Report No.364

epaResearch
Climate - Water - Sustainability
Identifying pressures • Informing policy • Developing solutions

Learning from Group Water Schemes: Community Infrastructures for Sustainable Development

Authors: Patrick Bresnihan, Arielle Hesse and James Merricks White

www.epa.ie

Rialtas na hÉireann
Government of Ireland

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. We are committed to protecting people and the environment from the harmful effects of radiation and pollution.

The work of the EPA can be divided into three main areas:

Regulation: *We implement effective regulation and environmental compliance systems to deliver good environmental outcomes and target those who don't comply.*

Knowledge: *We provide high quality, targeted and timely environmental data, information and assessment to inform decision making at all levels.*

Advocacy: *We work with others to advocate for a clean, productive and well protected environment and for sustainable environmental behaviour.*

Our Responsibilities

Licensing

We regulate the following activities so that they do not endanger human health or harm the environment:

- waste facilities *(e.g. landfills, incinerators, waste transfer stations)*;
- large scale industrial activities (*e.g. pharmaceutical, cement manufacturing, power plants)*;
- intensive agriculture *(e.g. pigs, poultry)*;
- the contained use and controlled release of Genetically Modified Organisms *(GMOs)*;
- sources of ionising radiation *(e.g. x-ray and radiotherapy equipment, industrial sources)*;
- large petrol storage facilities;
- waste water discharges;
- dumping at sea activities.

National Environmental Enforcement

- Conducting an annual programme of audits and inspections of EPA licensed facilities.
- Overseeing local authorities' environmental protection responsibilities.
- Supervising the supply of drinking water by public water suppliers.
- Working with local authorities and other agencies to tackle environmental crime by co-ordinating a national enforcement network, targeting offenders and overseeing remediation.
- Enforcing Regulations such as Waste Electrical and Electronic Equipment (WEEE), Restriction of Hazardous Substances (RoHS) and substances that deplete the ozone layer.
- Prosecuting those who flout environmental law and damage the environment.

Water Management

- Monitoring and reporting on the quality of rivers, lakes, transitional and coastal waters of Ireland and groundwaters; measuring water levels and river flows.
- National coordination and oversight of the Water Framework Directive.
- Monitoring and reporting on Bathing Water Quality.

Monitoring, Analysing and Reporting on the Environment

- Monitoring air quality and implementing the EU Clean Air for Europe (CAFÉ) Directive.
- Independent reporting to inform decision making by national and local government *(e.g. periodic reporting on the State of Ireland's Environment and Indicator Reports)*.

Regulating Ireland's Greenhouse Gas Emissions

- Preparing Ireland's greenhouse gas inventories and projections.
- Implementing the Emissions Trading Directive, for over 100 of the largest producers of carbon dioxide in Ireland.

Environmental Research and Development

- Funding environmental research to identify pressures, inform policy and provide solutions in the areas of climate, water and sustainability.

Strategic Environmental Assessment

- Assessing the impact of proposed plans and programmes on the Irish environment *(e.g. major development plans)*.

Radiological Protection

- Monitoring radiation levels, assessing exposure of people in Ireland to ionising radiation.
- Assisting in developing national plans for emergencies arising from nuclear accidents.
- Monitoring developments abroad relating to nuclear installations and radiological safety.
- Providing, or overseeing the provision of, specialist radiation protection services.

Guidance, Accessible Information and Education

- Providing advice and guidance to industry and the public on environmental and radiological protection topics.
- Providing timely and easily accessible environmental information to encourage public participation in environmental decision-making *(e.g. My Local Environment, Radon Maps)*.
- Advising Government on matters relating to radiological safety and emergency response.
- Developing a National Hazardous Waste Management Plan to prevent and manage hazardous waste.

Awareness Raising and Behavioural Change

- Generating greater environmental awareness and influencing positive behavioural change by supporting businesses, communities and householders to become more resource efficient.
- Promoting radon testing in homes and workplaces and encouraging remediation where necessary.

Management and structure of the EPA

The EPA is managed by a full time Board, consisting of a Director General and five Directors. The work is carried out across five Offices:

- Office of Environmental Sustainability
- Office of Environmental Enforcement
- Office of Evidence and Assessment
- Office of Radiation Protection and Environmental Monitoring
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet regularly to discuss issues of concern and provide advice to the Board.

