Remote sensing-based analysis of the impact of the Ásványi confluence structure on the Danube floodplain water supply system

LUCA NAGY, GÁBOR ERNŐ HALUPKA, BARBARA VIOLA, JÁNOS GRÓSZ*

Hungarian University of Agriculture and Life Sciences, Institute of Environmental Sciences,
2100-Gödöllő, Páter Károly Street 1., Hungary;
e-mail: grosz.janos@uni-mate.hu

Keywords: water management, water supply, QGIS, NDWI index

Summary: The objective of the research was to examine the effects of the Ásványi estuary sill located in the lower inter-island area of the inter-island wave field water replenishment system on water surface coverage using remote sensing data and the Normalized Difference Water Index (NDWI). The analysis covered the period from 2013 to 2023 and was based on Landsat 8 OLI satellite imagery, processed in QGIS. The research focused on monitoring temporal and spatial changes in water surface area and on comparing conditions before and after the construction of water-level control structures. Based on the results obtained, it can be concluded that the operation of the Ásványi estuary bottom sill and the lower-island water replenishment system had a positive effect on water surface coverage. The NDWI maps clearly show that the change was most noticeable in the tributaries close to the structures, where the riverbed widened. The spatial variations in water surface area observed during the study period indicated that many factors, including climatic, hydrological, riverbed morphological, and hydro-meteorological parameters, can influence changes in water surface area.

Introduction

The discipline of water management is among the most prominent areas of hydrology. Moving further, the accessibility of available water resources and analyses of the natural water supply system are very recent topics, in the shadow of the increasing number of extreme drought phenomena. Increasingly widely available remote sensing techniques -satellites, UAVs – provide a good opportunity for analyzing and measuring water-related issues (Döbrentey et al. 2024). Parallel to the development of different remote sensing techniques, a new scientific discipline emerged: geoinformatics. GIS (Geographical Information System) is a geoinformatics tool that enables the efficient processing and storage of large datasets linked to geographical locations (Deli and Mészáros, 2010). One of the most important points in water management is protecting and managing our existing water resources wisely. To do this, it is essential to map water resources and examine their temporal and spatial distribution, which can be achieved through remote sensing and geoinformatics (Nagy 2010).

Remote sensing provides basic data on water resources, hydrological processes, and the impacts of droughts and floods, while geographic information systems offer the most effective tools for managing water resources and drought and flood risks (Wang and Xie 2018). Remote sensing indices are often used to measure the extent of surface water. During water and moisture content monitoring, indices such as NDWI (Normalized Difference Water Index) and MNDWI (Modified Normalized Difference Water Index) are often used, which provide information on surface water coverage and, indirectly, on soil moisture conditions (Mustafa et al. 2017).

In the recent study, the NDWI index was used to distinguish water-related surfaces from other land cover types. The water index is based on a mathematical model that uses predetermined bands for calculation, making it easy to distinguish between water and non-water surfaces. Stuart McFeeters developed the NDWI index in 1996, which is still a widely used satellite remote sensing method (Özelkan 2020). The method uses the near-infrared (NIR) band and the green wavelengths of visible light (VIS) to determine surface water. The basis for distinguishing between water and other surfaces is determined by the ratio of reflectance values in the green and near-infrared bands. Water surfaces show higher reflectance in the green band and lower reflectance in the near-infrared band. In contrast, soil and vegetation show the opposite values.

The study area of the research is connected to the Danube River watershed. Szigetköz is one of Hungary's most unique landscapes, characterized by its hydrography, located at the first section of the Danube as it enters the country at Rajka. Its territory is bordered by the main branch of the Danube and the Mosoni-Duna, which are connected by a diverse system of tributaries, backwaters, and floodplains (Kun 2016). Szigetköz is an extremely important region from a hydrological and ecological perspective, as the tributary systems here support a rich wildlife and provide high-quality groundwater resources of outstanding importance (Chappon et al. 2024).

The area's water system underwent major changes due to the Bős (Gabčíkovo) hydropower plant, which began operating in the early 1990s. The construction of the artificial headrace canal and the diversion of the Danube resulted in a huge water shortage and the drying up of the tributary systems, leading to an ecological disaster (Trásy et al. 2024). To mitigate the adverse effects, rehabilitation measures were implemented, and bottom sills were installed to restore water flow and maintain a relatively constant water level in the branch systems.

The confluence structure of the Ásványi branch, one of the most important water replenishment elements in Alsó-Szigetköz, was also built as part of the rehabilitation action (Jakus et al. 2024). The project was completed, and the newly created artifacts were handed over in 2015. Its operation directly affects the water-surface coverage of tributary systems.

