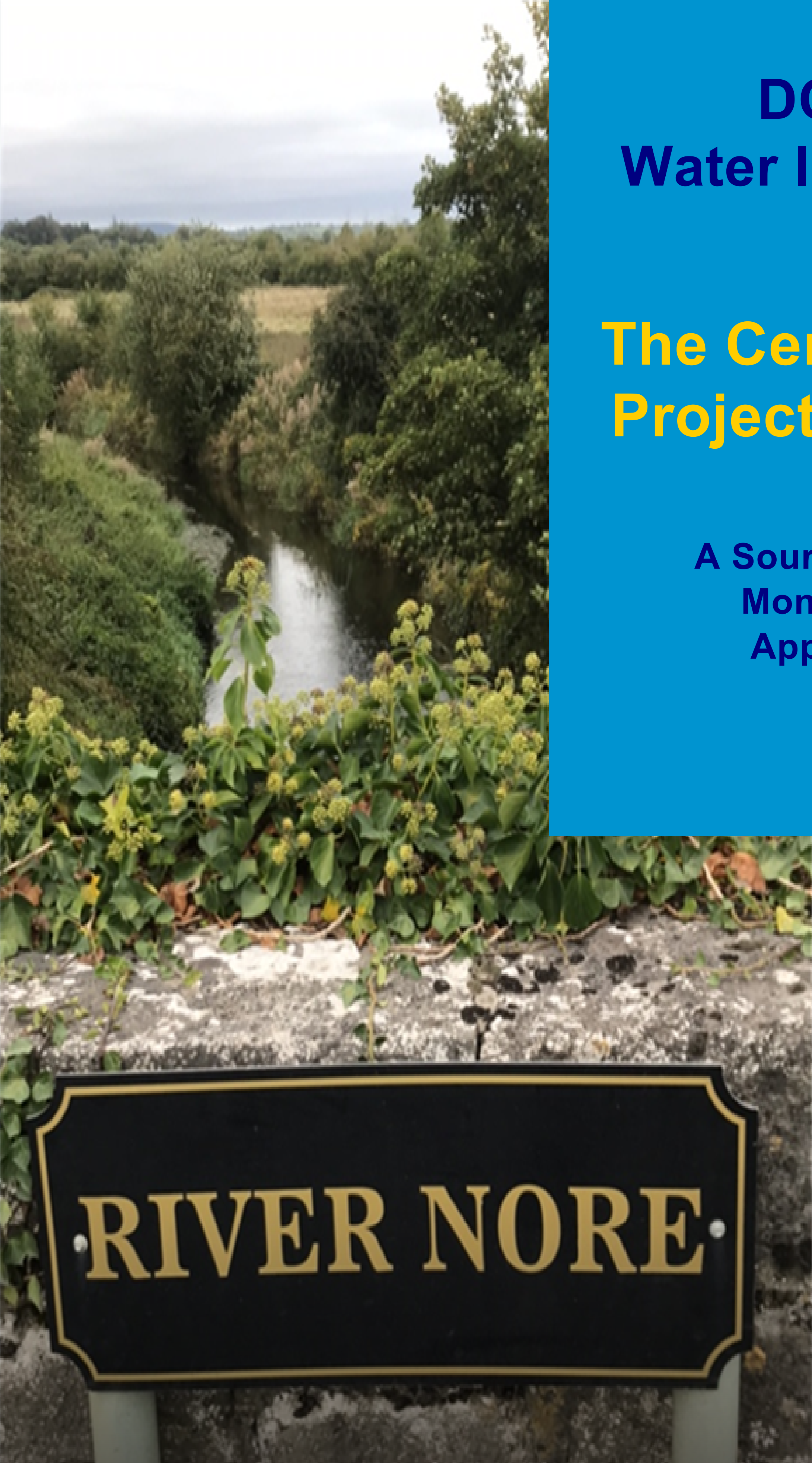
DCU Water Institute

The Centennial Project Report

A Source to Sea Monitoring Approach



The DCU Water Institute team would like to say a heartfelt thank you to the Centennial citizen scientists who carried out long term sampling along the River Nore and its tributaries. Citizens collected samples in sunshine and rain and have played a key part in improving the knowledge of water quality in the Nore catchment. With this information, we can identify areas of higher risk, protect our resources and ecosystems, and help inform how this and other water bodies can be protected into the future.

Thank you to the Nore River Catchment Trust for partnering with the Water Institute and for their continued support throughout the project. Sincerest thank you to the project funders Rethink Ireland, Ornua Co-operative Limited and the Department of Rural and Community Development. Finally thank you also to the DCU Educational Trust for their ongoing support.

NORE VISION
NORE RIVER CATCHMENT TRUST

RETHINK IRELAND

Ornua
THE HOME OF IRISH DAIRY

DCU
Dublin City University Educational Trust

An Roinn Forbartha Tuaithe agus Pobail
Department of Rural and Community Development

Cover photo: River Nore at Coolrain, Co. Laois (Source: Sean Phelan)

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1.0 Introduction

1.1 Citizen Science

DCU's Water Institute believes citizen science (CS) can help towards understanding more about water quality in Ireland by making it possible to test more locations, more frequently.

CS is research carried out by members of the public who volunteer to collect scientific data. Although citizens have been participating in and contributing to scientific research for years, the widespread use of smartphones has made it easier to share and map scientific data. CS is a growing trend globally, particularly in environmental science and monitoring (Kelly-Quinn et al 2022). The impact of continuous citizen science monitoring carried out by community groups is key to gathering data in terms of understanding climate change and its impacts locally. The uniqueness of this project brings the expertise of Dublin City University (DCU) Water Institute in addressing Source to Sea challenges and integrating it with citizen science to educate and also to gather impactful, relevant and current water quality data.

1.2 DCU Water Institute Citizen Science Strategy

Citizen Science is of strategic importance to the DCU Water Institute to enable and equip other environmental community groups to monitor the water quality in their waterways. Securing funding for an all-Ireland Citizen Science Water Programme will enable the DCU Water Institute to capture up-to-date water quality data across Ireland. This kind of data could potentially provide the opportunity to inform water policy in Ireland.