EPA RESEARCH PROGRAMME 2014–2020

Learning from Group Water Schemes: Community Infrastructures for Sustainable Development

(2017-W-MS-27)

EPA Research Report

Prepared for the Environmental Protection Agency

by

Maynooth University

Authors:

Patrick Bresnihan, Arielle Hesse and James Merricks White

ENVIRONMENTAL PROTECTION AGENCY
An Ghníomhaireacht um Chaomhnú Comhshaoil
PO Box 3000, Johnstown Castle, Co. Wexford, Ireland

Telephone: +353 53 916 0600 Fax: +353 53 916 0699
Email: info@epa.ie Website: www.epa.ie

ACKNOWLEDGEMENTS

This report is published as part of the EPA Research Programme 2014–2020. The EPA Research Programme is a Government of Ireland initiative funded by the Department of the Environment, Climate and Communications. It is administered by the Environmental Protection Agency, which has the statutory function of co-ordinating and promoting environmental research. The research for this report also benefited from Irish Research Council funding.

This project would not have been possible without the participation, generosity and openness of the individuals who shared their expertise and gave of their time freely. We are particularly indebted to Barry Deane, Brian Mac Domhnaill, Sean Clerkin and Patrick McCabe of the National Federation of Group Water Schemes for their support. Special thanks to the members of the Corracreigh, Lough Carra, Mid Roscommon, Oran Ballintubber, Peake Mantua, Polecat Springs, Robeen and Stranooden Group Water Schemes, as well as to all of those involved in the Lough Carra Catchment Association. We also want to acknowledge the ongoing engagement and help provided by the EPA, the Geological Survey of Ireland, the Local Authorities Water Programme officers and county council officials in Mayo, Roscommon and Monaghan. The authors would also like to thank the members of the project steering committee for their important advice and guidance over the duration of the project, namely Dorothy Stewart (EPA), Monica Lee (Geological Society of Ireland), Barry Deane (National Federation of Group Water Schemes) and Cecilia Hegarty (Research Project Manager on behalf of EPA Research).

DISCLAIMER

This report is based on research carried out from April 2017 to September 2019. More recent data may have become available since the research was completed.

The EPA Research Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

EPA RESEARCH PROGRAMME 2014–2020
Published by the Environmental Protection Agency, Ireland

ISBN: 978-1-84095-972-7 January 2021

Price: Free Online version

Project Partners

Dr Patrick Bresnihan
Department of Geography
Maynooth University
Maynooth
Ireland
Email: patrick.bresnihan@mu.ie

Dr Arielle Hesse
Department of Sociology
Drexel University
Philadelphia, PA
USA
Email: alh464@drexel.edu

Dr James Merricks White
School of Humanities, Education and Social Sciences
Örebro University
Örebro
Sweden
Email: james.white@oru.se

Contents

List of Figures

List of Tables

List of Boxes

Executive Summary

The most recent Environmental Protection Agency report on water quality (EPA, 2019) identified declines in many of our freshwater sources over the period 2013–2018. These declines are mainly attributable to high levels of agricultural run-off, on-site domestic wastewater treatment and inadequate urban wastewater treatment. The decline in quality of freshwater sources affects, in turn, the quality and affordability of Ireland's drinking water services.

Ireland's water infrastructure requires significant upgrades and extensions if it is to continue to provide safe, affordable drinking water to the population and avoid direct and indirect financial penalties from the European Commission. The 2013 reform of the Irish public water sector sought to address this through the establishment of a single, national water utility and the introduction of domestic metering and charges. In the face of public opposition, however, water charges have been suspended, and the future challenges for Irish Water are significant. As well as being a national priority, ensuring access to safe and affordable water and the sustainable use of freshwater systems are two of the United Nations Sustainable Development Goals (SDGs).

In the context of national and international debates around the future of water resources and provisioning, the experience and performance of Ireland's group water sector provides valuable insights and lessons. The WISDOM project examined the contexts and relationships that shape how community-managed water suppliers deliver clean drinking water to rural parts of Ireland as well as engage in source protection efforts. The project also provides recommendations on community participation and public engagement in environmental governance in Ireland that will have application beyond the rural water sector.

