

# Integration of AWEI and Otsu Threshold Algorithms for Maritime Boundary Delimitation: A Case Study of the Russia-Ukraine Conflict in the Sea of Azov

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**Abstract.** Since the Soviet Union dissolved in 1991, Russia and Ukraine, newly independent, face complexities concerning the legal status and demarcation of the Sea of Azov. Spanning approximately 37,600 km<sup>2</sup> with a maximum depth of 14 meters, this sea holds pivotal resources such as fish, gas, and oil, serving as a significant dividing point between these nations. Maritime boundary delineation, often set at 12 nautical miles from the baseline, is complex due to the sea's intricate coastline and small islands. Some coastal areas have distances less than 24 nautical miles, causing boundary overlaps. Russia and Ukraine have cited UNCLOS Article 298, exempting UNCLOS dispute resolution for the Sea of Azov's demarcation. This study aims to assess the AWEI and Otsu thresholding algorithms' efficacy in defining the maritime boundary between Russia and Ukraine in the Sea of Azov, utilizing 'LANDSAT/LC08/C02/T1\_L2' data. It also aims to comprehend the geopolitical and conflict resolution implications of delineating maritime boundaries aligned with UNCLOS 1982 for both countries and wider regions. The AWEI algorithm consistently maps coastlines, while Otsu thresholding facilitates automated image segmentation, yielding 117 base points covering 13,331 km<sup>2</sup> (Russia) and 21,749 km<sup>2</sup> (Ukraine) within the EEZ, based on equidistant and median base point analysis.

## 1 Introduction

Spanning from Russia to Ukraine, the Sea of Azov is a body of water. The maximum depth is only 14 meters, and it spans approximately 37,600 km<sup>2</sup> [1]. With their strategic importance to both countries, the Sea of Azov harbors a wealth of natural resources, including fish, gas, and oil [2]. There has been an ongoing disagreement regarding the legal status and territorial sea boundaries in the Sea of Azov, though, ever since Russia and Ukraine gained their independence in 1991 following the fall of the Soviet Union [3]. The contentious Russian occupation of Crimea in 2014 was the catalyst for the escalation of these hostilities. This happened after Ukraine canceled a cooperation agreement with the European Union and

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staged large-scale protests. Russia's annexation of Crimea had a major impact, leading to political and economic sanctions against Russia from the US and the EU. Additionally, this conflict resulted in more than 3,500 recorded fatalities [4].

Russia's takeover of Crimea has created several issues that go beyond land sovereignty and impact the waters of the Black Sea. Russia has begun redrawing its territorial waters and Exclusive Economic Zone (EEZ), leading to conflict with Ukraine over access to the Kerch Strait, which is the only passage connecting the Black Sea with the Sea of Azov [5]. The US State Department has accused Russia of systematically disrupting trade shipments in the region. To resolve this conflict, it is necessary to establish EEZ boundaries between neighboring countries that must be based on international law and equitable solutions. One approach that can be used to resolve territorial sea boundary disputes in the Sea of Azov is the equidistance and median line methods [6]. These methods are based on the principle that each point on the territorial sea boundary should be the same distance from the nearest baseline of the two disputing countries. In addition, the median line method is used when two countries' borders are contiguous [7].

However, the equidistance and median line methods also have some weaknesses and challenges in their application. First, these methods require accurate and complete data on the baselines and reference points of the two disputing countries. Both parties must agree upon this data before it can be used to calculate territorial sea boundaries using the equidistance method [8]. Second, this method may result in a territorial sea boundary that is disproportionate or inconsistent with the principle of equidistance if the base or coastline of either country is highly curved or variable. Third, this method cannot resolve territorial sea boundary disputes if there is a historical or traditional claim by one party to a particular sea area [8].

The territorial sea boundary is an imaginary line separating a country's sovereign territory from the free sea area. The territorial sea limit is set at 12 nautical miles from the baseline, which is the line connecting the outermost points of a country's coast [9]. However, in the case of the Sea of Azov, the baseline cannot be easily drawn due to the sinuous shape of the coast and the presence of small islands in the vicinity [10]. In addition, the distance between the coasts of Russia and Ukraine in the Sea of Azov is less than 24 nautical miles, making it impossible to draw their respective territorial sea boundaries of 12 nautical miles without overlapping each other [1].