In the hydrological state of surface waters, not only is water volume the determining parameter, but many other hydrological parameters must also be considered, such as flow systems, bed characteristics, and hydrometeorological parameters. The region is referred to as the "land of a thousand islands," as its ramified branch system divides the landscape, which is essentially 52 km long, 6-8 km wide on average, and covers 375 km^2, into small islands (Göcsei 1979). Its altitude ranges from 110 to 125 m above sea level.

Due to Szigetköz's geographic location, numerous factors influence its climate. As with the entire Kisalföld region, Szigetköz also has a moderately warm, moderately dry continental climate with mild winters (Szabó 2005). Its proximity to the Atlantic Ocean exerts an oceanic influence, reflected in cloud cover, balanced temperatures, and precipitation distribution (Bozsó 2025). In addition, due to the basin-like nature of the region, air currents from the surrounding mountains have a strong climate-modifying effect. This can result in extreme precipitation distribution and unpredictable rainfall (Szabó 2005).

From a water management perspective, the evaporation rate is of great importance. In Szigetköz, evaporation from open water surfaces is around 600 mm (ÉDUKÖVIZIG, 2010). Looking at the annual water balance, lower precipitation, hot summers, and predominantly windy weather result in a negative water deficit of 50–75 mm per year (Szabó 2005).

The primary objective of the research is to demonstrate, using remote sensing, that rehabilitation measures in Alsó-Szigetköz, particularly the construction of the confluence structure on the Ásványi branch, have affected the water-surface coverage of the active floodplain water replenishment system.

The following sub-objectives support the research:

– to create a satellite database covering a period of several years
– using the NDWI index in the analyses of water surface changes
– to describe the use of Landsat 8 and QGIS in remote sensing-based hydrological studies

Materials and methods

Szigetköz is located in the northwestern region of Hungary, in the northern part of the Kisalföld landscape. It is bordered by the Mosoni-Duna and Öreg-Duna. As previously mentioned, the area is approximately 375 km^2, stretching 52.5 km in length and averaging 6–8 km in width. Based on its slope, it can be divided into two parts: Upper and Lower Szigetköz. The Szigetköz branch system can be further divided into sub-branch systems. The study area comprises two sub-branch systems, the Ásványrárói and Bagaméri sub-branch systems, which were significantly affected by the 1992 Danube diversion and subsequent rehabilitation works (Figure 1). The study area was 25 km^2 (2500 ha) during the satellite-based analyses. These human interventions have significantly altered the former appearance of the naturally formed alluvial fan (Jakus et al. 2024).

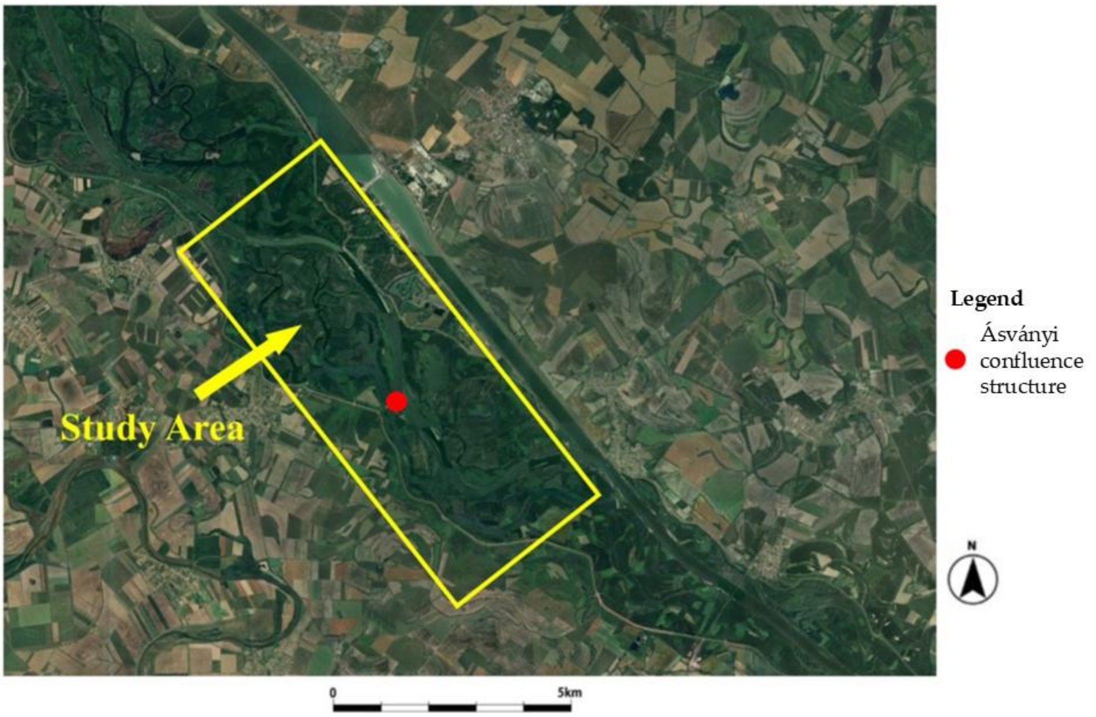

Figure 1. Location of study area (Source: Google Earth)