Over the past 20 years, the group water scheme sector has transformed itself by successfully addressing problems with water quality and leakage, in many respects outperforming the public sector (SDG 6). Three factors have contributed to this. First, in an era of infrastructural failure, when innovation is usually taken to mean disruption, group water schemes demonstrate the importance of taking the time to maintain community, the environment and technology. This work has been and must continue to be recognised and remunerated through public funding. Second, group water schemes are adopting and adapting to standardised regulations and technologies, successfully shaping their design and adapting their implementation to fit local needs and demands. Third, group water schemes, facilitated and represented by the National Federation of Group Water Schemes, have developed responsive forms of governance, which enable them to account for social differences and needs, as well as changing regulatory, environmental and financial demands.

The group water sector has also been active in the protection of freshwater sources (SDG 15). Through the leadership of the National Federation of Group Water Schemes, the sector has been progressive in terms of seeking to position source water as part of, rather than separate from, physical water infrastructure. Through our focus on three source water protection projects in Counties Mayo, Monaghan and Roscommon, we demonstrate the extent and value of local expertise regarding the connections between local environmental change, national and European policy, land use change, farming practice and economic pressures. This knowledge should be understood as a different form of expertise that can work with established scientific methods to generate more rigorous and critical insights into water-related issues. Finally, we show that source water protection is a complex and contentious area of water governance, as the protection of common goods can come into conflict with private interests relating to land use and farming. There is a contradiction, and inequity, in pursuing agricultural policies that benefit a minority of farmers while the environmental consequences of these policies are left to the rest of the community, including smaller, part-time farmers, to resolve.

1 Introduction and Approach

1.1 Background

Inadequate drinking water – an issue of both water quality and water quantity – presents a public health imperative requiring comprehensive action. Recognising that many people lack access to clean drinking water, the United Nations Sustainable Development Goal 6 (UN SDG 6), clean water and sanitation, has several aims, including to enhance the work of local communities in water and sanitation management. Our project seeks to understand the contexts and relationships that shape how community-managed water suppliers deliver clean drinking water to rural parts of Ireland.

Water scarcity and water quality are issues that cut across different contexts. While our project is focused in Ireland, the challenges of addressing clean water and sanitation are vast and varied. Attention to clean water and sanitation has often centred on challenges in the Global South, where basic water infrastructure may be absent and many face life-threatening disease arising from their waters' quality. The Organisation for Economic Co-operation and Development (OECD) projects that, by 2050, over 40% of the world's population will be living in a water-stressed area, with over 240 million people lacking access to an improved water source (OECD, 2015). In addition, agricultural demand for water will increase, and this sector is highlighted as an issue in terms of source water protection and land use policy and diffuse pollution. Yet, increasingly, contamination events and water shortages in the Global North have revealed fissures, oversights and contradictions in drinking water systems, highlighting them as a point of research and intervention. Upgrading water infrastructures is a key element of this work.

However, challenges to providing clean drinking water in Ireland, as in other places, are a question not just of water availability and its adequate treatment but also of the legacies of infrastructural (under)investment, economic policies and the contradictions that exist between growth-led development and sustainable water systems. Water has become a repository of many of our tiniest wastes: traces of our body wash, fake tans and pharmaceuticals mix with residues from agricultural pesticides and fertilisers. As these artefacts accumulate and mutate over decades, they pose new and expanding challenges to the provision of clean drinking water. Thus, addressing SDG 6 requires that we look beyond just our physical water infrastructures to the social, political, economic and ecological processes that pollute our freshwater systems. This aligns with the concerns of SDG 15, the sustainable use of freshwater systems. The WISDOM project unravels such connections by focusing on source water protection undertaken by group water schemes (GWSs).