According to the Cooperation Agreement on the Use of the Sea of Azov and the Kerch Strait, the Sea of Azov has historically been the internal waters of Ukraine and the Russian Federation [11]. Its delimitation should take place only with the consent of both States. The previous negotiations were unsuccessful, delimitation was not carried out, and an agreement was not reached. Due to the declarations of Russia and Ukraine under Article 298 of UNCLOS, any disputes related to the delimitation of the Sea of Azov have been excluded from the mandatory dispute settlement procedure under UNCLOS [12]. It is necessary to seek new approaches to the solution of disputes on maritime delimitation between these two countries, taking into account the current relations between Ukraine and the Russian Federation [13]. Ukraine is considering the possibility of terminating the Treaty. Termination of the Treaty is possible in accordance with the Vienna Convention on the Law of Treaties, but its benefits should be evaluated in detail. Also, it currently makes sense to establish a center line in the Sea of Azov to ensure the protection of Ukraine's sovereignty, national interests, and territorial integrity [12].

Amidst the strained relations between Ukraine and Russia, the escalating maritime boundary disputes necessitate innovative approaches for resolution [14]. Considering the current dynamics, exploring novel methodologies becomes imperative [15]. Reassessing existing agreements and potentially aligning with the Vienna Convention on Treaty Law emerges as a plausible option for Ukraine. However, a comprehensive analysis of the

associated advantages and implications is fundamental before any decisive actions [15]. Additionally, establishing a temporary median line within the Sea of Azov presents itself as a viable interim solution to safeguard Ukraine's sovereignty and territorial integrity while awaiting a mutually agreed-upon delineation of boundaries. This provisional demarcation serves as a pragmatic measure until both nations reach a consensus regarding their maritime borders.

## 1.1 Geography

Situated amidst the Crimean Peninsula, Ukraine, and Russia, the Sea of Azov is a region characterized by distinct geographical features [11]. Landforms such as spits play a pivotal role in delineating boundaries; for instance, the expansive Arabat Spit, spanning 113 km, serves as a natural divider between the Sea of Azov and Lake Syvash, creating a demarcation line between the Crimean Peninsula and mainland Ukraine [15]. Notable spits like Fedotova, Obytochna, Berdiansk, Bilosarai, Kryva, Yeiska, and Dovha further define the coastal terrain. Additionally, the coastline boasts significant bays such as Taganrog, the largest, along with Arabat, Obytochna, and Temriuk. Small islands, including Byriuchy, Cherepakha, Dovhyi, and Pishchani, speckle the Sea of Azov [16]. This region witnesses the confluence of numerous rivers, shaping estuaries, lagoons, and sandbars. Noteworthy coastal features like Lake Syvash, Utliuk Estuary, Miius River Estuary, and Beisuh River Estuary adorn the shoreline. Furthermore, the formation of lakes like Molochne, Khansk, and Dovhyi, separated from the Sea of Azov by spits, adds to the diverse landscape of this maritime territory [10]. The area of study in this research can be seen in Figure 1.



**Fig. 1.** Geography of the Azov Sea Region

## 2 Data and method

The secondary data used in this research are images obtained from LANDSAT-8 (LANDSAT/LC08/C02/T1\_L2). This data is processed using Google Earth Engine and ArcGIS software to calculate territorial sea boundaries and EEZs using the equidistance and

median methods with the Thiessen polygon menu. The data obtained needs to be corrected again in order to get higher accuracy.

### 2.1 AWEI algorithm

The AWEI (Automated Water Extraction Index) algorithm, serves as a pivotal tool in shoreline detection through satellite imagery analysis [17]. This algorithm effectively utilizes distinct band indices to detect coastlines, emphasizing the differences in brightness levels across various bands. AWEI leverages the disparity in characteristics—higher brightness in the Green band and lower in the SWIR2 band—to accentuate water pixels while minimizing noise from non-water areas. This differentiation is particularly crucial as non-water regions reflect differently in NIR and SWIR1 bands. The AWEI formula presented here is one variation of the AWEI formula, symbolizing an essential advancement in shoreline delineation methodologies [17]. The formula is expressed as:

$$AWEI = 4 \times (Green - SWIR2) - (0.25 \times NIR + 2.75 \times SWIR1) \tag{1}$$

The formula combines information from four different bands, namely Green (green), SWIR2 (Shortwave Infrared 2), NIR (Near Infrared), and SWIR1 (Shortwave Infrared 1) [15].