1. ábra. A vizsgált terület elhelyezkedése (Forrás: Google Earth)

Landsat 8 satellite imagery was used in the study. Since the Landsat 8 satellite was launched in February 2013, it was appropriate for the research to examine the 10-year period between 2013 and 2023. It operates with two instruments, the OLI (Operational Land Imager) and the TIRS (Thermal Infrared Sensor). It has 11 bands that could provide data for the different analyses. The resolution of most bands is 30 m, and the panchromatic band has a resolution of 15 m, and the thermal bands have a resolution of 100 m (Duan et al. 2021).

The Landsat 8 satellite provides two data quality levels (Level 1 and Level 2), which differ in processing level. Level 1 data provide radiometric and geometric corrections but lack atmospheric corrections and show the reflection from the upper atmosphere and the radiation measured by the sensor. Level 2 data includes all Level 1 corrections and also includes atmospheric correction using the LaSRC algorithm, thereby measuring surface reflectance and surface temperature.

At the beginning, the data collection focused on the summer period, but this was not possible due to many images being cloud-covered. Therefore, the targeted period will be the spring season to obtain a uniform sample series. In the data-preprocessing phase, Level-2 images were used in the analyses.

The satellite-based analysis focused on the two previously mentioned sub-branch systems (Ásványráró and Bagaméri). To separate the land and water-covered areas, the Normalized Difference Water Index (NDWI) was used during the study. As a result, water shows positive NDWI values, while vegetation and soil show negative values. The index values theoretically range from -1 to +1, with values between +0.1 and +1.0 typically indicating water cover, while values below 0 indicate a dry surface or vegetation (Acharya et al. 2018).

For the NDWI calculation, two satellite bands were required: the Green (visible light, Band 3) and NIR (Near-infrared, Band 5) bands. To conserve computer resources, a mask layer was used during the calculation, focusing on the previously introduced study area. In the separation process, the applied threshold value was 0,1 during the NDWI calculation.

One limiting factor in water surface analysis based on satellite remote sensing is shading, which can cause errors in NDWI values (Acharya et al. 2018). The index result can be greatly distorted by the increase in areas covered by forest and vegetation, as these easily shade the water surface, resulting in a smaller water surface area than in reality. As a result, narrow tributaries, reeds, and swampy areas, which are relatively common in the research area, may show uncertain index values.

Results and Discussion

The reason for choosing the period between 2013 and 2023 is to enable comparison of the condition before the construction of the confluence structure of the Ásványrárói branch with the water coverage during the works, as well as with the period following the completion of the project and the current conditions.

Table 1. Changes in water surface

1. táblázat. A Vízborítás változása

Year	Water coverage (m^2)	Water coverage (ha)	Water-cover changes (%)
2013	3 557 374	355,74	Basic year
2014	2 028 426	202,84	-43
2015	1 799 837	179,98	-49
2016	3 279 298	327,93	-8
2017	3 590 671	359,07	1
2018	3 377 388	337,74	-5
2019	3 555 572	355,56	0
2020	4 020 828	402,08	13
2021	3 601 466	360,15	1
2022	3 274 796	327,48	-8
2023	3 578 068	357,81	1

NDWI index maps created over a ten-year period clearly illustrate both the temporal and spatial changes in the floodplain water system of Szigetköz. After calculating the NDWI index, it became apparent that water coverage was greatest in the main branch of the Danube and in the wider tributaries directly connected to it. In the inner areas of the tributary system, along the narrower, shallower channels, the water surfaces varied greatly. This less stable condition may depend on the functioning of the water replenishment system, the Danube's water flow, and the extent of vegetation. Based on NDWI index values, Table 1 shows the water surface area by year and describes the change in water coverage as a percentage relative to the base year of 2013.

Based on NDWI values, the water surface area of the Ásványrárói tributary system showed significant annual fluctuations during the study period. The area's climate, the increasingly severe climate change of recent years, additional water management interventions, and the Danube's water flow may all be contributing factors.