Aided by state incentives and financial supports, GWSs developed through local cooperatives and voluntary labour in the 1960s and 1970s in response to the lack of piped water supplies in rural areas in Ireland. After Ireland joined the European Economic Community (EEC) in 1972, piped water enabled the expansion of animal-based agriculture as dairy and beef production became industrialised; more water facilitated larger and more productive herds. In the 1990s, however, many GWSs were failing water quality standards. With pressure from the European Union (EU), the Irish government provided support to GWSs to upgrade and rationalise their operations to improve water quality by developing new water treatment facilities. Through these projects, however, it became clear that water treatment is not the only issue; source water quality affects the cost of water treatment. Under the direction of its national representative body, the National Federation of Group Water Schemes (NFGWS), in the last 15 years, many GWSs have been involved in research to understand and remediate the pollution in their water sources.

The complexities of source water issues – and why geographers are well positioned to examine them – have become clear as the project has advanced. Source water protection is a question of geology, and different geological landscapes present different challenges for understanding groundwater sources. Source water protection is a question of boundaries; often polluters within a catchment for a GWS are not themselves supplied by the GWS and lack incentives to undertake voluntary measures to reduce pollution.

Source water protection is a question of land use policy and practice; intensive and animal-based agriculture is found to be unequivocally the source of certain kinds of pollution, yet the diffuse nature of this pollution and the difficulties of assigning responsibility make it difficult to manage. Some of the GWS landscapes we have visited look peaceful and still, a calmness that masks policies, ecologies and geologies that shape the quality of source waters and that have facilitated agricultural pollution over decades.

As we outline below, the past 20 years have seen the most dramatic changes in the rural water sector. The sector has collectively faced new regulatory and monitoring requirements, challenges from contamination and leakage, infrastructural disrepair and the restructuring of the public water sector into a semi-state utility. These changes have coincided with significant urban development, the intensification of agriculture in certain areas, the economic recession, demographic changes and new and more frequent extreme weather events across Ireland.

This WISDOM project set out to better understand the history and development of the rural water sector in the context of these complex and interlinked processes of social, political, economic and environmental change in Ireland. As human geographers, the researchers on this project have been trained to apply interdisciplinary perspectives to complex phenomena. The value of an interdisciplinary approach for better understanding and responding to the UN SDGs is widely recognised. As efforts to raise awareness of "source to tap" attest, water by its nature connects disparate spaces, people and activities in dynamic and unequal ways. To describe and critically assess these connections requires more contextual and interdisciplinary approaches to water and water governance.

However, although an integrated and interdisciplinary approach to water governance and catchment management is positively encouraged and promoted, it is not always clear what this means, how it might challenge existing approaches to scientific monitoring and assessment, and to what extent it takes place. Although this project focuses on GWSs within the context of the UN SDGs, the approach we have taken and developed can be of more general use to researchers seeking to work across disciplinary silos and to meaningfully incorporate the diverse forms of expertise that exist outside professional scientific fields and institutions. Thus, an overarching goal of this project is to develop and demonstrate the value of interdisciplinary, situated approaches to research that are not additive but synthetic, and do not reinforce hierarchies of knowledge but translate between different forms of expertise. Our research begins from a commitment to the plurality, partiality and incompleteness of knowledge (Nightingale, 2016). What stems from this commitment is not a weakening of scientific rigour, but a more meaningful, critical account of specific phenomena within their wider social, political, economic and environmental contexts (see Box 1.1).

This approach involves a critical openness to different ways of knowing the world. Although this may sound abstract, it is something that arose again and again throughout our research project. By interviewing and engaging with a wide range of individuals and organisations involved in the rural water sector and source water protection, it was evident that there were different relationships, perspectives and concerns relating to the same thing (e.g. a lake, infrastructure, farming). More significant was that these differences were recognised by many of those involved in the rural water sector and catchment management. Through frequent, often informal, interactions, individuals from different organisations, places and backgrounds found ways of sharing their insights and knowledge. The reverse, however, was also evident: the frustration that individuals and groups felt in not having their experience and expertise heard or taken seriously, particularly at an institutional level.

