Assessing the Impact of Drought on Zlatar Lake Area Changes Using Random Forest with Sentinel-1 SAR and Sentinel-2 Multispectral Data

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Original scientific paper
UDC: 551.577.38(285)(497.11)
556.535.2(285)(497.11)
DOI: 10.5937/tehnika2406663N

Drought, a complex natural hazard, poses significant challenges for water resource management due to its unpredictable nature. This study investigates the impact of the drought on Zlatar Lake in Serbia, a key artificial reservoir in the Uvac Valley, over a period extending from May 2021 to October 2022. By utilizing Sentinel-1 Synthetic Aperture Radar (SAR) and Sentinel-2 Multispectral Instrument (MSI) imagery, and classifying 17 scenes, the research employs the Random Forest classification algorithm to analyze changes in the lake's water area. Key indices, including the VV/VH ratio, Normalized Difference Polarization Index (NDPI), and various spectral water indices (NDWI, MNDWI, SWI, NDVI), were used to enhance classification results. The study achieved high overall accuracy (OA) and Kappa values in classifying individual scenes, with Sentinel-1 reaching an OA of 96.47% and a Kappa coefficient of 92.71, while Sentinel-2 showed an OA of 99.14% and a Kappa coefficient of 98.20. Results revealed a significant water area decline, with Sentinel-1 data decreasing from 7.12 km² in May 2021 to a minimum of 4.60 km² in June 2022, then rising to 5.22 km² by October 2022. Sentinel-2 data showed a similar trend. This study highlights the effectiveness of combining SAR and optical data for monitoring water body changes and provides valuable insights for drought impact assessment and water resource management.

Key Words: *Drought, Sentinel – 1 SAR, Sentinel – 2 MSI, Random Forest*

1. INTRODUCTION

Drought, a natural phenomenon that manifests in virtually all regions [1], is widely acknowledged as the most intricate natural hazard, impacting a larger population than any other natural disaster. The unpredictability of drought in terms of its frequency, duration, and intensity complicates forecasting efforts [1]. This issue has garnered escalating attention from both national and international organizations and institutions, underscoring its significance as a global concern. Among extreme meteorological events, drought is distinguished by its gradual onset, prolonged persistence, and notable unpredictability, rendering it one of the most challenging atmospheric hazards to manage.

Drought is widely acknowledged as a natural disaster that inflicts substantial damage across numerous economic sectors [4]. It manifests in various forms: during the non-vegetative period, drought can cause a reduction in water levels, leaving the surface layer of soil without essential moisture. This condition delays crop sowing and postpones germination until the first rainfall. In the summer months, a lack of moisture induces water stress in plants, significantly reducing yields.

An important characteristic of drought that distinguishes it from other natural hazards is the lack of a universal definition, with hundreds of definitions existing. Authors in [5] also conclude that due to the complex nature and widespread impacts of drought, it is difficult to provide a universal definition, which complicates the identification and monitoring of key characteristics such as its duration, intensity, severity, and spatial extent.

Drought can be systematically categorized into four primary types: meteorological, hydrological, agricultural, and socioeconomic [6]. In essence, the progression of drought follows a specific sequence: an initial lack of precipitation leads to meteorological drought, which subsequently impacts soil moisture levels, thereby causing agricultural drought. This chain of

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Paper received: 19.08.2024.
Paper accepted: 21.08.2024.

events results in diminished water flow from land into streams and standing water bodies, culminating in hydrological drought [7]. Specifically, meteorological drought is distinguished by insufficient precipitation, agricultural drought by a shortage of soil moisture, and hydrological drought by decreased streamflow and declining groundwater levels [8].

The origins of hydrological droughts are multifaceted, stemming from both atmospheric and hydrological processes within a watershed. Atmospheric processes, which initiate the onset of hydrological droughts, are influenced by climate variability. Hydrological droughts exhibit distinct developmental patterns in relatively stable climates compared to those with well-defined seasons. In stable climates, the primary factor influencing drought onset is subnormal precipitation, typically coupled with above-normal evapotranspiration. Conversely, in climates characterized by distinct seasons, additional mechanisms contribute to the emergence of summer and winter droughts. In climates with warm seasons, the most substantial replenishment of watershed water transpires during the wet season. A drought occurring during these wet seasons diminishes the watershed's water storage capacity, thereby exerting a significant impact on conditions during the subsequent dry season [9].

This study aims to investigate how the area of water in Zlatarsko Jezero (or Kokin Brod Lake), a significant artificial reservoir in the Uvac Valley of Serbia, changed during the drought period of 2022. Using a time series of Sentinel-2 MSI and Sentinel -1 SAR imagery from May 2021 to October 2022, the research employs the Random Forest (RF) to classify water areas and analyze their variations over time. The study will provide insights into the impact of the 2022 drought on the lake's water levels and evaluate the effectiveness of these machine learning algorithms in monitoring environmental changes in water bodies.