To validate our satellite-based data, we compared the remotely sensed data with the water-level datasets available on the websites of the General Directorate of Water Management and the National Hydrological Forecasting Service (http1, http2). The dataset connected to the General Directorate of Water Management is a daily dataset, and the measuring point is located at the Ásványi confluence structure. Another dataset that is related to the National Hydrological Forecasting Service is a monthly dataset, and the measuring point is located in Medve. The monthly water-level dataset showed the trend for the period we examined (2013–2023). Based on basic statistical analyses, an 83% correlation was observed between the satellite-based data and the water-level dataset. During the examined period, the main trends matched between the two datasets.

The NDWI maps created from satellite images are shown in Figure 2. Thus, Figure 2 shows the situation before the intervention in 2013; 2014 shows the depleted water supply during the works; 2017 shows the start of water retention after construction was completed; and 2019 shows the growing and widening water surface.

To illustrate the changes in water cover over the analyzed period at a finer scale, Figure 3 shows the differences in a specific area near the water discharge structure.

The starting point is 2013, so this is the basic year for the comparison. This shows the status of the branch system before the intervention. In the analysis of water surface coverage, this is the starting year. The created satellite images show jagged riverbeds and small patches in the middle of the riverbeds, which may represent groups of islands formed by the drop in water level caused by the diversion, with vegetation growing on them.

The work was mainly carried out in 2014, with further interventions in 2015 in the tributary systems below the study area. As a result, the water flow into the Szigetköz during construction was lower than usual. This is also shown by the significantly reduced water surface area, which fell by almost half compared to 2013. In numerical terms, this represented a 43% reduction in water surface area in 2014, and in 2015 it continued to decline by 49%.

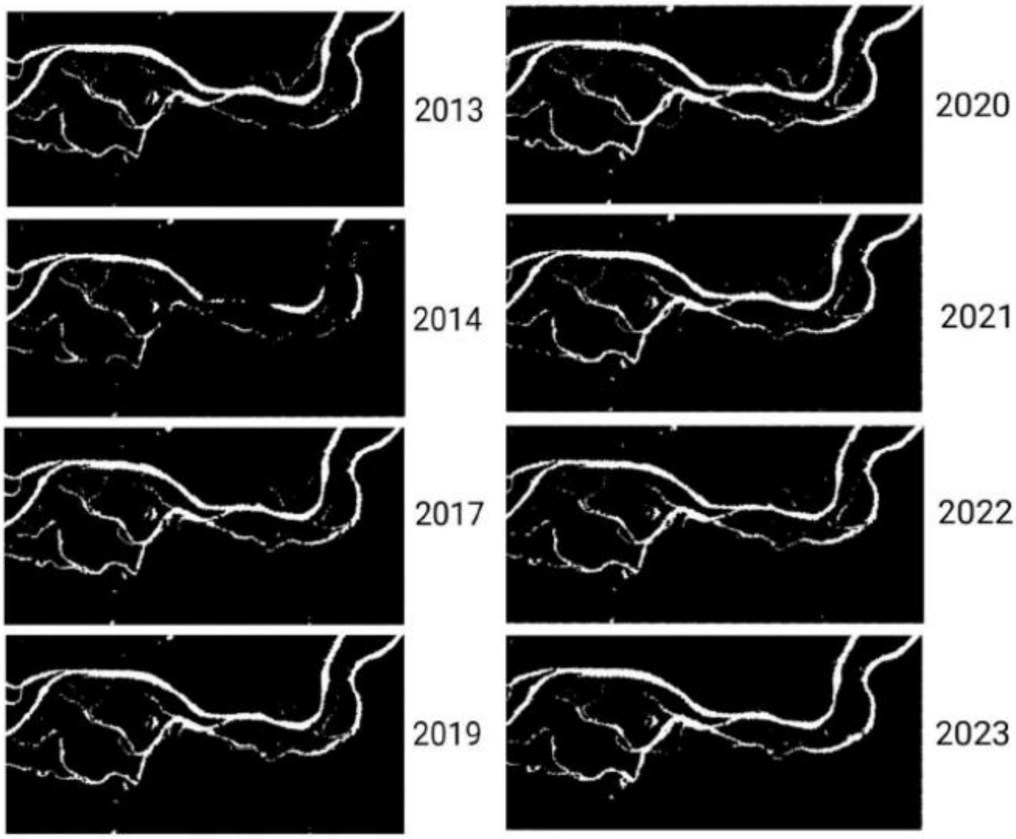

Figure 2. NDWI maps show the water cover changes for the whole study area (2013–2023)

2. ábra. NDWI térképek a kutatási terület vízborításának változására (2013–2023)

Following completion of the works, the water surface area increased again between 2016 and 2018 with the start of operation of the Ásványi estuary structure. The water surface area, which had halved in previous years, showed a change of only -8% in 2016. As shown in Table 1, the first positive year after the intervention, i.e., the year with an increase in water surface area, was 2017, with a 1% increase. In the following year, 2018, the area covered by water decreased again, albeit minimally, by 5%. In terms of data per square meter, there is no significant change compared to the starting year of 2013, but satellite images show that the widening of channels and larger branches within the tributary system has begun, and previously fragmented sections of the branch system have become connected.