### 2.2 Otsu threshold algorithm

The Otsu thresholding algorithm operates by segmenting pixels into two classes based on their intensities [18]. It determines an optimal threshold value by maximizing inter-class variance and minimizing intra-class variance. Employing this method, pixels with AWEI values above the threshold are classified as water [19]. The algorithm analyzes AWEI values to ascertain the best threshold for dividing pixels into two groups: water and non-water. This is achieved by testing various threshold values and measuring the distribution of pixel values on each side. The objective is to discover a threshold where the total spread of both groups—foreground, and background—is minimized, utilizing the following function:

$$\sigma_b^2(t) = \omega_0(t)\omega_1(t)[\mu_0(t) - \mu_1(t)]^2 \tag{2}$$

### 2.3 Median line

Figure 2 shows the illustration of median line.

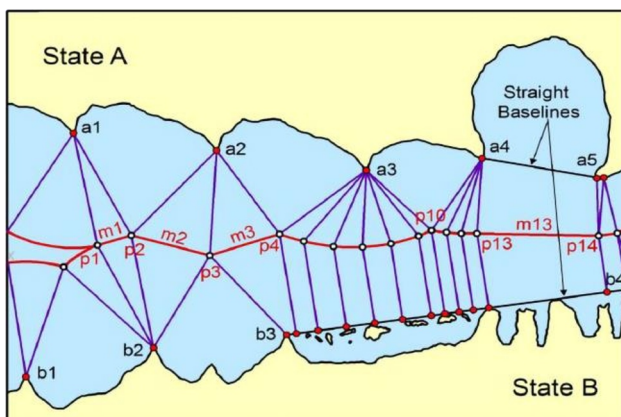


Fig. 2. Median Line for Facing Countries [23]

The Median Line is a line that delineates the midpoint between two adjacent maritime zones, which is often used in cases where the zones are adjacent to each other [20]. The Median Line is used to determine the boundaries of maritime jurisdiction between countries that have opposing or adjoining coastlines [21]. The Median Line can also be used to resolve maritime disputes between countries that have overlapping claims.

## 2.4 Equidistant line

Equidistant lines, which are pivotal in delineating maritime borders for neighboring or opposing nations, are established based on a rigorous process [8]. The procedure involves interconnecting baseline points along the coastlines of each country, extending perpendicular lines seaward known as normal lines, and determining midpoint Equidistant Points between adjacent normal lines. These Equidistant Points, maintaining equidistance from their respective normal lines, collectively form the Equidistant Line [22]. This boundary plays a crucial role in ensuring an equitable distribution of maritime jurisdiction, complying with international agreements, and adhering to territorial regulations related to exclusive economic zones, territorial waters, and continental shelves [23]. The precision of this delineation serves to resolve overlapping claims and mitigate disputes arising from maritime territories. The illustration of equidistant line can be seen in Figure 3.

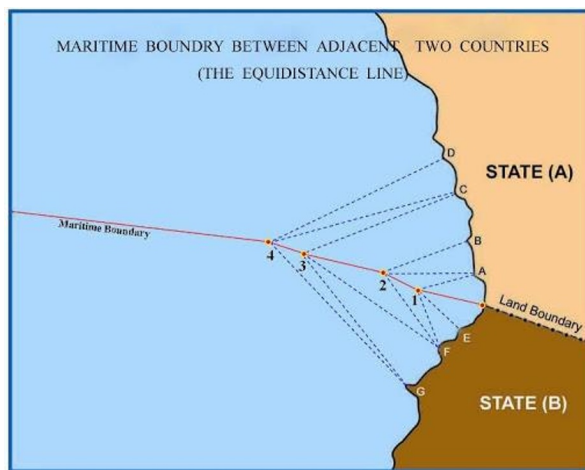


Fig. 3. Equidistant Line for Adjacent Two Countries [23]

## 2.5 Methodology

The meticulous configuration of parameters and the series of procedural steps encapsulated within the code form the backbone of the sequential image analysis workflow. The variable `'exportResolutionMeters'` is a crucial determinant, setting the spatial resolution for the entire image analysis process. Specifically defined as `'30'` within `'var exportResolutionMeters = 30;'`, this assignment dynamically shapes the resultant pixel resolution in meters, intricately influencing the precision and granularity of the analytical outcome. This choice meticulously balances desired precision levels with computational efficiency, offering an optimal trade-off for processing.