1.3 The Partnership

The Water Institute is a cross-faculty initiative which carries out research and education in the area of water. It works with other universities, government bodies, industry, and society to develop solutions to national and global problems in water.

Nore River Catchment Trust (NRCT) is a community based organization working with individuals and groups in the River Nore catchment area with the vision of a healthy and vibrant Nore catchment that is appreciated and enjoyed by all.

1.4 The Centennial Project

The Centennial Project is a research project supported by the Glas Community Fund which has been created by Rethink Ireland in partnership with Ornua Co-operative Limited and the Department of Rural and Community Development. The research is part of the DCU Water Institute Citizen Science Initiative whereby projects are co-created with citizens and use monitoring tools to deliver valuable data for water management and protection.

The Centennial Citizen Science project involved a water quality testing programme carried out by DCU Water Institute in collaboration with Nore River Catchment Trust (NRCT).

1.5 Rationale

Reliable safe water and sanitation are essential for public health. In Ireland, our water supply is under pressure and water quality is getting worse. According to the Environmental Protection Agency (EPA, 2020), just 57% of rivers, and 54% of lakes were in satisfactory ecological health in 2019. The deterioration in recent decades is shocking. Just 22 of our rivers were classified as 'pristine' or achieving the highest biological quality in 2019, this is down from 575 in 1990.

Poor water quality has serious consequences. It fuels a biodiversity crisis, which has seen an 80% reduction in global populations of freshwater species since 1970, and is undermining the health of ecosystems upon which our food supply, health, livelihoods and economies depend. Human activities such as agriculture, waste water discharges, forestry, peat extraction, mining and quarrying are amongst the leading causes of poor water quality in Ireland.

The Water Institute is committed to citizen science where communities can identify water quality issues in local rivers or streams, and also champion those that have good quality water. According to the EPA, the water quality of our rivers, lakes, estuaries and coastal areas continues to decline (EPA, 2022) and as a result the Water Institute plans to assist in reversing that trend through the help of citizen scientists. Previous water quality projects created by the Water Institute include the BACKDROP project (Hegarty et al, 2021) which investigated the water quality on the River Liffey, and several successful nationwide WaterBlitzes, the most recent of which sampled waterbodies in 700 locations across Ireland.

1.6 Objectives

The objective of the Centennial project was to enable communities within a catchment to develop their own programme of testing through groups like the Nore River Catchment Trust, so that the local waterways can be monitored on a regular basis. The project also created an awareness and an understanding among communities of what drives water quality which in turn affects the local environment.

A Source-to Sea approach was taken with the project so that the river Nore could be assessed from its upper catchment area as it progressed southwards to join with its other 'Three Sisters' rivers, the Barrow and the Suir, as they enter the sea near Waterford. The source-to-sea approach directly addresses the connections between land, water, estuary, coast, and ocean ecosystems, as the water quality throughout a catchment will have a direct impact on our oceans, so regular monitoring has a far-reaching effect.

2.0 Engagement and Training

Information gathered during the 2021 WaterBlitz indicated that nitrate levels in the south-east of Ireland were high, resulting in low quality water. These results mirrored data from an EPA report, 'Water Quality in 2020 – An Indicator's Report' (EPA, 2021a) which warranted further investigation in the region. River groups or trusts in the south-east were researched to find a suitable partner to carry out this work and NRCT was chosen.

A study area was identified in the NRCT area that had key pressures and priority areas for action according to the 3rd Cycle Draft Nore Catchment Report (EPA 2021b). In collaboration with NRCT, this area was expanded across the northern section of the Nore catchment encompassing the southern half of the county of Laois. With the assistance of NRCT, two training days which were publicised in Laois took place in Durrow and Mountrath during March 2022. From those that attended, a group of 22 participants decided to become citizen scientists and join the Centennial project. These participants chose or were assigned 27 sampling locations across the study area which included the River Nore and 12 of its tributaries. Participants were given the required equipment to carry out the project and a start date was decided with monthly sampling over a period of 7 months. Participants brought another person along each time they sampled for health and safety reasons so 44 people participated in total.

Citizen scientists at training day, Canoe Club, Durrow, Co. Laois, 12th March 2022.

Citizen scientists at training day, above and below, at White Horses River Park, Mountrath, Co. Laois, 26th March 2022.

3.0 Methodology

3.1 Citizen Science Framework

The DCU Water Institute uses a Framework for all Citizen Science Activities as in table 1 below.

Table 1: Citizen Science Framework (Amended from Kelly-Quinn et al, 2022).

FRAMEWORK FOR CITIZEN SCIENCE CORE ACTIVITIES		
Knowledge | Awareness | Engagement | Skills | Behaviour		
Steps	**Key Tasks**	**Activity Example**
Project establishment	Define the citizen science project objectives and establish coordination. Enable participation at various levels (from spot records to regular monitoring). Establish a data repository and data entry system. Agree/design citizen science methods/tools and produce training resources.	• Co-define project aims and objectives. • Establish project coordination. • Work with locals to develop local citizen science activity. • Select recording system/metric that enable participation. • Develop training resources. • Establish data entry system and validation system. • Establish data repository. • Consider Health & Safety. • Set up a web presence.
Training	Train the volunteers enabling them to become familiar with the methodology for data collection and upload.	• Co-develop a training programme for volunteers with input from trainers and experts • Develop training resources, field guides appropriate to working in France – including necessary translations. • Host training workshops for volunteers.
Data Acquisition	Develop an equipment checklist. Enable access to equipment. Highlight priorities for data collection. Data gathering.	• Supply/support purchase of the equipment needs. • Agree sites for monitoring. • Review and validate data. • Upload data to repository.
Interpretation & Reporting	Interpret and report the findings. Make the results accessible.	• Analyse data to indicate water quality, illustrate water quality patterns/trends. • Visualise the results on maps. • Make results accessible to the public. • Make data available to relevant agencies. • Reflect on experiences with Citizen Scientists.
Communication	Establish communication channels between volunteers and with trainers. Share the work and the results.	• Establish communication with local meetings. • Share results with the public including local organisations through the website, local talks, etc.