2. MATERIALS AND METHODS

2.1. Study Area

Zlatar Lake, also known as Zlatarsko Jezero, is a significant artificial reservoir in the Uvac Valley, situated 10-15 km from Nova Varoš. Surrounded by the Zlatar mountains to the southwest and the Murtenica mountains to the northeast, the lake covers an area of approximately 7.25 km² and extends from 15 to 23 km in length. Created in the 1960s by damming the Uvac River, the dam stands 82 meters high, making it the largest earth dam constructed in Europe, with water levels varying up to 45 meters. Zlatar Lake is the third-largest lake in Serbia, following Đerdap and Perućac Lake on the Drina River. This study aims to explore the impacts of drought on this vital water resource and its implications for regional water management.

The study area is illustrated in Figure 1, highlighting the region of interest for this analysis.

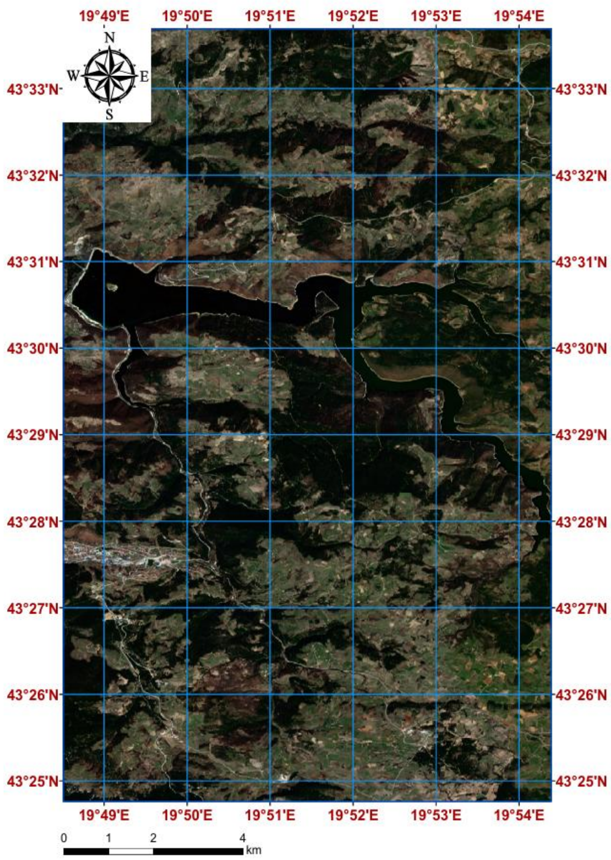

Figure 1 - Study Area

2.2. Data

For this research, the dataset includes remote sensing data from two Sentinel missions: Sentinel-1 and Sentinel-2, covering the period from May 2021 to October 2022.

Sentinel-1 is a polar-orbiting mission focused on monitoring land and ocean surfaces under any weather conditions and at any time of day. This mission consists of two satellites, Sentinel-1A and Sentinel-1B, which operate in the same orbital plane. Sentinel-1A was launched on April 3, 2014, and Sentinel-1B followed on April 25, 2016. These satellites are equipped with advanced C-SAR radar instruments that can penetrate clouds and work in low-light conditions, ensuring reliable and accurate Earth surface observations. The radar data from Sentinel-1 is available in various polarization modes, with spatial resolutions ranging from 5 to 100 meters and coverage swaths between 80 and 400 kilometers.

Table 1. contains information about the Sentinel-1 radar satellite imagery.

Table 1. Sentinel-1 Acquisition Details

Platform short name	Acquisition mode	Acquisition date	Product type	Relativne orbit number	Orbit direction
Sentinel – 1	Interferometric Wide (IW)	2021-06-23; 2021-09-27; 2022-01-19; 2022-02-12; 2022-03-20; 2022-06-24; 2022-07-18; 2022-08-11; 2022-10-22; 2021-11-14	IW_SLC__1S	153	Descending
Sentinel – 1	Interferometric Wide (IW)	2021-05-13; 2021-07-12; 2021-08-11; 2021-10-28; 2022-04-02; 2022-05-20; 2022-09-05;	IW_SLC__1S	175	Ascending

Sentinel-2, on the other hand, is a polar-orbiting, multispectral mission designed to provide high-resolution imagery for land surface monitoring, including vegetation, soil, and water bodies.

The mission comprises Sentinel-2A and Sentinel-2B sate-llites, which facilitate comprehensive land and coastal monitoring. Sentinel-2A was launched on June 23, 2015, and Sentinel-2B entered orbit on March 7, 2017.