The most spectacular increase in water surface area occurred between 2019 and 2020. The structure successfully contributed to increased water retention and improved water movement in several sections of the floodplain. This resulted in a +13% change in water surface area by 2020 compared to 2013 conditions. Smaller channels that were not visible on satellite images began to fill with water, and the riverbeds continued to widen. The size of the islands that had formed in the middle of the riverbed has also begun to decrease as water levels rise, and at the same time, the shallow banks covered with vegetation have been submerged, causing the terrestrial vegetation there to recede due to the excessive water cover.

In 2021–2022 (compared to 2020, which was almost the same as the base year), the water surface area decreased again, attributed to drought conditions and low Danube water flow. Based on the images, the retreat of water was particularly noticeable in the narrower tributaries during this period. However, the data also show that even during periods of water shortage, the area maintained a water volume close to that before the intervention. In 2021, thanks to water retention, this resulted in a +1% increase in water surface area, while in 2022, the water supply to the tributaries decreased by 8%.

In 2023, the water surface area increased again. The tributaries within the branch system visibly widened, and the smaller islands mentioned earlier almost completely disappeared. This year's images show an increasingly coherent picture of the area's water coverage, yet based on the data obtained during the calculations, we can conclude that the increasing temperature caused by climate change and the parallel increase in evaporation have a negative effect on the water body, as we observed only a 1% increase compared to the data from 10 years ago.

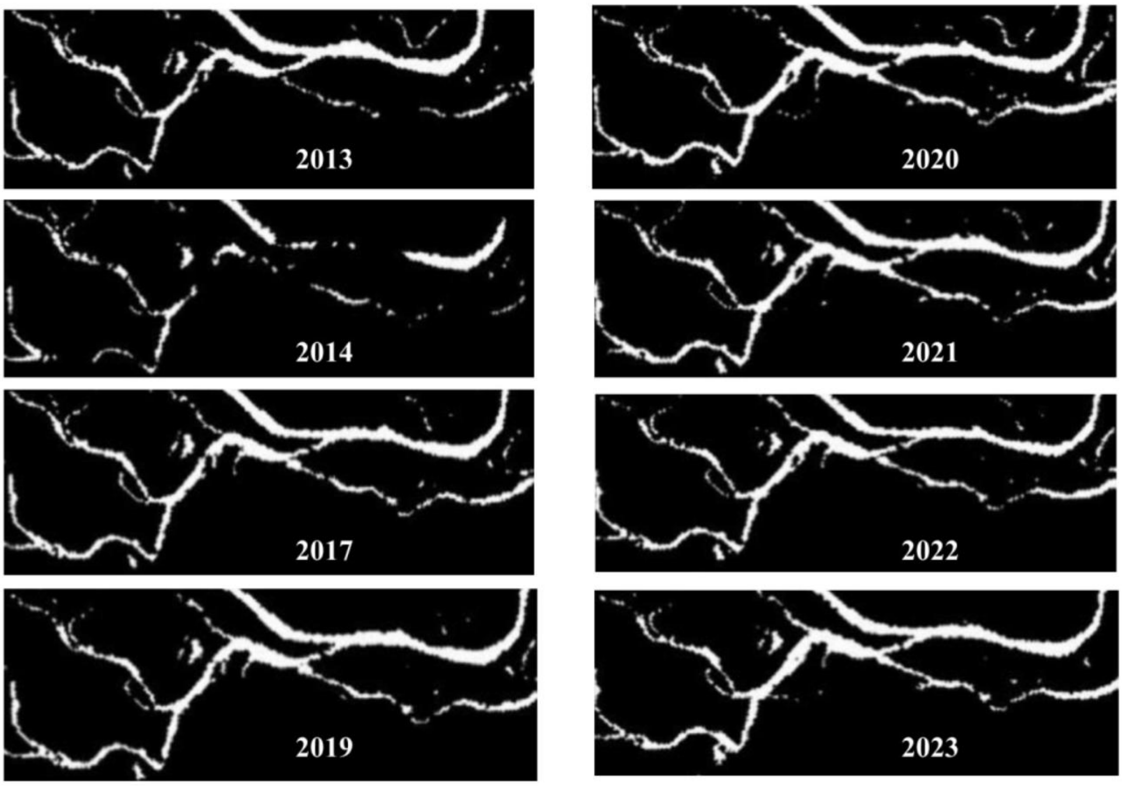

Figure 3. Water-covered area changes between 2013 and 2023 at a specific location near the confluence structure