3.2 Monitoring methodology

Water quality was investigated using criteria such as the presence of nitrates and phosphates and turbidity, with the tools indicated in Table 2.

Table 2. Water quality measurements and observations undertaken.

Parameter	Method	Tool
Nitrate	Colour Transition Reagent	Measurement kit and colour card
Phosphate	Colour Transition Reagent	Measurement kit and colour card
Turbidity	Visual	Secchi Disc and tube
Flow	Visual	Qualitative, observation
Description	Digital	Camera/photo

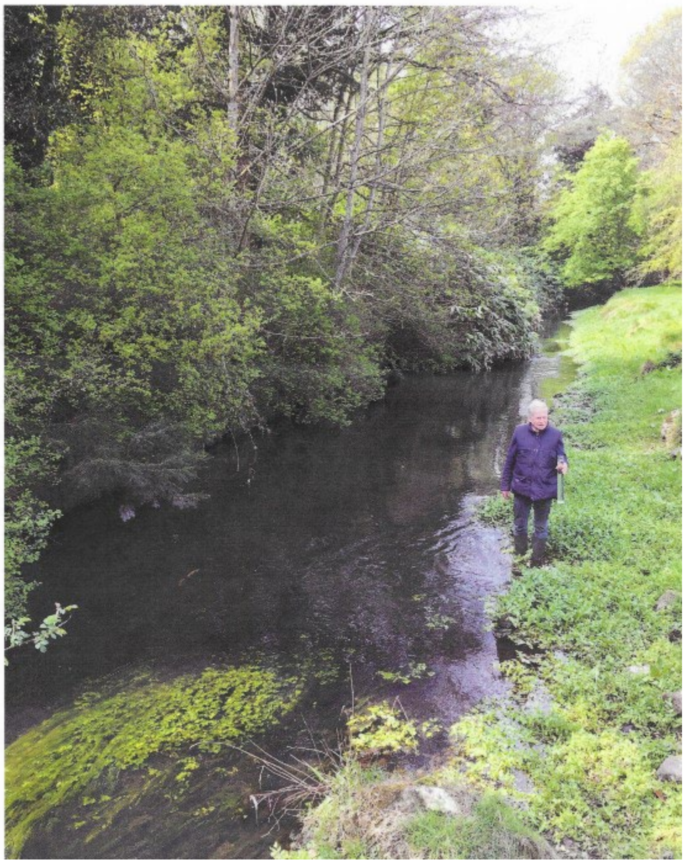
Water pollution from nitrates and phosphates can come from several sources but mostly from domestic sewage inputs in the form of phosphates, and runoff from fertilised farmlands in the form of nitrates. Where nutrients are present in large amounts, 'eutrophication' can occur leading to an increase in the presence of algae and a reduction in the amount of oxygen in the water available for aquatic species. Turbidity, or cloudiness of the water, is checked for as particles present may have an effect on its quality. Observational data was also collected to complement the analytical data, such as: the presence of plants and animals to establish the health of the local ecosystem; land use around the sample site which may impact the waterway and contribute to nutrient pollution; and any signs of pollution being discharged from the surrounding area.

The equipment used to monitor water quality was the FreshWater Watch kit which comprised: instructions, nitrate testing tubes, phosphate testing tubes, sample cup for the tests, nitrate and phosphate colour charts, Secchi tube and disposable gloves. The nitrate and phosphate test kits consist of transparent plastic tubes, in which citizen scientists mixed a specific amount of unfiltered water from the sampling cups with pre-measured reagents in the tubes that produced increasing colour values with increasing concentration. The colour change in the sample tube was compared visually to nitrate and phosphate colour charts which gave a range within which the result fell.

The Secchi tube was filled with water from the sample location, and turbidity was determined by the depth at which the black and white disc at the bottom of the tube was visible. This depth is read on the side of the tube. A form on the ArcGIS Survey123 App was used to collect data. DCU Water Institute carried out analytical validation studies to ensure that the kits used record the nutrient values correctly. After data collection, the data was cleaned to ensure that the sample locations were correct, and to check for any other anomalies in the data.

As much as was possible, participants collected data from their chosen location during the same week each month over a period of time chosen by DCU Water Institute. This facilitated some comparison of weather conditions over the period of the study.

The Nore at Knockanoran Wood, Durrow, Co. Laois (Source: Mary Donohue).



Above: Tributary to the Gloreen (or Ballyroan) stream at Banny's Bridge, Ballyroan, Co. Laois (Source: Paula Byrne). Right: River Gully at Moyne, Durrow, Co. Laois (Source: Hubert Hamilton).

The Nore at Tallyho Bridge near Durrow, Co. Laois (Source: Richard White).

Left: The Mountrath river at Mountrath playground (Source: Jayne Telford). Right: The Nore at Dunmore Wood, Durrow, Co. Laois (Source: Angela Walsh).

4.0 Centennial Findings

4.1 Data collected

In total 140 datasets were collected by 22 citizen scientists over the 7-month period of the Centennial project, with the overall results for nitrates and phosphates illustrated in Fig.1.