Both satellites operate in identical orbits at an altitude of approximately 786 kilometers, with a Sun-synchronous orbit that allows them to capture images of the same location every 5 days from the same angle. Equipped with multi-spectral sensors, Sentinel-2 delivers detailed information on vegetation health, soil moisture, and changes in water bodies.

Table 2. contains information about the Sentinel-2 optical satellite imagery.

Table 2. Sentinel-2 Acquisition Details

Spacecraft name	Product Type	Processing Level	Sensing start	Sensing orbit number	Sensing orbit direction
Sentinel-2B	S2MSI2A	Level-2A	2021-05-09; 2021-06-23; 2021-07-13; 2021-08-12; 2021-09-26; 2021-10-31; 2021-11-15	36	Descending
Sentinel-2B	S2MSI2A	Level-2A	2022-01-16; 2022-02-10; 2022-03-22; 2022-04-06; 2022-05-21; 2022-06-20; 2022-07-15;2022-08-02; 2022-09-08; 2022-10-18;	136	Descending

2.3 Methodology

The preprocessing of SAR data commenced with the removal of thermal noise from all Sentinel-1 SAR data. Subsequently, orbit files were employed to update the orbit state vectors within the abstract metadata for the Sentinel-1 SAR data. Radiometric calibration was conducted to convert the data into radar backscatter bands ($\sigma 0$).

To mitigate speckle noise, a Refined Lee filter was applied. Thereafter, multilooking was utilized to ensure that the pixels were square. The radar backscatter bands underwent orthorectification using the Range Doppler Terrain Correction algorithm in conjunction with SRTM DEM data, which has a spatial resolution of 1 arcsec. The back-scatter coefficient in decibels was derived from the orthorectified radar backscatter bands using the equation $10\times log10(\sigma^0)$. Lastly, all Sentinel-1 SAR imageries were clipped to align with the extent of the study area. Concurrently, the preprocessing of Sentinel 2 data concentrated on Level 2A images that underwent atmospheric correction. These images were resampled to a 10-meter spatial resolution, subset to the specific area of interest, and reprojected to maintain spatial consistency. Consequently, the optical bands were prepared for subsequent analysis. For the Random Forest Classification, each time series of SAR and optical data was processed individually to generate detailed classification maps. Co-variables were prepared by calculating and scaling SAR and optical indices to ensure consistency and accuracy in the input data. The

SAR backscatter data was appropriately scaled, and these scaled covariables were then utilized as inputs for the Random Forest model. The model was calibrated specifically for each time series and applied to generate classification maps. As a result, 18 classification maps were produced for Sentinel 1 data and 18 classification maps for Sentinel 2 data, with each map representing a different month.

This process ensured that each month was individually assessed, providing a comprehensive set of monthly classifications for both Sentinel 1 and Sentinel 2 data.

