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MONITORING GROUNDWATER DEPENDANT HABITATS USING SENTINEL-1 SAR

Ted McCormack, Owen Naughton, Hannah Mulcahy, Áine O'Connor
Geological Survey Ireland | South East Technological University | National Parks and Wildlife Service | Ireland



> Copernicus satellite data have transformed how we monitor turloughs in Ireland. We can now extract information at a previously impractical scale.
>
> **Hannah Mulcahy**
> *Turlough & Freshwater Ecologist*
> *National Parks & Wildlife Service*

Blackrock Turlough in Co. Galway, Ireland, during wet winter periods. Turloughs are colloquially known as 'disappearing lakes' | Credit: Own Work

Under the Habitats Directive, the National Parks and Wildlife Service in Ireland must assess the conservation status of turloughs, a priority groundwater-dependent habitat. However, the large number of widely distributed turloughs presents significant monitoring and mapping challenges. Copernicus Sentinel-1 data offer a practical and effective means of assessing turlough distribution and hydrological function.

THE CHALLENGE

Turloughs are seasonal groundwater-fed lakes found in Ireland's limestone regions. Owing to their distinctive flooding regime and resulting flood-dependent ecology, they are designated as priority habitats under the EU Habitats Directive. Responsibility for implementing this legislation and overseeing turlough conservation rests with the National Parks and Wildlife Service (NPWS).

A key NPWS obligation is Habitats Directive Article 17 reporting on the national conservation status of habitats and species. This requires an assessment of the distribution, range, extent, structure and functions of these habitats. However, turloughs can be difficult to identify and delineate accurately. Many sites are difficult to access, and terrestrial ecology can only be surveyed during summer dry periods.

To improve the accuracy of habitat range and area estimates and provide information on hydrological function for Article 17 reporting, NPWS requires alternative data sources for turlough monitoring.

THE SPACE SOLUTIONS

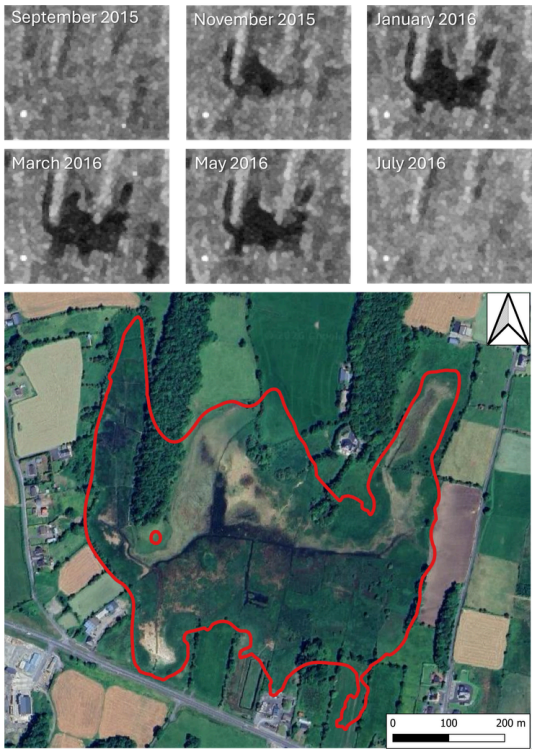
As documented in the 2018 Copernicus4Regions publication, Geological Survey Ireland (GSI), in collaboration with South East Technological University, successfully used Sentinel-1 imagery to monitor and map groundwater flooding. Building on this expertise, GSI is expanding its Sentinel-1 analytical capabilities to encompass both the detection and monitoring of groundwater-dependent habitats alongside active groundwater flooding.

Turloughs are especially suited for Earth Observation technologies, particularly Sentinel-1 SAR imagery. Their spatial extent allows for reliable detection, and their relatively slow flood pattern aligns with Sentinel-1's data acquisition frequency.

GSI leverages these characteristics to fulfil two primary objectives:

1. Systematic Scanning: Identifying previously undocumented turloughs across the landscape.
2. Hydrogeological Assessment: Quantifying water level fluctuations to evaluate the hydrogeological functioning of individual turloughs.