Catchment management is intrinsically related to the geographies and development (or underdevelopment) of urban wastewater treatment, domestic wastewater, agricultural policy and enforcement of agricultural regulations, water abstraction, and drinking water, among many other water use issues. The relationship and complexity of these issues are laid out in the Second River Basin Management Plan (RBMP). There is clearly a desire for engaged, interdisciplinary approaches to water governance. At the same time, what is currently practised in this area tends to rely on individuals developing informal connections and interactions with people and organisations, or on the expectation that integrated understanding and shared knowledge will arise naturally if information and data are simply made available. However, a rich body of

Box 1.1. Geographies of catchment data

In Ireland, integrated catchment management (ICM) is a dominant approach to water management. ICM manages water by integrating ecological factors with social, political and economic ones to understand what affects water quality within a "catchment" (an area from which water flows into a water body). Data problems, however, can limit the extent of this approach. When we explored publicly available data on economic and social factors that affect water quality to better contextualise the catchments in our field sites, we found it trickier than we had anticipated to draw meaningful conclusions.

1. Boundaries do not align

The first problem we encountered is that it is difficult to make the data speak to each other. This issue is rooted in boundaries that do not line up. Political, social and economic data are often available by county, but often county lines do not match up with catchment boundaries.

2. Regional units and drivers of pollution

Another issue is the aggregation of data into higher order spatial units. Although counties are a commonly used boundary, certain data types are only made available at the regional level. This is the case for the data the Central Statistics Office (CSO) provides regarding one important source of water pollution: agricultural activities.

3. Units and boundaries change over time

When boundaries used for data collection periodically change (as a result of changes in population, etc.), the CSO revises older data to ensure comparability across time. However, some of the data from much older datasets are not easily made compatible. By not being able to make comparisons across time, it can be more difficult to trace the drivers of pollution and their impacts on water quality.

4. Politics and multiple spatial units in water management

There are many other boundaries at play in water management; these can change over time. The Water Framework Directive (WFD) introduced river basin districts (RBDs) as expansive spatial units to manage water resources. However, the RBDs introduced under the First RBMP (2009–2014) were significantly changed under the Second RBMP (2018–2021).

Trying to understand what has been going on in the catchment from the data that have been collected over decades requires an understanding of the relationship between these different geographies, the data available according to these geographies, and their limitations. Significantly, approaching catchment management in a more integrated way requires reconsidering how we gather and produce data, and the boundaries and geographies we use to do that. Moreover, however imperfect, statistical data still offer only one way of understanding catchments. How people experience catchments by living and working in them are geographies that our fieldwork seeks to draw out and which elicit more textured and layered understandings of what is going on in a catchment than the partial stories other data present.

For an interactive, visual mapping of this argument and other maps, go to: https://webrecorder.io/MULibWeb/waterschemes/20200515140307/http://waterschemes.ie/category/maps/

literature and methodological approaches that have been developed since the 1980s demonstrate just how challenging it can be to bring together different forms of expertise, including "local" knowledge. To create the conditions for engaged, interdisciplinary research requires creative methods and resources, including time. Here we focus on two aspects of our own approach to interdisciplinary and situated research that we developed during this project.

1.2 Interdisciplinary Research

Although there is widespread recognition that environmental change involves the intersection of natural processes with social processes and activities, there continues to be a strong division between how and by whom these "natural" and "social" processes are studied and analysed. This is in large part because of the different training that natural and social scientists receive, and the embedded institutional cultures and professional trajectories that researchers operate within.

Where efforts exist to combine different disciplinary expertise, the approach tends to be additive, that is, a *multidisciplinary* approach that assumes that different methods, data and analysis can simply be added together to create a combined output (Nightingale, 2016). Although this can work in some contexts, what is ignored by this additive approach is that different disciplines and forms of expertise are different precisely because they ask fundamentally different questions about a phenomenon, apply different methods and analyses, and generate findings that are not easily combined or meaningful to each other (Box 1.1).

By starting from a specific goal, e.g. providing clean water in rural Ireland, it quickly becomes apparent that multiple forms of knowledge and expertise are required to provide a substantial account of the factors involved in achieving this goal. It also becomes clear how different ways of knowing focus on certain aspects of this process, while leaving out other aspects. The relationship between drinking water provision and source water protection is a good example of this. Knowledge of these relationships involves some familiarity with water treatment processes, infrastructure and the work carried out by GWS board members, managers and caretakers, as well as some understanding of the physical geography and geology of an area, the chemical and ecological status of the water bodies, and the activities, particularly land use, that happen on the catchment, as well as the historical changes in those activities and land use and how these relate to prevailing policies of agricultural intensification, for example.