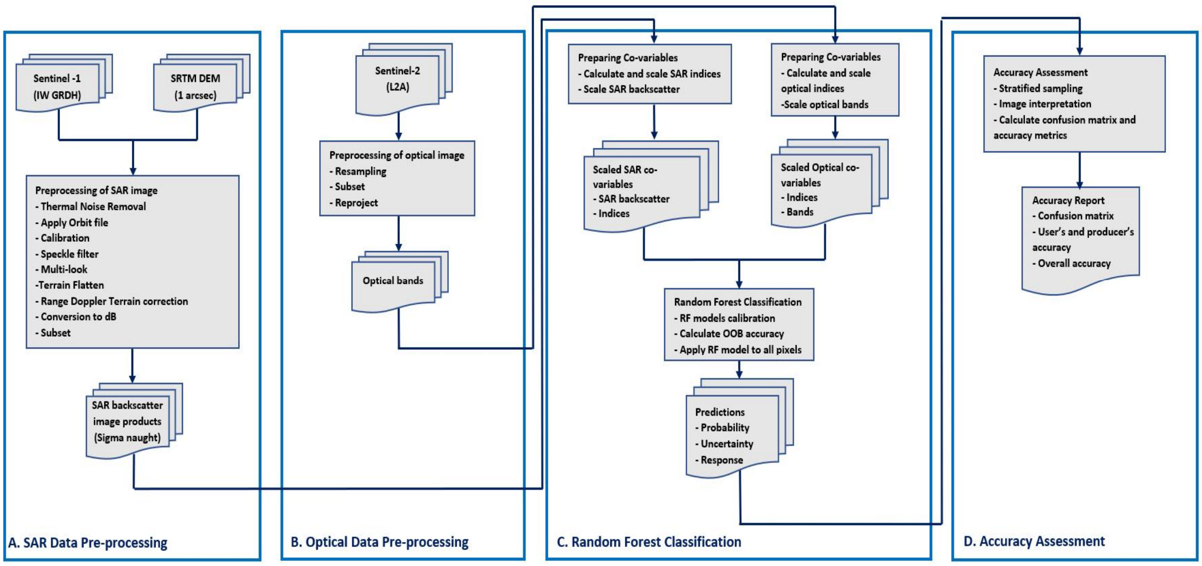

Figure 2 - The flowchart of the overall methodology employed in this study

In the analysis of Sentinel-1 SAR data, two key radar indices were employed to assess water area changes: the VV/VH ratio and the Normalized Difference Polarization Index (NDPI). The VV/VH ratio, calculated as the ratio of the backscatter coefficients in vertical-vertical (VV) and vertical-horizontal (VH) polarizations, helps differentiate between water and land surfaces. Water bodies typically have lower VV/VH ratios due to their distinctive reflective properties compared to terrestrial surfaces.

Table 3. Sentinel-1SAR Indices

Abbreviation	Equation	Reference
NDPI	$\frac{VV - VH}{VV + VH}$	[10]
VVrVH	$\frac{VV}{VH}$	[10]

For the purpose of drought assessment, Sentinel-2 satellite data was employed to generate several critical indices: the Normalized Difference Water Index (NDWI), the Modified Normalized Difference Water Index (MNDWI), the Normalized Difference Vegetation Index (NDVI), and the Sentinel-2 Water Index (SWI). NDWI and MNDWI were utilized to evaluate changes in water bodies and surface moisture levels. These indices were collectively analysed to determine the impact of drought on the region.

Table 4. Sentinel-2 Spectral Water Indices

Abbreviation	Equation	Reference
NDWI	$\frac{\rho_{Green} - \rho_{NIR}}{\rho_{Green} - \rho_{NIR}}$	[11]
MNDWI	$\frac{\rho_{Green} - \rho_{SWIR2}}{\rho_{Green} - \rho_{SWIR2}}$	[12]
SWI	$\frac{\rho_{VRE1} - \rho_{SWIR2}}{\rho_{VRE1} - \rho_{SWIR2}}$	[13]
NDVI	$\frac{\rho_{NIR} - \rho_{RED}}{\rho_{NIR} - \rho_{RED}}$	[14]

2.4. Classification Accuracy Assessment

Model performance metrics are derived by juxtaposing the predicted classifications of data points in the test dataset with their corresponding reference class labels. This evaluative process is effectively visualized through a confusion matrix, specifically tailored for a binary classification (Table 5).

Table 5. The binary classification confusion matrix consists of the following components: True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN).

		Reference Data	
		Water	Non-water
Classification Result	Water	TP	FP
	Non-water	FN	TN

The values in the confusion matrix represent the number of instances in the test dataset that are correctly classified (elements along the diagonal of the confusion matrix) and the instances where the classes are incorrectly predicted (elements off the diagonal of the confusion matrix). The number of predicted insta-nces per class is given by the rows of the matrix, while the columns represent the number of instances that belong to the actual, reference class labels.

Table 6. Binary assessment metrics

Metric	Equation
Overall Accuracy (OA)	$\frac{TP+TN}{TP+TN+FP+FN}$
Producer's Accuracy for positives	$\frac{TP}{TP+FN}$
User's Accuracy for positives	$\frac{TP}{TP+FP}$
Producer's Accuracy for negatives	$\frac{TN}{TN+FP}$
User's Accuracy for negatives	$\frac{TN}{TN+FN}$

The Kappa coefficient (κ) is a statistical measure that quantifies the level of agreement between observed and predicted classifications while correcting for the likelihood of chance agreement. It is calculated using the following formula [15]:

$$k = \frac{P_o - P_e}{1 - P_e} \quad (1)$$

where P_o represents the observed agreement (i.e., the proportion of instances where the classification matches the reference data), and P_e denotes the expected agreement by chance (i.e., the proportion of instances where the classification would be expected to match the reference data purely by chance).

3. RESULTS

This study focuses on analyzing Sentinel-1 and Sentinel-2 satellite data to examine the effects of the 2022. drought on Zlatarsko Jezero, a crucial artificial reservoir in Serbia.

The primary aim is to investigate how the drought influenced water area and levels throughout the period of concern, utilizing remote sensing data and the Random Forest classification algorithm.

Figure 3. illustrates the variations in Overall Accuracy (OA) for both Sentinel-1 and Sentinel-2 data across the study period.