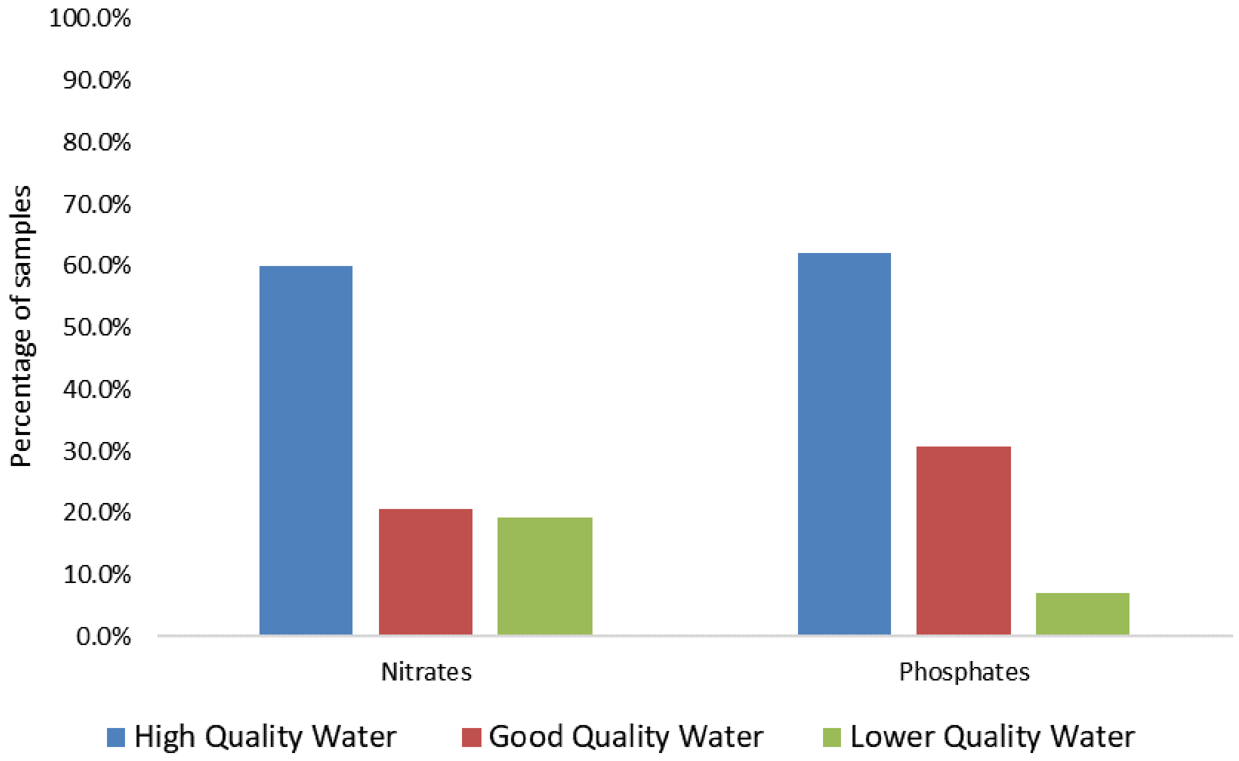


Figure 1. Levels of nitrates and phosphates recorded in all data during the Centennial project.

The categories used for high, good and lower quality water are based on the criteria used by the EPA for categorising these nutrient levels. For nitrates (measured as nitrate-nitrogen), high quality is <0.9 mg/l NO_3-N, good quality is <1.8 mg/l NO_3-N, and lower quality is >1.8 mg/l NO_3-N. For phosphates (measured as orthophosphate as phosphorous) high quality is <0.025 mg/l PO_4-P, good quality is <0.035 mg/l PO_4-P, and lower quality is >0.035 mg/l PO_4-P. How this translates to the ranges used by Freshwater Watch is shown in Table 3 below.

Table 3: Ranges used for graphs in this report.

	Lower quality water	Good quality water	High quality water
Phosphates (PO_4-P, mg/l)	0.05–0.1 0.1–0.2 0.2–0.5 0.5–1	0.02–0.05	0–0.02
Nitrates (NO_3-N, mg/l)	2–5 5–10	1–2	0–0.2 0.2–0.5 0.5–1.0

From the data gathered during the course of the project, it was found that 81% of all samples taken had high or good quality water when tested for nitrates, while this figure for phosphates was 93%. Therefore 19% of all samples had lower quality water when tested for nitrates, and 7% had lower quality water when tested for phosphates.

The nitrate results and ranges across the 27 locations are depicted in Fig. 2 below.

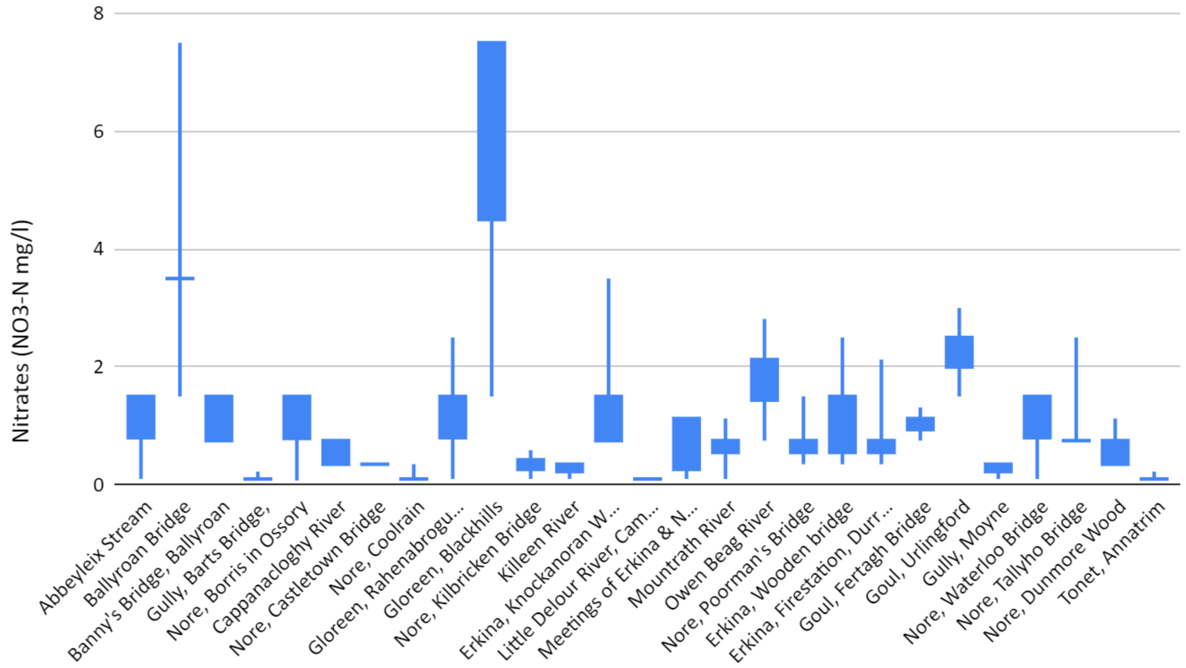


Figure 2. Nitrate results and ranges from 140 samples at 27 locations used in the Centennial Project. Nitrate results ranged from <0.2 mg/l to 5-10 mg/l.