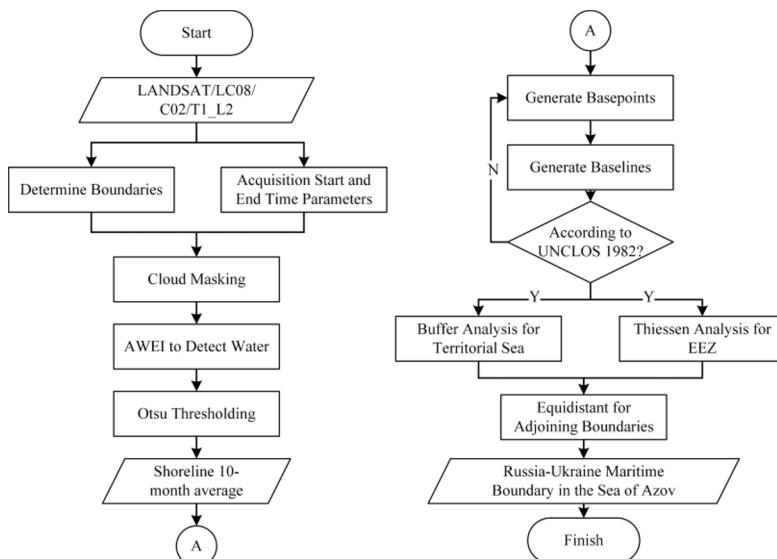
Subsequently, the initialization of temporal parameters (`'startDate'` and `'endDate'`) and the definition of the `'geometry'` variable establish temporal boundaries and delineate the geographic region of interest, respectively. In this script, the geographical expanse

encompasses the Sea of Azov. Following these parameter configurations, the code sequentially executes operations, including loading Landsat imagery, applying temporal and spatial filters, and implementing the detailed cloud masking procedure ('maskL8sr'). This meticulous process involves intricate band scaling methodologies for optical and thermal bands, coupled with specific masking to eliminate cloud or atmospheric influences, ensuring a clearer spectral analysis.

Furthermore, the script performs band selection ('collection.select'), a pivotal preparatory step curating essential spectral bands for subsequent analysis. The synthesis of a composite image ('composite') visualized through RGB representation ('rgbVis') provides a comprehensive understanding of the image, facilitating interpretation and qualitative assessment. Continuing, the computation phase involves the Automated Water Extraction Index (AWEI) and water body detection via the Otsu thresholding method ('detectWater'). This intricate process computes the threshold for water detection, meticulously adjusting parameters such as 'cannyThreshold', 'cannySigma', and 'minValue', adapting to scale and bounds for precise detection.

The code then translates detected water bodies into vector-based representations ('vectors') at a specific resolution ('exportResolutionMeters'). These vectors undergo refinement ('simplifyAndExtractCoastline'), balancing the intricacies of vector representations while maintaining accuracy. Finally, the processed coastline vectors ('coastlineVector') visually delineate the land-water boundary, aiding subsequent analytical procedures or export. Each numeric configuration within this code significantly contributes to precision, scale, and computational efficacy. Fine-tuning parameters is crucial to tailor outputs to research needs and constraints, ensuring optimal outcomes.

Moving on to the computation of median lines, the process involves determining midpoints between pairs of normal lines from both nations, ensuring an equal distance from respective normal lines. These midpoints form the basis for creating the median line, meticulously adhering to international agreements and territorial boundaries while delineating the maritime boundary. The creation of equidistant lines starts with identifying baseline points along respective coastlines, which are crucial for measuring territorial sea widths and delineating boundaries. Connecting adjacent baseline points forms the baseline itself, defining territorial sea boundaries based on coastline characteristics.



**Fig. 4.** Data Processing Scheme of Work

Perpendicular lines (normal lines) drawn from baseline points indicate directions towards the sea, their lengths varying based on claimed territorial widths. Midpoints between pairs of normal lines from both nations, known as equidistant points, maintain equal distances from respective normal lines, forming the Equidistant Line outlining maritime boundaries while complying with international agreements and avoiding territorial overlaps or exceedances. The scheme of work of this research can be seen in Figure 4.

### 3 Results and discussion

#### 3.1 Basepoints on the Predicted Shoreline

The map of the Basepoints illustrates the foundational basepoints used in the delineation process of the maritime boundary between Russia and Ukraine. These basepoints, situated along the coastlines of both nations, serve as reference points to establish their respective maritime boundaries. This depiction represents the initial phase in determining the maritime boundary between the two countries. The precise determination of these basepoints is paramount, as they form the fundamental elements for calculating the median line and equidistant line, which serve as primary principles in defining maritime boundaries.