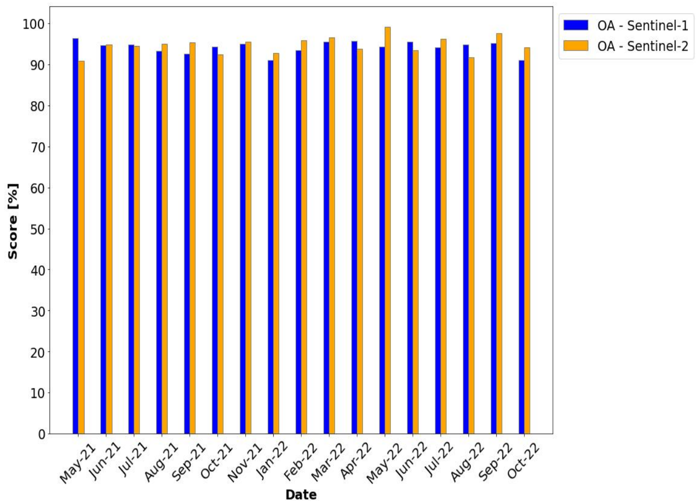

Figure 3 - Comparison of Overall Accuracy for Sentinel-1 and Sentinel-2 Data

For Sentinel-1, the Overall Accuracy (OA) ranges from 90.99% to 95.65%, reflecting high classification reliability.

For Sentinel-2, OA varies from 90.89% to 99.14%, with a peak of 99.14% in May 2022. This suggests a robust level of accuracy in distinguishing water and non-water areas throughout the study period. Sentinel-1 shows generally high Kappa values, ranging from 0.81 to 0.91, indicating strong agreement bet-ween predicted and reference data. Sentinel-2 exhibits even higher Kappa values, ranging from 0.81 to 0.98, as shown in Figure 4.

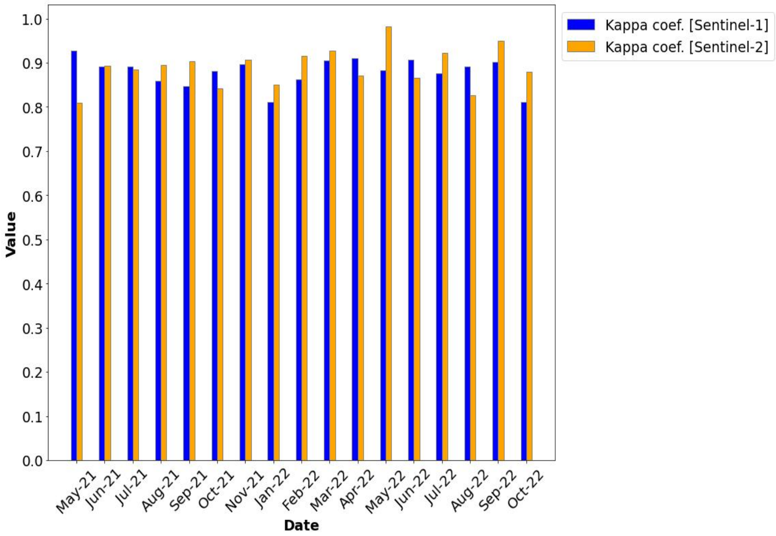

Figure 4 - Comparison of Kappa coefficients for Sentinel-1 and Sentinel-2 Data

Figure 5. provides a detailed overview of the Producer's Accuracy (PA) and User's Accuracy (UA) for the Water class, for Sentinel-1 and Sentinel-2 data throughout the study period. This figure consolidates the accuracy metrics for detecting the lake's water, offering a comparative view of how well each satellite's data classified the lake water area.

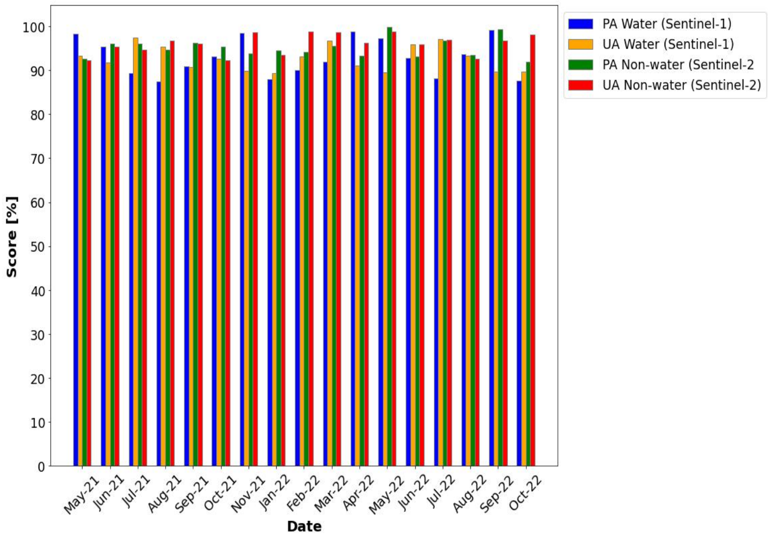

Figure 5 - Producer's and User's Accuracy for Water Class in Sentinel-1 and Sentinel-2 Data

The figure illustrates that for Sentinel-1 data, the Producer's Accuracy for the Water class remains consistently high, ranging from approximately 87.6% to 99.25%, while the User's Accuracy varies between 89.64% and 97.52%.