3. ábra. A vízzel borított terület változása 2013 és 2023 között egy adott helyen a műtárgy közelében

Possible reasons for annual changes

Several factors can influence annual and spatial changes in water coverage. Some of these have had a significant impact on the study area:

– Climate

- The impact of climate change
- The water yields and flow of the Danube
- Water regulation measures
  - Operating procedures of water replenishment systems
  - Other applied water management aspects
- Land-use and changes in land use and land-cover

It is important to emphasize that these factors, on their own, do not result in the current state; rather, they have a combined effect on the area.

Climate conditions mainly affect the hydrometeorological parameters (precipitation amount, temporal and spatial distribution of precipitation, water flow, etc.). Climatic conditions are clearly reflected in the NDWI time series. The increase in average temperature in recent years and the annual fluctuations in precipitation can be compared to the expansion of water surfaces. According to HungaroMet data, temperatures have risen significantly since the turn of the millennium, while precipitation has fluctuated considerably (http3).

As shown in Table 1, the water surface area of the study area increased in 2020, then decreased again in 2021 and 2022. This can be explained by the fact that while 2020 was exceptionally rainy, the years 2021–2022 were characterized by drought. Before 2020, the size of the water surface was quite variable, as were the annual precipitation totals.

The rise in temperature and the spatial and temporal unevenness of precipitation distribution lead to increased evaporation and a decrease in surface water resources. Increasingly dry summers place a heavy burden not only on groundwater resources, but also on the condition of our lakes and rivers. According to HungaroMet's national data series (http3), the average summer temperature has increased by more than 1 °C over the past decade compared to the summers of 1981–2010. This trend is particularly pronounced in shallow tributaries, where water depths are low, and evaporation is relatively greater. This is exacerbated by the lack of precipitation over the past few years.

The annual and seasonal fluctuations in the Danube's water flow are closely related to the extent of water coverage. During periods of low water, the water supply to the floodplain branch system weakens, while in years of high water, the proportion of flooded areas increases. It is important to note that the water supply of the Szigetköz catchment area is regulated, so that major flood waves on the Danube do not necessarily affect the water supply of the tributary systems, or only to a minor extent. Furthermore, according to the agreements following the diversion of the Danube, artificial flooding is carried out in the area between April 15 and May 31 each year (Jakus et al. 2024). The aim is to simulate the larger flood waves that occurred before regulation, thereby helping maintain biodiversity in the area.

Changes in water coverage are determined not only by natural factors, but also by human intervention. During the period under review, the most significant impact was exerted by the operation of the Ásványi estuary structure and the bottom sills and closures built in parallel with it. Their purpose was to stabilize the tributary system and water levels. Based on the NDWI maps, after the structure was put into operation, the water surface area increased in the nearby areas, especially in the Ásványrárói tributary system and in the area between the estuary structure and the bottom sill built in the Bagaméri tributary system. In other areas, the change was less noticeable.

Changes in land use also contribute significantly to the extent of water coverage. Before the Danube was regulated, there was significant agricultural activity in the Szigetköz region, but this became difficult due to water shortages caused by diversions. Subsequently, the proportion of agricultural land decreased, and plant communities began to develop in an unregulated manner in many places (Szabó, 2006).

As shown on the map prepared by the Water Authority, Szigetköz features an extremely diverse water system. From the wider tributaries connecting to the main branch, narrower channels branch off in all directions, forming smaller internal lake systems. In contrast, the NDWI map does not show most of these channels, and even larger contiguous water areas are marked only as individual points, so there is a possibility of shadowing errors during the investigation.

Conclusions

The climatic, hydrological, and anthropogenic factors presented jointly explain the annual and spatial changes in water coverage. The database confirms that the decrease in water surface area during drought years is not solely due to engineering structures, but rather a complex process that may be partly driven by climate change.

Before the construction of the Ásványi estuary sill, water shortage was the main problem in the branch systems of the Lower Szigetköz. After the diversion of the Danube, water supply to tributaries decreased significantly, leading to the gradual drying up of backwaters, the disappearance of aquatic and marsh habitats, and a drop in groundwater levels (ÉDUVIZIG, 2020). In the period before the intervention, the amount of water flowing into the tributaries decreased significantly, especially in the Ásványrárói tributary, where low water yields often caused the shallow channels to dry up completely in the summer. This water shortage led to the destruction of aquatic vegetation, a decline in species richness, and a decline in water-related fauna (Jakus et al., 2024).