As we discuss below, knowledge of a catchment does not end at the spatially determined boundaries of the catchment unit. What happens within a particular catchment, particularly relating to land use and farming practice, cannot easily be separated from policies that are decided outside the catchment unit. Under the current RBMP, catchment assessments do combine different disciplines within the natural sciences (biology, chemistry, ecology) but do not, at least formally, extend to an assessment of these broader political, economic and social changes. Significantly, the source protection work of the NFGWS does account more for these connections and relationships.

1.3 Situated Research and Local Expertise

Calls to incorporate community knowledge in decision-making position local knowledge as an efficient, timely and sustainable complement to scientific knowledge (Metcalfe *et al*., 2015; Singleton, 2000). However, "local" knowledge or "lay" knowledge is often considered as additive and secondary to "scientific" analysis, incorporated only at certain stages of the decision-making process rather than being a key component of how procedures, goals and decisions are designed and pursued. One of the challenges, then, is to fundamentally rethink how knowledge and expertise are described and valued within water governance.

Although not all knowledge is equally valid or objective, it is also true that there exist hierarchies of knowledge that exclude valid and valuable forms of expertise that could support more informed, context-specific assessments of environmental change. Wehn *et al*. (2018) locate this problem in the tendency for water governance to be dominated by scientists and experts who value their own kinds of expertise in decision-making and can undervalue or devalue the very knowledge they purport to include. Governance and management should not be "led" by experts, but, instead, incorporate scientific experts as one kind of expertise among many (McCormick, 2007). Thus, effective public engagement should seek the co-production of knowledge through multiple forms of expertise (Landström *et al*., 2019; Lane *et al*., 2011). It is a challenging shift in emphasis, but one that can be pursued without flattening the greater relevance of some forms of knowledge to certain kinds of issues (Forsyth, 2004).

As we have learnt from our own research, while the knowledge that communities and non-professionals have about their water and catchments is often spoken

about in positive terms, there are few, if any, channels for it to be incorporated into the management process. Where and when it is included is usually determined by management structures and experts. Thus, scientists often set the standards and goals of water governance before local communities are involved and determine where local knowledge would be relevant (Bresnihan and Hesse, 2019).

As with interdisciplinary research, the effort to democratise science beyond professional organisations involves more than adding together different perspectives. It requires a shift in how science is currently produced and used. We are mindful that this shift in approach to expertise is challenging given current assaults on facts and scientific expertise within public discourse. Focusing on shifting what counts as expertise is not about undermining science, but about democratising science such that it might foster better outcomes (Harding, 2000) and lead to greater trust in scientific and institutionally led efforts.

Throughout this research project we have met with many individuals involved in the rural water sector and in source water protection projects who do not have scientific or engineering qualifications or formal training, yet their knowledge of water infrastructures, water quality, land use change and farming practices, ecology, national and European policies, and local politics and culture is extensive and valuable. This is particularly evident within the GWS sector, where individuals involved in managing and maintaining the water network possess expertise in engineering, water chemistry and treatment, farming practices, catchment dynamics, accounting, behaviours relating to water use, and more. This knowledge is not easily classifiable as “local”. Often, the use of “local” to describe the knowledge that non-certified experts possess can diminish its value and role within decision-making. “Local” can equate, dismissively, to “personal” and thus not be taken as seriously as formal scientific expertise, thereby reinforcing the hierarchies of knowledge that exist.

In response to the distinction between “local” and “scientific”, we use the term *situated* to capture the ways in which knowledge can be simultaneously local and scientific (Haraway, 1988). It is clear from our research that those working in a professional, scientific capacity and those without professional qualifications informally share knowledge and insights in ways that challenge any neat distinctions between “local” and “scientific”. We want to make this traffic in knowledge more explicit and visible, which involves formalising how these different forms of knowledge are brought together and translated.

The devaluation of certain forms of local knowledge and expertise not only constitutes a barrier to effective governance and public participation, but is an important missed opportunity to generate more rigorous and critical insights into water-related issues (see Bresnihan and Hesse, 2019). Where local expertise and knowledge have not been integrated in governance and management meaningfully and consistently, low levels of trust and collaboration have been found; in contrast, meaningful engagement and inclusion of local experience have been associated with higher levels of trust, adoption of implementation strategies and meeting environmental targets (Rhoads *et al*., 1999).