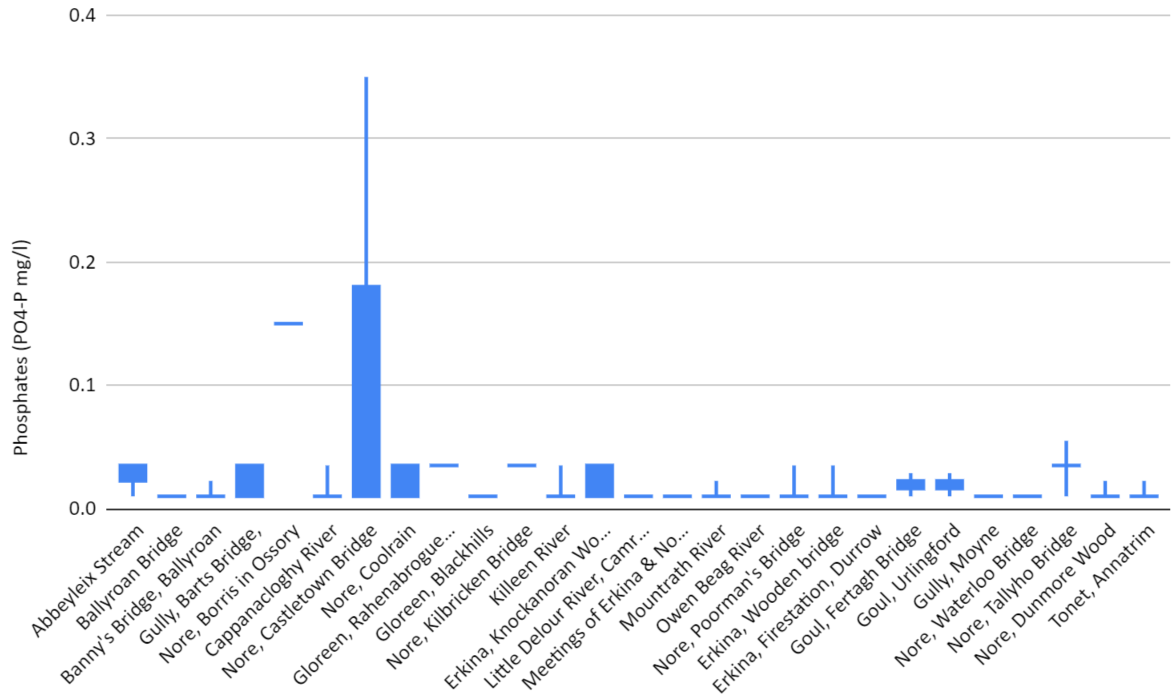


Figure 3. Phosphate results and ranges from 140 samples at 27 locations used in the Centennial Project. Phosphate results ranged from <0.02 mg/l to 0.2-0.5 mg/l.

4.2 Data representation

The maps shown in Figs. 4 and 5 identify the sampling locations across the upper Nore catchment with the median nitrate and phosphate results. The median is the middle value from the dataset collected at each location. From the results it is apparent that the nitrate levels are lower in the tributaries and main body of the upper section of the Nore, and these levels increase as it winds its way seaward through the lower catchment.

In Fig. 6, the Corine Land Cover Dataset (2018) depicts land use across the upper Centennial study area which is predominantly peatland and forest; this appears on the map as blue and bright green/dark green respectively.

Across the remainder of the study area land use is predominantly agricultural which is represented on the map as pale green/yellow. This dataset ties in with land use recorded by citizen scientists at their sampling locations as seen in Fig. 7 which is 58% agricultural and 14% grassland/shrub. Urban and industrial areas are shown in red/purple.