This map serves as a cornerstone for subsequent delimitation processes. A comprehensive understanding of the location and distribution of these basepoints is crucial to ensure that subsequent calculations, such as determining the median line and equidistant line, are executed accurately and align with the principles of international law governing maritime boundary delimitation. The illustration of basepoint distribution in Russia-Ukraine can be seen in Figure 5.

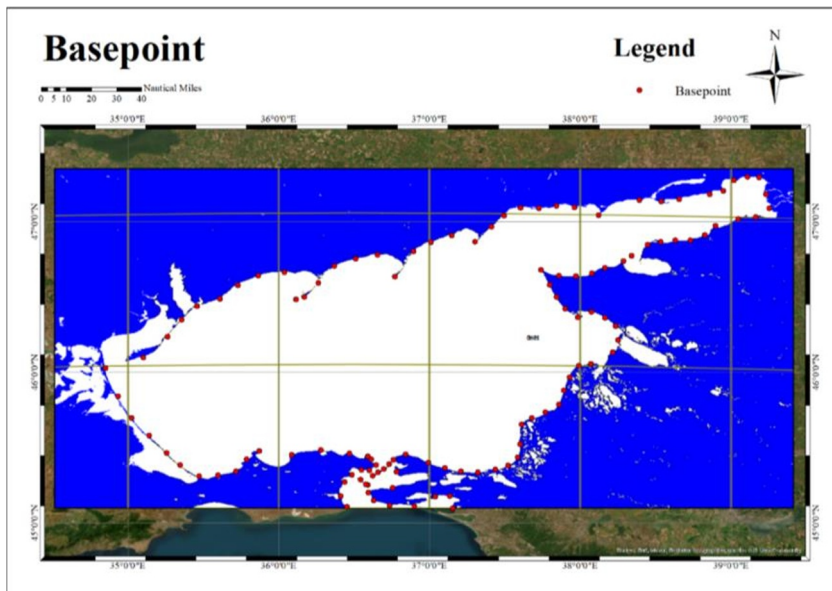
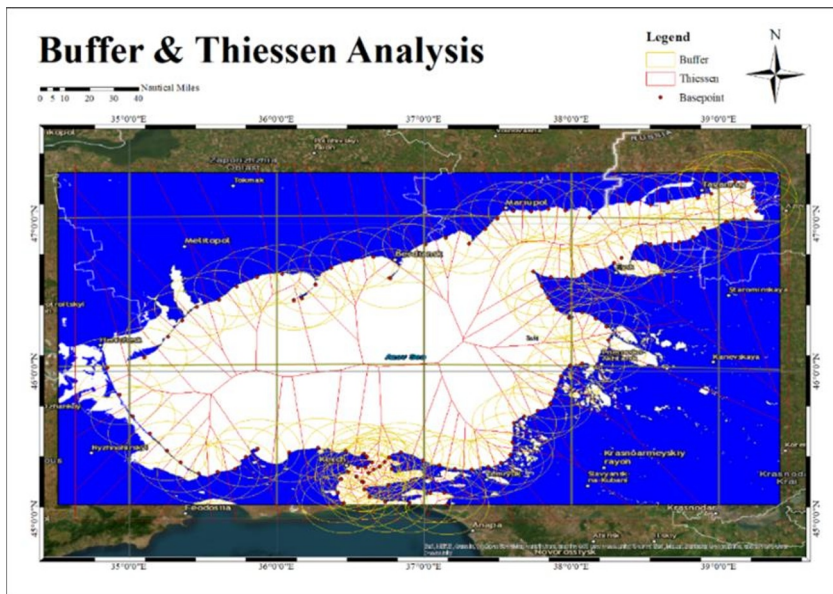


Fig. 5. Map of Basepoint Distribution in Russia-Ukraine

#### 3.2 Median and equidistant line

This map illustrates the boundary delineation process between Russia and Ukraine using the Thiessen processing and buffering techniques within ArcGIS. The utilization of Thiessen

processing involves creating polygons around a set of basepoints or centroids, optimizing the area closest to each basepoint. Buffering, on the other hand, involves creating zones or areas of influence around specific features, often using distances or measurements as parameters. This map showcases the application of advanced geospatial methodologies to derive the Median and Equidistant Lines, fundamental components in maritime boundary delimitation. Thiessen processing enables the creation of polygons based on proximity, aiding in establishing precise boundaries, while buffering techniques expand the scope of influence around critical reference points, contributing to the accurate depiction of the maritime boundary. The illustration of buffer and thiessen analysis between Russia-Ukraine in the Sea of Azov can be seen in Figure 6.