This reflects the model's reliable performance in identifying the lake but also indicates some variability in the classification accuracy. For Sentinel-2 data, the Producer's Accuracy for the Water class shows a similarly strong performance, with values ranging from 88.3% to 98.425%. The User's Accuracy also demonstrates high values, fluctuating between 88.94% and 99.7%, highlighting the model's effectiveness in detecting the lake while also showing periods of increased misclassification.

Figures 6 through 9 provide a series of visual representations of the lake's water area at four distinct points in time. Each figure includes three panels: an RGB composite image (left), a classified scene using Sentinel-1 data (middle), and a classified scene using Sentinel-2 data (right). Figure 6 displays data from May 2021, capturing the lake's water area early in the study period. Figure 7 shows the conditions in October 2021, providing a view of the lake during a later phase of the year. Figure 8 presents the lake's water area from April 2022, illustrating conditions in the spring of the following year. Figure 9 features data from October 2022, offering a snapshot at the end of the study period. These dates were selected as they effectively highlight significant changes in the lake's water area over time.

Due to the constraints of presenting all images in the study, these particular dates were chosen to represent key moments in the seasonal and temporal variations of the lake's water level.

By focusing on these specific periods, the figures illustrate how the lake's water area fluctuated throughout the drought period, providing a clear view of the impacts of drought on the lake.

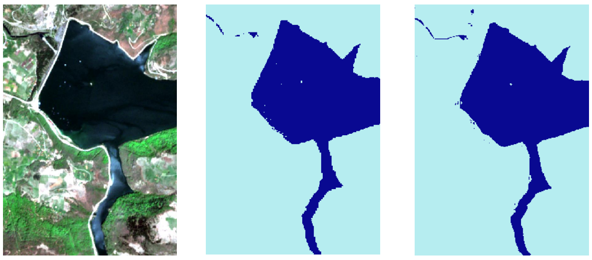

Figure 6 - RGB composite (left), Classified scene using Sentinel-1 data (middle) and Classified scene using Sentinel -2 data for May-2021

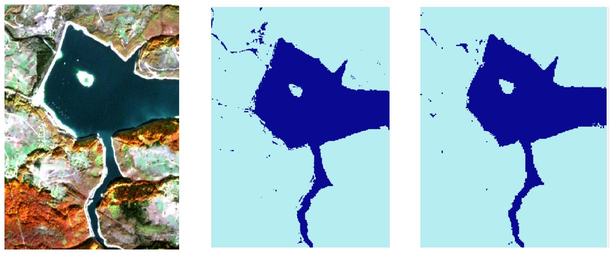

Figure 7 - RGB composite (left), Classified scene using Sentinel-1 data (middle) and Classified scene using Sentinel -2 data for October-2021

Figure 8 - RGB composite (left), Classified scene using Sentinel-1 data (middle) and Classified scene using Sentinel -2 data for May-2022

Figure 9 - RGB composite (left), Classified scene using Sentinel-1 data (middle) and Classified scene using Sentinel -2 data for October-2022

Figure 10 presents a detailed view of how the area classified as water, using both Sentinel-1 and Sentinel-2 data, varied throughout the study period. The plot effectively captures the fluctuations in water area from May 2021 to October 2022, providing insights into the lake's response to the drought conditions experienced during this period.

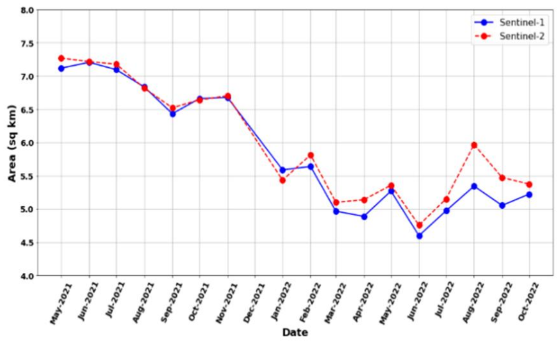

Figure 10 - Analysis of Water Area Changes Over Time

The data reveals a general downward trend in water area over time, consistent with the impacts of the drought. In May 2021, the water area was approximately 7.12 km² according to Sentinel-1 and 7.27 km² according to Sentinel-2. Over the following months, a gradual decline is observed, with the water area reducing to around 6.43 km² by September 2021. This reduction reflects the early stages of drought stress on the lake.