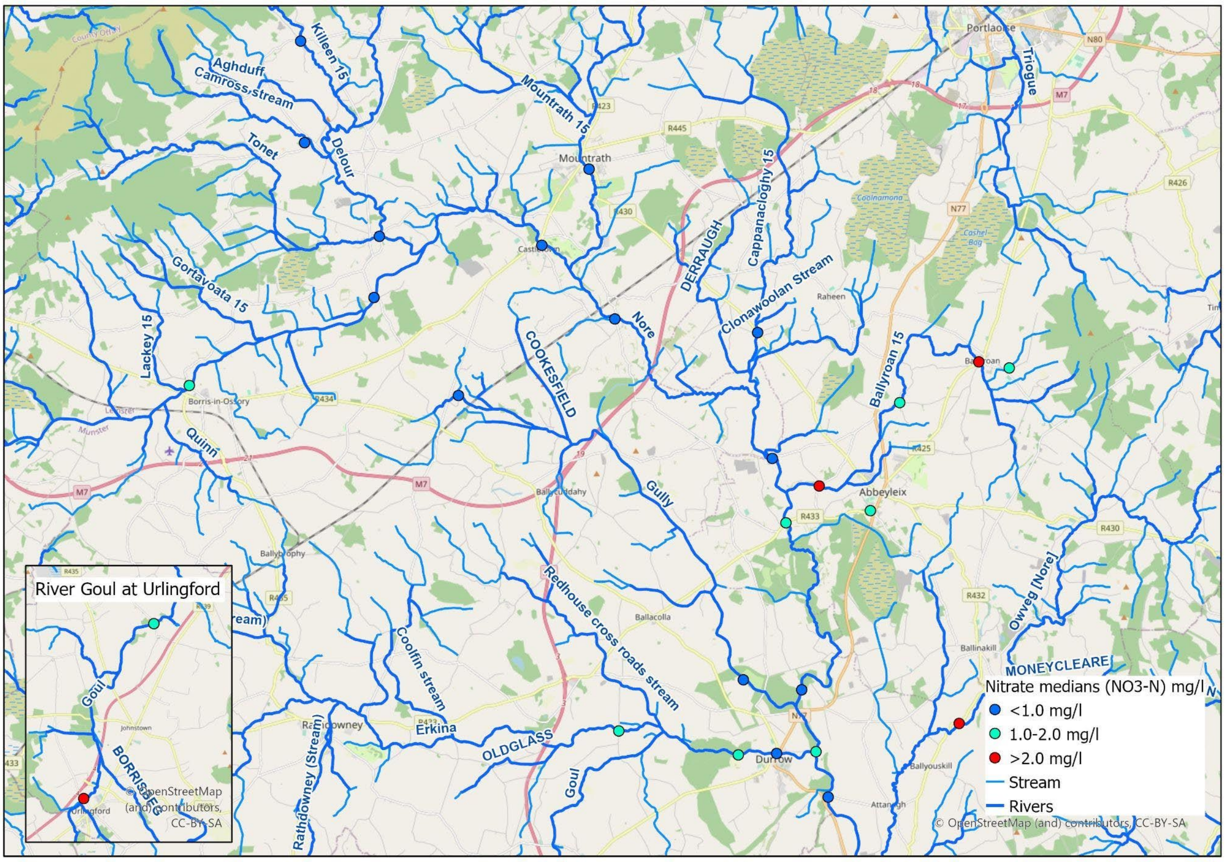


Figure 4. Map with the medians of nitrate results collected at each sampling location (140 datasets at 27 locations).

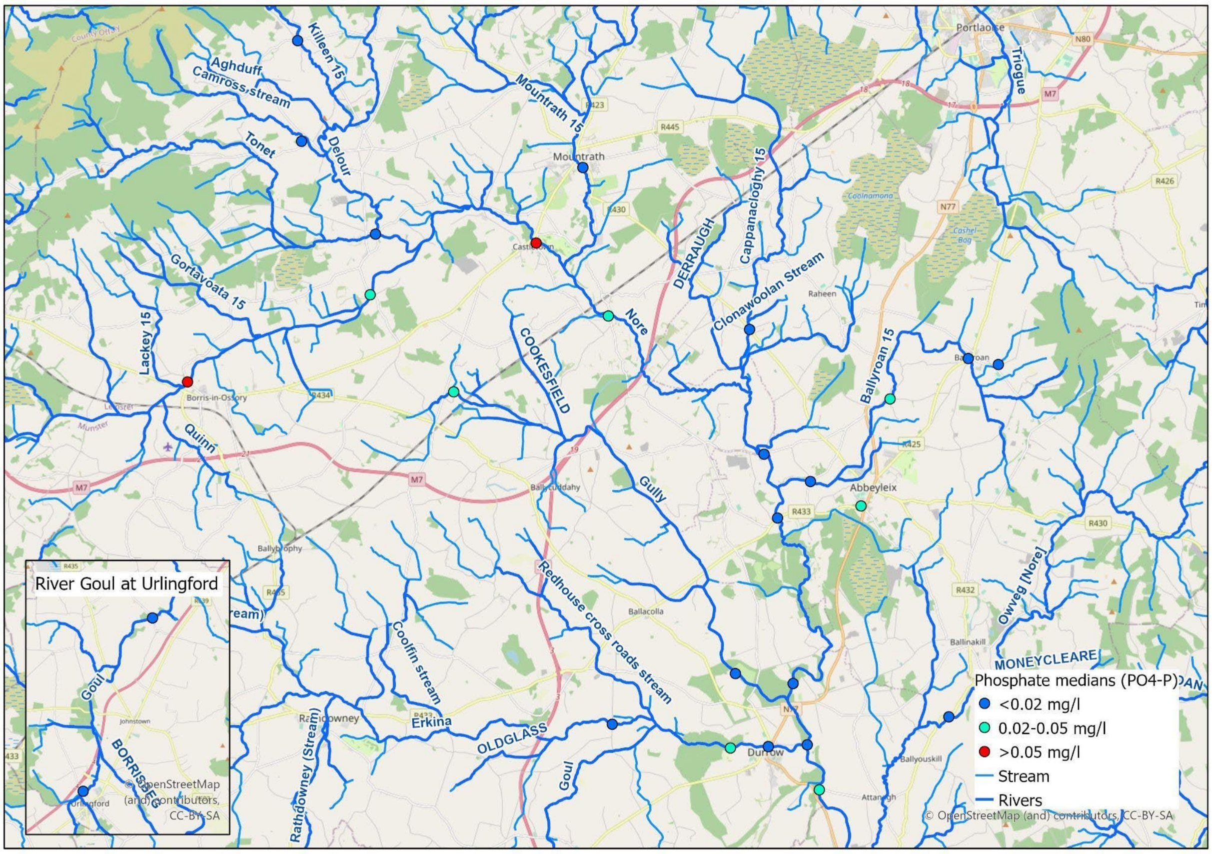


Figure 5. Map with the medians of phosphate results collected at each sampling location (140 datasets at 27 locations).