These observations are integrated with contextual datasets such as geology, topography and surface drainage to assess the likelihood that the water is groundwater-derived. The resulting open-access national maps provide a basis for NPWS to conduct targeted habitat surveys, which can then validate whether sites fulfil the hydrogeological and ecological criteria required for definition as turloughs.



SAR Mapping process
Top: Sequence of Sentinel-1 images showing seasonal flooding. Bottom: Outline of resulting newly identified turlough, Drumadoon, Co. Mayo. Ecologically surveyed in 2026 and confirmed for addition in future Article 17 reporting | Credit: own work

THEMATIC AREA
Biodiversity and Environmental Protection

REGION OF APPLICATION
Ireland: Northern and Western | Southern | Eastern and Midland

SENTINEL MISSION USED
S1

COPERNICUS SERVICE USED
-

THE BENEFITS AND THE BENEFICIARIES

The remote sensing workflows executed by GSI identified approximately 834 turloughs, significantly expanding the NPWS's existing catalogue of 451 known sites.

Of the 379 new sites, a targeted subset of 23 sites was formally included in the 2025 Article 17 Report, increasing the reported turlough range by fourteen 10 x10km squares. In preparation for the next round of Article 17 reporting, due in 2031, NPWS are carrying out ecological surveys on all new sites, to facilitate a more comprehensive conservation status. To date, at least 20 of the 32 prospective turloughs surveyed in 2026 showed evidence that they currently fit the ecological definition.

This significant expansion of the national turlough evidence base represents a transformative advancement in turlough monitoring in Ireland.

Beyond detecting new sites, improving area mapping and providing data on hydrological functioning, it is also enabling GSI and NPWS to refine the definition and ecological understanding of these priority groundwater dependant habitats.

These positive outcomes demonstrate the long-term utility of Sentinel-1 satellite monitoring and mapping methodologies in Ireland. This framework initially underpinned the development of national groundwater flood mapping and is now supporting the monitoring of groundwater dependent Priority Habitats. Collectively, these advancements benefit Irish citizens by enhancing their knowledge of their environment, but also directly supporting Ireland in fulfilling its statutory obligations under both the EU Floods Directive and EU Habitats Directive.

	TIER 1 SERVICE PROVIDER	TIER 2 PRIMARY USER	TIER 3 SECONDARY USER	TIER 4 END USER BENEFICIARIES
SERVICES AND BENEFITS	Copernicus Sentinel-1 Imagery	Habitat location maps & flood characteristics	Accurate reporting for EU Habitats Directive	Better conservation of priority habitats
BENEFICIARIES	Geological Survey Ireland	National Parks and Wildlife Service	European Union	Environment, Citizens

EU POLICY / DIRECTIVE

Habitats Directive

TYPE OF SERVICE PROVIDER

Public Service

TYPE OF FUNDING SOURCE

National or regional non space Programme

USAGE MATURITY LEVEL

4



A FUTURE WITH COPERNICUS

Copernicus Earth Observation data have proven highly advantageous for the monitoring of groundwater-dependent habitats in Ireland. While initially used in a targeted capacity to assist NPWS in completing the 2025 Habitats Directive Article 17 Report, its integration will expand over the coming years to support the subsequent 2031 reporting cycle, National Nature Restoration Plan and other statutory frameworks. Future initiatives will focus on thorough hydrogeological characterisation of all turloughs, alongside research into localized vegetation mapping within these habitats using Sentinel-2.



DID YOU KNOW?

Historical names: Old placenames are often the best clues for finding overlooked habitats. For example, several new turlough habitats found during this project were located in townlands that have the word "turlough" in their name.

Acknowledgements

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Contacts

Ted McCormack | ted.mccormack@gsi.ie
Owen Naughton | owen.naughton@setu.ie
Hannah Mulcahy | Hannah.Mulcahy@npws.gov.ie
Áine O'Connor | Aine.OConnor@npws.gov.ie

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