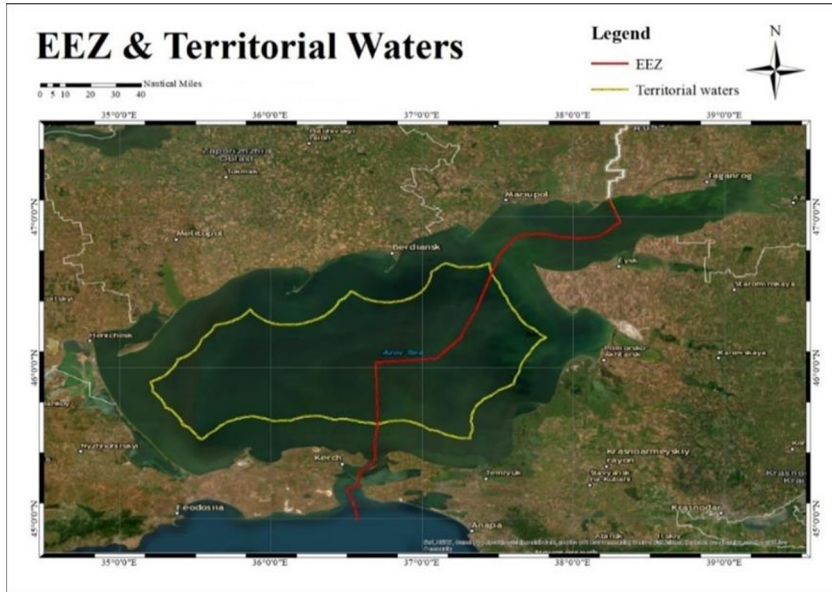
**Fig. 6.** Buffer and Thiessen Analysis Maps between Russia-Ukraine in the Sea of Azov

### 3.3 Maritime boundary result

The discrepancy in territorial sea and Exclusive Economic Zone (EEZ) measurements between the research conducted by Schatz in 2020 and the current study is striking. Schatz's research reported Russia's territorial sea at 1932.312 NM<sup>2</sup>, whereas the present study indicates 2191.842 NM<sup>2</sup>. Similarly, Ukraine's territorial sea was documented as 4441.904 NM<sup>2</sup> in Schatz's study, contrasting with the current measurement of 4675.126 NM<sup>2</sup>. These observed variations, particularly in Ukraine's case, carry substantial implications according to the provisions outlined in the United Nations Convention on the Law of the Sea (UNCLOS) 1982.

UNCLOS 1982 is a fundamental international framework governing maritime jurisdiction and resource rights. The discrepancy in the territorial sea and EEZ measurements, especially the noticeable increases for both Russia and Ukraine in the current study, suggests potential disparities or inaccuracies in prior measurements. Considering the UNCLOS 1982 guidelines, these updated measurements potentially indicate that Ukraine should have broader rights to exploit and manage marine resources within its maritime boundaries than its current entitlements suggest. This disparity underscores the critical necessity for precise and consistent measurements in defining maritime boundaries. It highlights the need for accuracy to ensure equitable distribution of maritime resources and adherence to international

maritime laws for coastal nations. The illustration EEZ & territorial sea between Russia-Ukraine in the Sea of Azov can be seen in Figure 7.