Based on remote sensing analysis, the intervention increased the extent of water surfaces, especially near the structure. NDWI-based analyses also showed that in several years, the area covered by water surfaces was larger than before the structure was built. This change brought about a revival of aquatic habitats. Plants that prefer shallow water areas reappeared in the backwaters.

However, the intervention also has a negative side. Rapid water-level fluctuations can cause local soil erosion and siltation in some areas, altering the morphology of riverbed and floodplain habitats in the long term. Nevertheless, the construction of the structure is overall positive, as it has altered the natural functioning of the floodplain water system, created a different habitat, improved hydrological and ecological conditions, and provided resources for maintaining biodiversity.

In summary, the research yielded several findings. Based on recent research, it can be concluded that the construction of the Ásványi estuary bottom sill and the associated water replenishment system have played a significant role in increasing water surface coverage in the Lower Szigetköz over the past few years. Based on satellite image analysis processed using the NDWI index for the period 2013–2023, the water surface area in the study area increased in certain periods after the intervention, especially in the wider side branches and near channels close to the structure. This suggests that the structure's water-retention effect improved water supply in the floodplain, stabilized the groundwater level, and supplied water to dried-up areas.

However, the extent of the water surface did not show consistent increases year after year. For example, the drought period between 2021 and 2022 and the simultaneous rise in temperature are clearly evident in the analyses, confirming that the extent of water coverage is greatly influenced not only by the hydrological impacts of human intervention but also by climatic and hydrological conditions. On the other hand, without the constructed structures, the 2021–22 drought would have been even more severe.

From an economic and social perspective, the construction of the water replenishment system had a positive impact on local recreational and tourism opportunities. The damming resulted in a nearly constant water level in the tributary systems, boosting water tourism, rowing, and fishing. Thanks to the stabilized water surface, campsites were established, boat marinas were built, and accommodation and other services became available, boosting the local economy.

References

Acharya, T.D., Subedi, A., Lee, D.H. 2018: Evaluation of Water Indices for Surface Water Extraction in a Landsat 8 Scene of Nepal. Sensors, 18: 2580. https://doi.org/10.3390/s18082580

Bozsó I. 2025: A műholdas földmegfigyelés fajtái és platformjai; aktív mikrohullámú megfigyelés. Haditechnika, 58(6): 35–39. https://doi.org/10.23713/HT.58.6.07

Chappon, M., Madarász, K., Bene, K. 2024: Assessing the Long-Term Groundwater Level Dynamics in the Szigetköz, Hungary. Chemical Eng. Tran., 114: 859–864. https://doi.org/10.3303/CET24114144

Deli Zs., Mészáros Cs. 2010: A légi hiperspektrális távérzékelés. Szakdolgozat. Eötvös Loránd Tudományegyetem Földrajz- és Földtudományi Intézet, Térképtudományi és Geoinformatikai Tanszék, Budapest.

Döbröntey R., Grósz J., Keleti J. R., Szegi T., Fuchs M., Michéli E., Csorba Á. 2024: Pilóta nélküli légi járművek alkalmazása a vizes élőhelyek modern felmérésében. Agrokémia és Talajtan, 73(1): 101–112. https://doi.org/10.1556/0088.2024.00155

Duan, W., Maskey, S., Chaffe, P. L. B., Luo, P., He, B., Wu, Y., Hou, J. 2021: Recent Advancement in Remote Sensing Technology for Hydrology Analysis and Water Resources Management. Remote Sens., 13(6): 1097. https://doi.org/10.3390/rs13061097

Észak-dunántúli Környezetvédelmi és Vízügyi Igazgatóság 2010: A Víz Keretirány-elv hazai megvalósítása VÍZGYŰJTŐ-GAZDÁLKODÁSI TERV, 1-1 Szigetköz vízgyűjtő, Győr. http://www2.vizeink.hu/files/1-1_Szigetkoz.pdf_100422.pdf

Göcsei I. 1979: A Szigetköz természetföldrajza. Akadémiai Kiadó, Budapest, 9.

Jakus G., Kertész J., Simon G.M., Pannonhalmi M., 2024: Az újjászülető Szigetköz. Hidrol. Közlöny, 104: 17–39. https://doi.org/10.59258/hk.14994

Kun, Z. :2016: Ecological restoration and water system development in the protected site and floodplain areas of Szigetköz in Hungary. Győr: Észak-Dunántúli Vízügyi Igazgatóság (ÉDUVIZIG).

