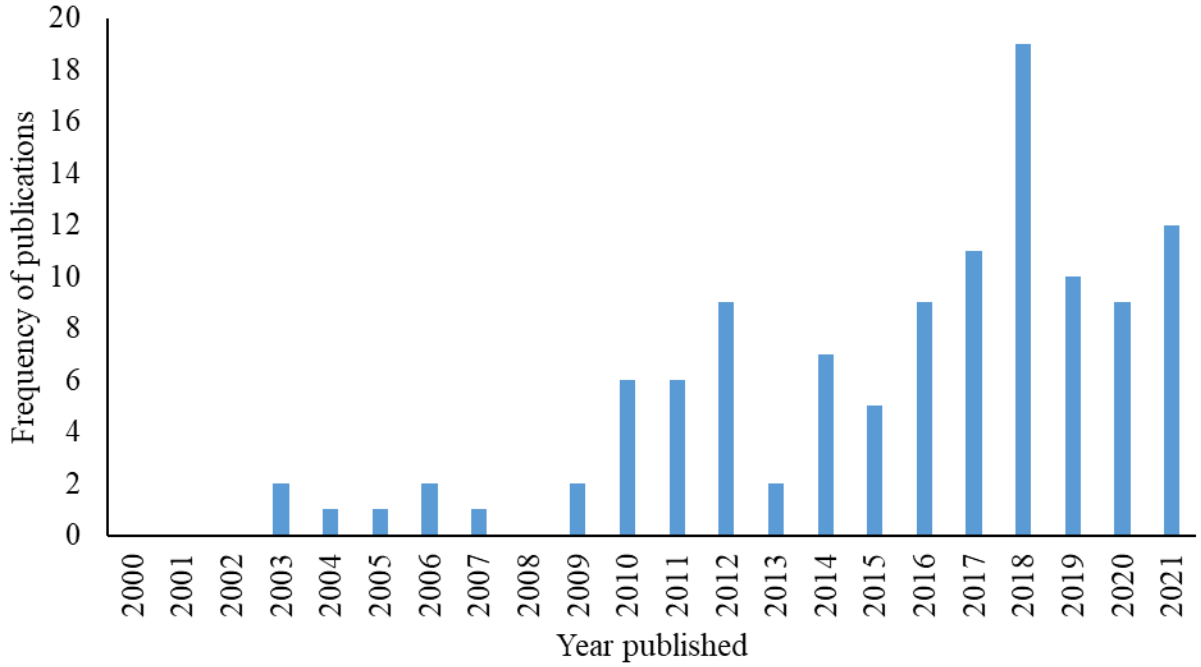

Figure 1: Remote sensing publication growth in GDEs between 2000 and 2021

Results (Continued)

Multispectral data, machine-learning algorithms (spectrally derived indices and image classification) and DEM have been used in GDEs studies.

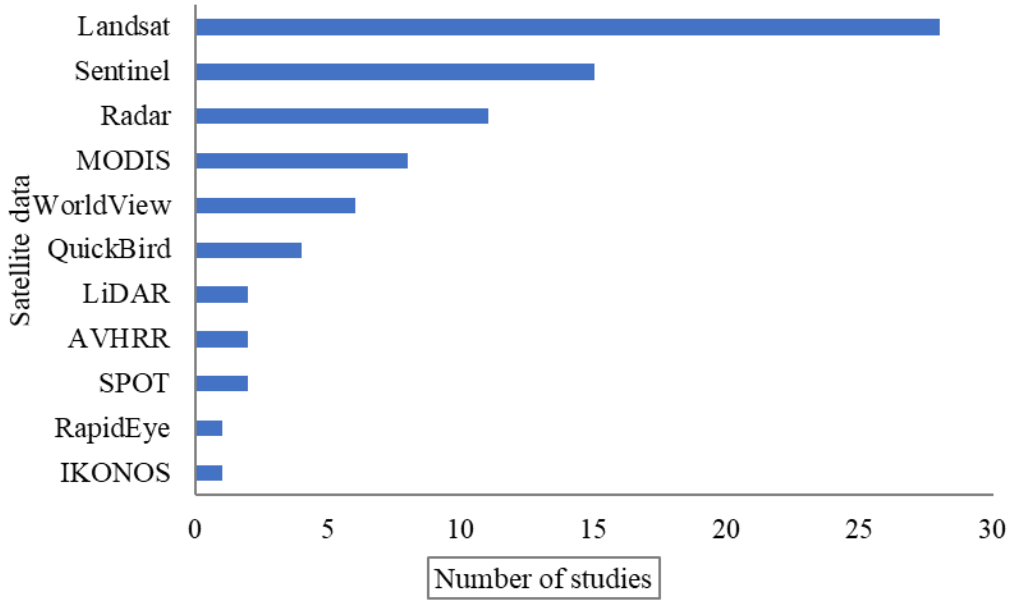

Figure 2: Number of satellite data application in groundwater-dependent ecosystems studies

- Spectrally derived indices
  - NDVI and NDWI – widely used
- Image classification (supervised classification)
  - Random Forest (RF) and Support Vector Machine (SVM)

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Results (Continued)

- Climate change impacts have been investigated in groundwater and slightly in GDEs.
- Multispectral datasets and algorithms are associated with some pitfalls
  - For instance, wide commonly multispectral dataset (i.e Landsat) associated with confusion of different land covers particularly in small areas
  - NDVI, result in poor performance in sparsely vegetated areas and its saturation in densely vegetated areas or during peak phase.

- Technological advancement of the remotely sensed datasets improve on the characterization and understanding of GDEs.

Discussion

- Multispectral datasets (Landsat-8 OLI and Sentinel-2)-widely used in GDEs due to their technologically advanced characteristics.

- Indices such as NDVI and NDWI - ability to extract GDEs aspects such as vegetation and water respectively.

- Algorithms such as SVM - enable the user to change the parameter settings and adding training subsets.

Discussion (Continued)

- Climate change impacts investigation in groundwater and GDEs
  - Impacts – groundwater recharge (Meixner et al. 2016; Yagbasan 2016).

- Thus, the availability of technologically advanced multispectral datasets (Landsat-8 OLI and Sentinel-2)
  - supervised classification
  - machine-learning algorithms,
  - improved indices (NDVI, NDWI),
  - ancillary data (DEM) and
  - climate variables can offer great opportunity for GDEs assessment and monitoring.

Conclusion

- Advancement in remote sensing provide
  - unique opportunity to assess and monitor GDEs in this climate changing environments.

- Although remarkable progress has been made, this review has revealed the need to further remote sensing and geospatial analysis studies to map and characterize the seasonal variability,
  - as well as long-term changes in GDEs, in the face of climate change and variability as well as water security particularly in data limited environments.

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Thank you!!!

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