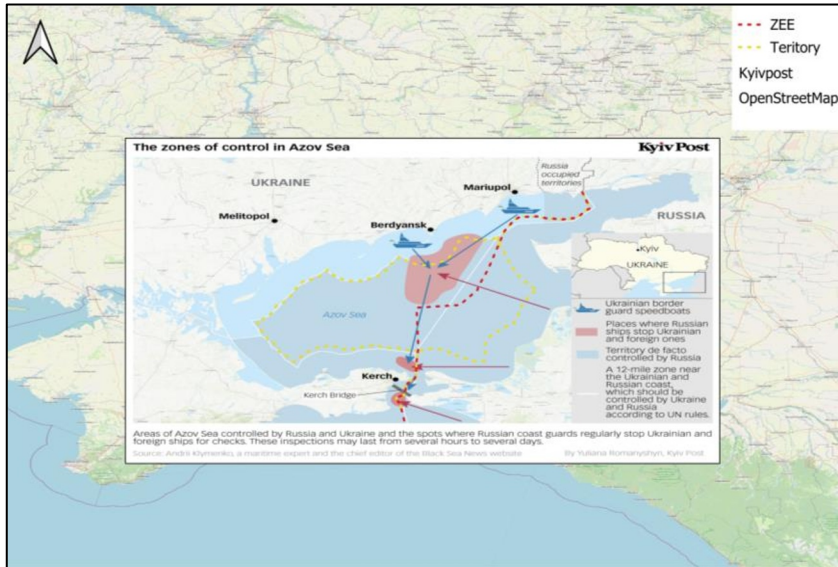


**Fig. 7.** EEZ & Territorial Sea between Russia-Ukraine in the Sea of Azov

### 3.4 Comparison with Romanyshyn's research

During the delineation process of the Exclusive Economic Zone (EEZ) boundary between Russia and Ukraine in the Sea of Azov, a mere distance of approximately 350 nautical miles separates the respective coastlines. Employing the Thiessen median line method, our calculation yielded an EEZ boundary spanning 90,452 nautical miles. In contrast, an independent source, Kyivpost's map, outlines this boundary at 80,149 nautical miles, indicating a noteworthy discrepancy of 10,303 nautical miles [13].

This substantial divergence in delineated boundaries underscores the imperative for meticulous scrutiny regarding the methodologies, data sources, and criteria employed in establishing maritime demarcations. The discernible variance between these measurements beckons a rigorous review of the methodologies deployed in boundary delineation processes, especially within the context of international maritime law frameworks such as the United Nations Convention on the Law of the Sea (UNCLOS). This divergence accentuates the criticality of precision and harmonization in demarcating maritime zones, substantiating the necessity for comprehensive and standardized approaches in defining such boundaries. The illustration delimitation comparison illustration with Romanyshyn research can be seen in Figure 8.

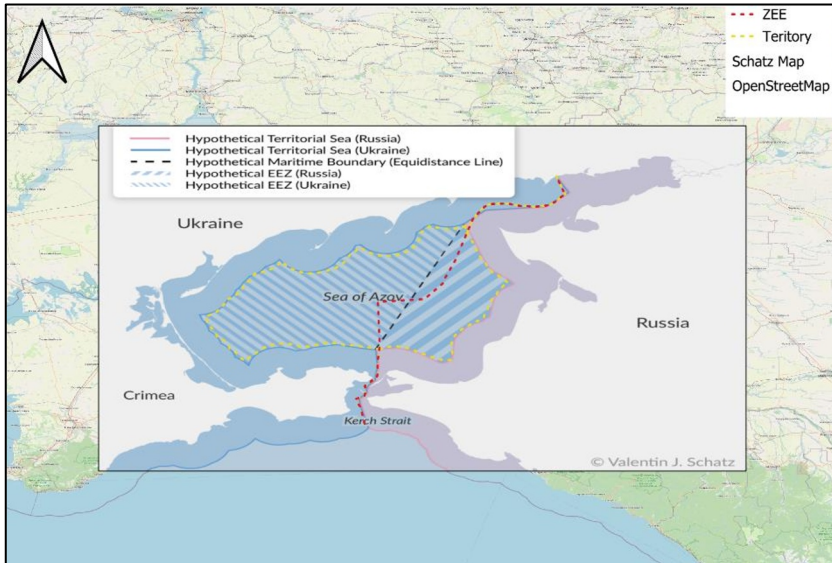


**Fig. 8.** Delimitation Comparison Illustration with Romanynshyn Research

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**Fig. 9.** Illustration of Delimitation Comparison with Schatz Research

## 4 Conclusion

The application of these algorithms marks a critical step in the preliminary assessment of accurate maritime boundaries using satellite imagery data. The AWEI algorithm has proven its reliability in meticulously outlining coastlines, ensuring a solid foundation for subsequent boundary delineation. Similarly, the Otsu thresholding method's efficiency in automating image segmentation streamlines the identification of 117 pivotal base points.

Upon subjecting these base points to equidistant and median analyses, the derived areas amount to 13,331 km<sup>2</sup> for Russia and 21,749 km<sup>2</sup> for Ukraine within their Exclusive Economic Zones (EEZ). Converting these figures to maritime measurements, the approximate translation is 5,146 NM<sup>2</sup> for Russia and 8,373 NM<sup>2</sup> for Ukraine.

This process underscores the vital role of advanced algorithms in extracting crucial maritime boundary data from satellite imagery. The precision of the AWEI algorithm in coastline mapping provides a reliable starting point for further boundary determinations. Simultaneously, the Otsu thresholding method's effectiveness in pinpointing base points significantly facilitates subsequent equidistant and median analyses.