McFeeters, S. K. 1996: The use of the Normalized Difference Water Index (NDWI) in the delineation of open water features. Intern. J. of Remote Sens., 17(7): 1425–1432. https://doi.org/10.1080/01431169608948714

Mustafa, M.T., Hassoon, K.I., Hussain, H.M., Abd, M.H., 2017: Using water indices (NDWI, MNDWI, NDMI, WRI and AWEI) to detect physical and chemical parameters by apply remote sensing and GIS techniques. Int. J. Res. Granthaalayah, 5: 117–128. https://doi.org/10.29121/granthaalayah.v5.i10.2017.2289

Nagy P. Z. 2010: Webes Térinformatikai Technológiák [szakdolgozat], Debreceni Egyetem Informatikai Kar, Debrecen.

Özelkan, E. 2020: Water Body Detection Analysis Using NDWI Indices Derived from Landsat-8 OLI. Polish J. of Envir. Stud., 29: 1759–1769. https://doi.org/10.15244/pjoes/110447

Szabó M. 2005: Vizes élőhelyek tájökológiai jellemvonásai a Szigetköz példáján [akadémiai doktori értekezés], Budapest.

Szabó M. 2006: Tájszerkezeti változások a Szigetközben a mező- és erdőgazdálkodás, és a Duna elterelésének hatására. In: Táj, környezet és társadalom. https://www2.sci.u-szeged.hu/eghajlattan/baba/Szabo.pdf.

Trásy, B., Magyar, N., Hatvani, I.G., Garamhegyi, T., Kovács-Székely, I., Kovács, J., Trásy-Havril, T. 2024: Drivers of Daily Water Level Fluctuation of Shallow Groundwater in the Inner Delta of the River Danube. Water, 16(14): 2011. https://doi.org/10.3390/w16142011

Wang, X., Xie, H. 2018: A Review on Applications of Remote Sensing and Geographic Information Systems (GIS) in Water Resources and Flood Risk Management. Water, 10: 608. https://doi.org/10.3390/w10050608

Internet links

http1: https://www.vizugy.hu/?mapModule=OpGrafikon&AllomasVOA=8A143555-8F1A-44B2-964B-476B5F1EE7ED&mapData=Idosor#mapModul (Elérés: 2026. április 27.)

http2: https://www.hydroinfo.hu/Html/archivum/archiv_tabla.html (Elérés: 2026. április 27.)

http3: https://www.met.hu/eghajlat/magyarorszag_eghajlata/eghajlati_visszatekinto/elmult_evtized_idojarasa/ (Elérés: 2025. november 3.)

A Duna hullámtéri vízpótló rendszerén elhelyezkedő Ásványi torkolati műtárgy hatásai a vízpótló rendszerre műholdas távérzékelés alapján

NAGY LUCA, HALUPKA GÁBOR ERNŐ, VIOLA BARBARA, GRÓSZ JÁNOS*

Magyar Agrár- és Élettudományi Egyetem, Környezettudományi Intézet,
2100 Gödöllő, Páter Károly utca 1; e-mail: grosz.janos@uni-mate.hu

Kulcsszavak: vízgazdálkodás, távézékelés, árterület, NDWI-index

Összefoglaló: A kutatás fő célkitűzése az volt, hogy távérzékelt adatok segítségével (NDWI-index) megvizsgáljuk az Ásványi torkolati műtárgy hatását a vízfelület-borítottság változására vonatkozóan. Az elemzés a 2013 és 2023 közötti időszakra készített Landsat 8 OLI műholdfelvételeken alapult, amelyeket QGIS szoftver segítségével dolgoztunk fel. A kutatás a vízfelület időbeli és térbeli változásainak nyomon követésére, valamint a vízszint-szabályozó műtárgyak megépítése előtti és utáni állapotok összehasonlítására összpontosított. A kapott eredmények alapján megállapítható, hogy az Ásványi torkolati műtárgy és az alsó-szigeti vízpótló rendszer működése pozitív hatással volt a vízfelületi kiterjedésére. Az NDWI-térképek egyértelműen mutatják, hogy a változás leginkább a műtárgyak közelében lévő mellékfolyókban volt észlelhető, ahol a folyómeder kiszélesedett. A vizsgálati periódusban tapasztalt vízfelület területi változásai rámutattak arra, hogy sok tényező, köztük éghajlati, hidrológiai, medermorfológiai és hidrometeorológiai paraméterek befolyásolhatják a vízfelszín felületi kiterjedésének változását.