The water area continued to decrease through the winter and into 2022, reaching its lowest point in March 2022, with Sentinel-1 recording 4.96 km² and Sentinel-2 recording 5.10 km². This significant reduction highlights the severity of the drought impact during this period. The area showed some recovery in the subsequent months, but remained lower than the pre-drought levels, indicating a persistent effect of the drought on the lake's water levels.

By October 2022, the area of water was recorded at 5.22 km² for Sentinel-1 and 5.37 km² for Sentinel-2, demonstrating a partial recovery but still reflecting reduced water levels compared to earlier in the study period.

This plot underscores the effectiveness of both Sentinel-1 and Sentinel-2 in capturing temporal changes in water area. The consistent patterns observed in the data from both sensors affirm the reliability of the remote sensing techniques used in this study. The decreasing trend in water area, as depicted in the figure, provides a clear representation of the drought's impact on the lake, highlighting the critical need for effective water resource management in the face of prolonged drought conditions.

4. DISCUSSION

This study provides a comprehensive assessment of the impacts of the 2022 drought on Zlatar Lake by utilizing Sentinel-1 and Sentinel-2 remote sensing data. The analysis focused on changes in water area over time, leveraging classification accuracy metrics and temporal variations to understand the extent and implications of the drought.

The accuracy of the classification for both Sentinel-1 and Sentinel-2 data was evaluated through Overall Accuracy (OA), Producer's Accuracy (PA), and User's Accuracy (UA) for the water class.

For Sentinel-1, the Overall Accuracy ranged from approximately 90.99% to 95.55%, with Kappa coefficients reflecting high classification consistency, ranging between 0.81 and 0.91. The Producer's Accuracy for water varied from 87.6% to 99.25%, indicating reliable detection of water, while the User's Accuracy for water ranged from 89.64% to 97.52%, reflecting the accuracy of water classification.

Similarly, Sentinel-2 data demonstrated Overall Accuracy between 90.89% and 99.14%, with Kappa coefficients ranging from 0.81 to 0.98. The Producer's Accuracy for water ranged from 88.98% to 99.70%, and the User's Accuracy ranged from 88.94% to 99.04%. These metrics highlight the robust performance of both Sentinel-1 and Sentinel-2 in accurately classifying the water class.

The comprehensive analysis of temporal changes in the water area has unveiled a notable decline, attributable to the 2022 drought. Data acquired from both Sentinel-1 and Sentinel-2 satellites demonstrated a consistent downward trend in the lake's water area from May 2021 to October 2022.

Initially, the measurements indicated a water area of approximately 7.12 km² for Sentinel-1 and 7.27 km² for Sentinel-2. However, as the drought intensified, the water area reduced to 4.96 km² and 5.10 km², respectively, by March 2022. This reduction emphasizes the severe impact of the drought, with the lake's water levels significantly dropping below predrought conditions.

Although there was some degree of recovery in the latter months of the study, the water area remained below initial measurements, indicating the prolonged effects of the drought on the lake. The partial recovery observed by October 2022 suggests that while some replenishment occurred, the lake's water levels did not fully revert to their predrought state, underscoring the enduring impact of severe drought conditions.

It is important to note that the resolution and accuracy of the data significantly influence the classification of water areas. Sentinel-1's radar data, which is advantageous in all weather conditions, may face difficulties in differentiating between various water surfaces due to fluctuations in radar backscatter. Conversely, Sentinel-2's optical data, is vulnerable to atmospheric disturbances and cloud cover, which may affect the precision of water detection during certain periods.

Another constraint is the temporal resolution of the data utilized in the study. Monthly intervals may not adequately capture the short-term variations in water levels that can occur between these observations. Increasing the frequency of data acquisition could provide a more detailed understanding of how drought impacts water levels on a finer scale, highlighting critical periods of drought severity or recovery that may be overlooked with monthly data points.

The dependency on satellite data without extensive ground truth validation introduces an additional layer of uncertainty. Despite the high classification accuracy metrics such as Overall Accuracy (OA) and Kappa Coefficients, incorporating ground-based verification would enhance the reliability of the findings.

Moreover, the study's focus on the drought of 2022 does not account for long-term climatic trends or seasonal variations. Elements such as shifting precipitation patterns, changes in land use, and broader climate variability could also impact water levels. A more comprehensive analysis would involve examining these factors to gain a deeper understanding of their interaction with drought conditions.