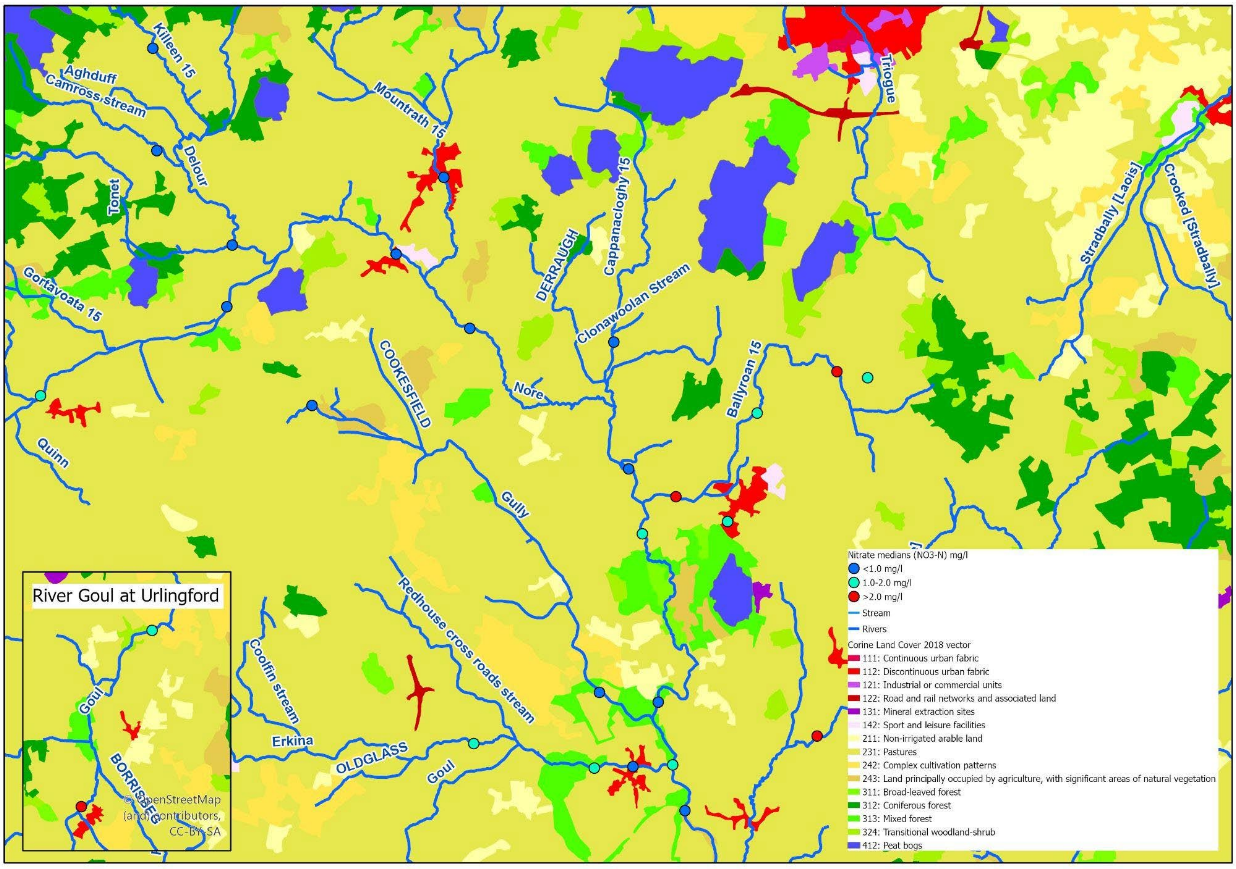


Figure 6. Corine Land Cover Dataset (2018) applied to Centennial study area.

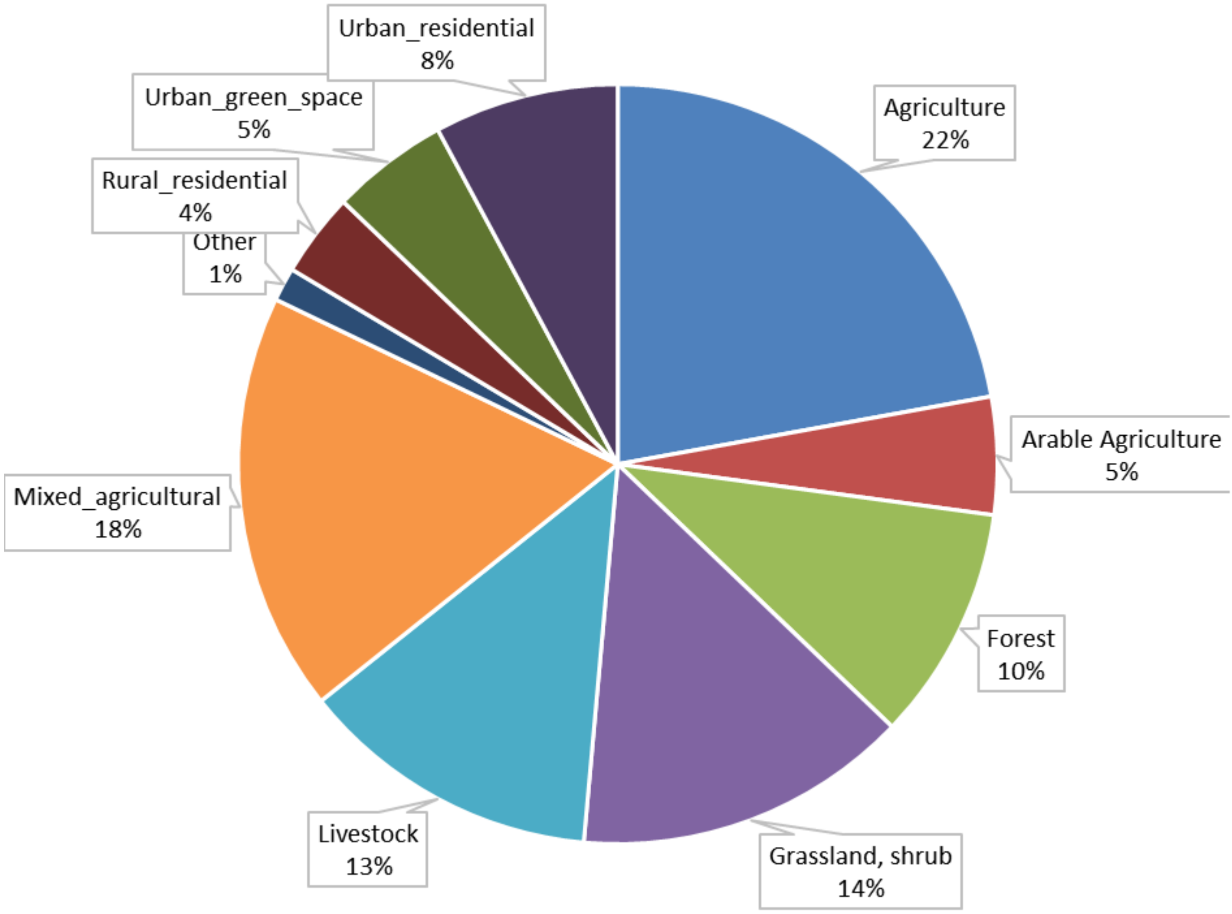


Figure 7. Land use recorded at sampling locations during the Centennial project.