The delineated areas resulting from this analysis hold substantial implications for both Russia and Ukraine concerning their EEZ's. The translated areas emphasize the varying extents of their maritime territories, accentuating the pivotal importance of accurate boundary delineation in international waters.

## References

1. I. Zavialov, A. Osadchiev, R. Sedakov, B. Barnier, J.M. Molines, V. Belokopytov, Water exchange between the Sea of Azov and the Black Sea through the Kerch Strait, **15-30** (2020)
2. V. Spiridonov, Industrial Projects in Russia's Coastal Regions: The Risks Arising, **5(2)**, 43-76 (2023)
3. D. Marples, The Collapse of the Soviet Union, 1985–1991, **203-206** (2013)

4. J.A. Shields, J. Shields, Framing the First month of the Russian-Ukrainian war in digital communications and how those communications affect the conflict, (2023).
5. K. Åtland, Redrawing borders, reshaping orders: Russia's quest for dominance in the Black Sea region, (2021)
6. S. Lewis, S. Lewis, Russia's Continued Aggression Against Ukraine Illegal Actions in the Kerch Strait and Sea of Azov, (2019) 1847.
7. A. Molander, Equitable Principles of Maritime Boundary Delimitation: The Quest for Distributive Justice in International Law by T. Cottier, Cambridge, 203-6 (2023)
8. J. Zhang, S. Chen, P. Ning, X. Zhang, An equidistance / equiratio method of maritime delimitation on the Earth ellipsoid, *J Sea Res*, 191, 102322 (2023)
9. L. Leonardo, Overlapping Entitlements between the Continental Shelf beyond 200 Nautical Miles and the Exclusive Economic Zone, (2019)
10. R.D. Kosyan, M.V. Krylenko, Estuarine, Coastal and Shelf Science Modern state and dynamics of the Sea of Azov coasts, *Estuar Coast Shelf Sci*, **224**, 314–23 (2019)
11. A. Skaridov, The Sea of Azov and the Kerch Straits, I, 4–5 (2006)
12. I. Law, Ukraine v. The Russian Federation: Navigating Conflict over Sovereignty under UNCLOS, **97**, (2021)
13. J. Biersack, S.O. Lear, Eurasian Geography and Economics The geopolitics of Russia's annexation of Crimea: narratives, identity, silences, and energy, 37–41 (2014)
14. Y. Romanyshyn, Kyivpost, The zones of controls in azov sea, 3 (2018)
15. V.J. Schatz, D. Koval, Russia's Annexation of Crimea and the Passage of Ships Through Kerch Strait: A Law of the Sea Perspective, *Ocean Dev Int Law*, 0, 1–23 (2019)
16. D.S. Yost, The Budapest Memorandum and Russia's intervention in Ukraine, **505–538**, Vol. 3, (2015)
17. Y. Kim, S. Kwak, M. Lee, M. Jeong, M. Park, Y.G. Park, Determination of Optimal Water Intake Layer Using Deep Learning-Based Water Quality Monitoring and Prediction, (2024)
18. L.H. Trinh, T.G. Le, V.H. Kieu, T. Minh, L. Tran, T. Thu, et al., Application of remote sensing technique for shoreline change detection in Ninh Binh and Nam Dinh provinces (Vietnam) during the period 1988 to 2018 based on water indices, (2020) 20.
19. T.Y. Goh, S.N. Basah, H. Yazid, M. Juhairi, A. Safar, Performance analysis of image thresholding: Otsu technique, *Measurement*, **298–307**, 114 (2018)
20. S. Husham, P. Raja, A. Mustapha, P. Raja, M.K. Al-obaidi, S.T. George, Comparative Analysis between Active Contour and Otsu Thresholding Segmentation Algorithms in Segmenting Brain Tumor Magnetic Resonance Imaging A brain tumor is becoming a worldwide government health issue with the increasing, (2020)
21. P. Bekker, C.M.S. Cameron, M. Nabarro, R. Van De Poll, OTC-29178-MS Resolving the Un-Delimited Arctic Boundary Between Canada and the United States in the Beaufort Sea by Using a Law-and-Science Approach, (2018)
22. S. Lokita, The Role of the Archipelagic Baselines in Maritime Boundary Delimitation Sora Lokita Division for Ocean Affairs and the Law of The Sea Office of Legal Affairs, The United Nations, (2010).

23. T. Cottier, Equitable Principles of Maritime Boundary, (2015)
24. T. Sea, A. Subsection, United Nations Convention on the Law of the Sea, :7–208 (1982)