For future research, enhancing the temporal and spatial resolution of observations could yield more detailed insights into water level changes. More frequent satellite imagery or the use of high-resolution data from other missions could more effectively capture short-term variations. Integrating optical and radar data with ground-based measurements would also bolster the validation of remote sensing results and improve overall accuracy.

Longitudinal studies spanning several years or even decades would facilitate a deeper understanding of the long-term effects of droughts on water bodies. Such studies could uncover patterns related to climate change and contribute to the development of more effective water management strategies.

5. CONCLUSION

This study has effectively harnessed Sentinel-1 and Sentinel-2 satellite data to examine the impact of the 2022 drought on Zlatar Lake, a vital water resource in Serbia. The analysis uncovered a significant decline in the lake's water area during the drought period, with measurements indicating a reduction from approximately 7.12 km² in May 2021 to 4.96 km² by March

2022. This substantial decrease highlights the severity of the drought's impact on the lake’s water levels and underscores the critical need for proactive water management strategies.

The high classification accuracy achieved using both Sentinel-1 and Sentinel-2 data underscores the effectiveness of remote sensing in monitoring changes in water bodies under drought conditions. Sentinel-2’s optical imagery provided exceptionally high accuracy in classifying water areas, while Sentinel-1’s radar data offered consistent performance across various weather conditions. The comparative analysis of these datasets not only highlights the strengths and limitations of each sensor but also emphasizes the value of integrating multiple data sources for a comprehensive approach to environmental monitoring.

Notably, the study’s ability to capture detailed temporal changes in water area demonstrates the potential of remote sensing for assessing the dynamic impacts of drought over time. This capability is crucial for understanding how extreme weather events affect water resources and for planning effective response measures.

However, the study acknowledges several limitations, including the temporal resolution of data, potential atmospheric interference, and the absence of ground truth validation. Addressing these limitations through more frequent observations, improved data fusion techniques, and incorporating ground-based measurements could significantly enhance future analyses and provide a more precise assessment of drought impacts.

The insights derived from this study are crucial for effective water resource management and drought preparedness. By understanding the impacts of drought on Zlatar Lake, policymakers and water managers can implement targeted conservation strategies, optimize reservoir management, and strengthen drought resilience.

Future research should build on these findings to explore longterm trends, refine remote sensing techniques, and integrate additional data sources, ensuring a more detailed and nuanced understanding of drought impacts. Continued advancements in remote sensing and data integration will be vital in developing adaptive strategies to manage water resources amid increasingly frequent and severe drought conditions.

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REZIME

PROCENA UTICAJA SUŠE NA PROMENE POVRŠINE ZLATARSKOG JEZERA KORISTEĆI RANDOM FOREST SA SENTINEL-1 SAR I SENTINEL-2 MULTISPEKTRALNIM PODACIMA

Suša, složena prirodna nepogoda, predstavlja značajan izazov za upravljanje vodnim resursima zbog svoje nepredvidive prirode. Ova studija istražuje uticaj suše na Zlatarsko jezero u Srbiji, ključnom veštačkom rezervoaru u dolini Uvac, u periodu od maja 2021. do oktobra 2022. godine. Korišćenjem Sentinel-1 Synthetic Aperture Radar (SAR) i Sentinel-2 Multispectral Instrument (MSI) podataka, i klasifikacijom 17 scena, u radu je izvršena analiza promena površine pod vodom korišćenjem Random Forest algoritma. Ključni indeksi, uključujući odnos VV/VH, Normalizovani indeks razlike polarizacije(NDPI) i različite spektralne vodene indekse (NDWI, MNDWI, SWI, NDVI), korišćeni su za poboljšanje tačnosti klasifikacije. Studija je postigla visoku ukupnu tačnost (OA) i Kappa vrednosti u klasifikaciji pojedinačnih scena, pri čemu je Sentinel-1 dostigao OA od 96,47% i Kappa koeficijent od 92,71, dok je Sentinel-2 pokazao OA od 99,14% i Kappa koeficijent od 98,20. Rezultati su otkrili značajan pad u vodnoj površini, pri čemu su podaci Sentinel-1 pokazali opadanje sa 7,12 km² u maju 2021. godine na minimum od 4,60 km² u junu 2022. godine, a zatim rast na 5,22 km² do oktobra 2022. godine. Podaci Sentinel-2 su pokazali sličan trend. Ova studija naglašava efikasnost kombinovanja SAR i optičkih podataka za praćenje promena u vodnim telima i pruža uvide za procenu uticaja suše i upravljanje vodnim resursima.

Ključne reči: *suša, Sentinel – 1 SAR, Sentinel – 2 MSI, Random forest*