4.3 Data Interpretation

Where elevated nitrate results were found, there may be a link with bridge construction in Ballyroan during the project causing sediment in the water to which nutrients could have become attached. However, nitrate results at this location were consistently in the range for low quality water which corresponds with several recorded Environmental Protection Agency (EPA) results of 5 mg/l further downstream during 2022.

The sample point at the river Gloreen, Blackhills, was downstream of Ballyroan Wastewater Treatment Plant and had cattle access. This location also had elevated nitrate results. It was found to regularly have nitrate levels of 5-6 mg/l when tested by the EPA at the same location up to and during the project period.

There are EPA monitoring stations at 14 of the 27 Centennial sampling locations. The range of their nitrate results during 2022 corresponded very closely to that of the Centennial citizen scientists' nitrate ranges in 12 of these locations. At 10 of the EPA stations, the phosphate ranges corresponded very closely to that of the Centennial phosphate ranges.

These results illustrate that citizen science data gathered by project participants can detect similar nutrient levels to the data collected by the EPA, and also on a more comprehensive basis over a particular period of time. This could be very useful in detecting temporal trends in nutrient levels, in specific locations chosen by citizen scientists.

Phosphate results were good overall and mainly fell into the high quality and good quality- water categories with the slightly elevated values of good quality water at centres of population which may result from urban run-off.

5.0 Observational Data

5.1 Biodiversity

Data uploaded to the ArcGIS Survey 123 App by the citizen scientists demonstrated the biodiversity of the River Nore ecosystem. Numerous sightings were recorded of various bird species such as swallows, swans, dippers and herons. Fish were observed, and insects mentioned included dragonflies, damselflies and pond skaters. Plant species included willow, rosebay, willowherb and blackberry. Participants also observed trees and vegetation cut down over the course of the study as they returned to the same location each month.

5.2 Invasive species

One of NRCT's goals is to identify instances of invasive species which are problematic on stretches of the Nore. These include Himalayan Balsam, Giant Hogweed and Japanese Knotweed, which can disrupt local ecosystems and threaten native biodiversity. Citizen scientists checked for these at sampling sites. During the course of the project Giant Hogweed was spotted at one location. This was reported to the local authority and appropriate action was taken to remove it, showing the impact of this type of project. Bamboo was also observed which may have spread from gardens. While kayaking along the main stretch of the Nore being investigated, another citizen scientist reported the presence of Japanese Knotweed, Himalayan Balsam, Cherry Laurel and Chilean Rhubarb along the route.

5.3 Pollution Sources

According to citizen scientists, litter was present at 24% of the 140 dataset collections. Pollution sources recorded at sampling points included residential discharge, urban road run-off, bridge construction, agricultural run-off, land drainage pipes, polluting agricultural practices and animal access to rivers.

5.4 Seasonal changes

Over the course of the project, participants observed the water level and flow of their waterbodies and recorded this information in the ArcGIS Survey123 App. This data was estimated based on regular observations and comparisons of the same sampling location. As the project progressed from spring to summer to autumn, the citizen scientists' data showed a decrease in water level and flow during the drought of summer 2022, with a subsequent increase in autumn. Photographs taken by participants also provide observational records of the river changes, and of the seasonal changes in plant biodiversity, as at the River Gloreen in the photos below.

Seasonal changes on the River Nore at Poorman's Bridge, near Abbeyleix, Co. Laois, in March and July 2022. (Source: Tadhg Carroll)

6. Conclusion

This project was established to carry out research on water quality in collaboration with citizen scientists and supported by Rethink Ireland and Earthwatch Europe. The aim of the project was to investigate temporally and spatially, where stressed areas in the upper Nore catchment arose, and to do this through a co-created project with a local community. Through local knowledge in the choice of sampling sites, and a group of citizen scientists collecting data while working with academics to understand this section of the catchment, lengths of the streams and rivers which should be prioritised have been identified. These include the Ballyroan stream, where increased turbidity and higher nitrate levels were recorded due to nearby works.

The local community were particularly interested in mapping the occurrence of invasive species, as this is a threat to the biodiversity of the rivers and streams of the area. Action was taken by the local authority when giant hogweed was recorded to the south of Ballyroan as part of this project.

In the Centennial Project, citizen scientists were fully trained and equipped to collect water samples on their local waterways using a water testing kit and app in line with the Citizen Science Framework. They tested water quality and captured information on the surrounding environment, enhancing their knowledge on source to sea challenges. Monthly workshops and support were provided by the Citizen Science Officer in DCU.

The information gathered was disseminated in easy to read infographics and maps. This data was shared with all environmental stakeholders and disseminated across relevant social media platforms. The 22 citizen scientists who engaged with the Centennial Project had the knowledge to understand water testing data and cascade their learnings within their communities for the longer term.

Key findings:

- Nitrate levels generally increase as the Nore moves from source to sea, with lower levels in the upper catchment which has a predominantly peatland/forest land use. Higher nitrate levels were found in the lower catchment which has a predominantly agricultural land use.
- There were particular instances of nitrate pollution which may have been due to bridge construction and animal access at sample locations.

- Phosphate levels were slightly elevated at centres of population which may have resulted from urban run-off.
- Data gathered by citizen scientists was found to contain similar levels of nutrients to data gathered by the EPA where Centennial sample locations and EPA monitoring stations were co-located.

River Nore at the Canoe Club, Durrow, Co. Laois. (Source Mary Connell)

Word cloud generated from sampling locations.

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Left: River Erkina at The Meetings, Durrow, Co. Laois (Source: Emer O' Brien), and right, Cappanacloghy River, Cromoge, Co Laois (Source: Fergal Cushen).

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Sampling at the Nore, Kilbricken Bridge, Co. Laois. (Source: Avril Williams)

River Erkina, Wooden Bridge, Ballybodin, Co. Laois (Source: Mary Bryan).

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