The knowledge that people possess about the places where they live and work is not easily categorised or even articulated; it is not information waiting to be included within existing catchment management projects. As with the work involved in interdisciplinary research, engaging with different forms of knowledge requires method and time. And, as with interdisciplinary research, it is often through the identification of a common problem or issue that these different forms of knowledge and experience can be brought to the surface and articulated together (see Box 1.2).

1.4 Methods

Different methods can be used to create the conditions for more interdisciplinary and situated understandings of environmental issues. Table 1.1 provides a brief overview of the established social research methods we used in this project. These methods have not been applied or developed sufficiently in the Irish context and can be an effective means for generating more interdisciplinary and situated understandings of environmental issues, not just those relating to the two UN SDGs focused on here. There is no one-size-fits-all approach to interdisciplinary, situated research. The methods have to be adapted to the specific cases and contexts involved in the research.

Box 1.2. Situated knowledge and local expertise

The below photograph (Figure 1.1) was taken by the manager of a GWS in Roscommon. He took the picture as part of our participatory photography project (see Box 1.3). The picture shows poor slurry-spreading practice – the slurry is clearly dried on top of the soil in a thick layer, and any rainfall would quickly wash away the slurry into a watercourse.

Figure 1.1. Photograph of slurry in a field in County Roscommon.

The photographer is also a part-time farmer, and the photograph is of his own field. He took the photograph deliberately to highlight the difficulties and complexities of protecting water quality and to show why any meaningful solution cannot rely on individual, voluntary behavioural change. After highlighting the risk to water quality of slurry and other agricultural inputs, he discussed the reasons why stopping the practice of slurry spreading is so difficult. First, there is too much slurry, more than the land can take, and this is the result of government policies that have encouraged and facilitated increases in herd size since the 1980s. Second, even though technologies have been designed to reduce methane emissions from slurry spreading, the machines that are used by the contractors are too big, resulting in compaction of the soil, further reducing the capacity of the soil to absorb the slurry. Third, as a part-time farmer, he outsources slurry spreading to someone else. As there is demand for slurry spreading (and baling) in the summer months, the contractor employs seasonal workers, mostly students home from college, to carry out the work. These young, seasonal workers can be less diligent than they should be, eager to get the work done as fast as they can.

Through his interpretation of this image, this individual was able to connect the risks to water quality from slurry spreading with the legacies of agricultural policies, the limits of technological solutions, and the seasonal, rural economy of farming. What is more, he did not shirk from identifying himself as complicit in this story, despite being aware of the problems and being directly affected by their consequences (in terms of the quality of water for the GWS). The ability to understand and connect local environmental change, national and European policy, land use change, farming practice and economic pressures is an example of what we mean by *situated knowledge*. This is an understanding of local water and the factors affecting it that relies on an understanding of non-local processes and drivers, connecting aspects of rural life and economy that might ordinarily be kept apart by the disciplinary silos of institutional science.

The methods outlined in Table 1.1 are commonly used to elicit more in-depth understandings of people's perceptions, experiences and knowledge of the world. Often, measures that are taken to include local knowledge in environmental governance are understood more as a means of "community outreach" or "community engagement", rather than a means of generating substantial and meaningful insights into the issue at hand (e.g. drivers of pollution in a catchment). Interactions between scientific experts

Table 1.1. Qualitative research methods used in this project

Research method	Benefits
Visual and audio recordings	Allow documentation of research, prompt memories of our discussions and observations, and can be used to represent our analysis of the case studies
Catchment tours/walks	Allow for ground truthing and validating models, drawing on local expertise of land use, histories and relationship to place
Participant observation	Allows for in-depth understanding of practices and the relationships between individuals and community and place by sharing in activities (e.g. driving, attending meetings)
Ethnographic research	Allows for contextualised, in-depth accounts of perceptions of environmental impacts and governance efforts
Open-ended interviews	Allow for free-form answers, generating unexpected and important findings relating to changes in environment, land use change and relationships to state agencies
Autophotography	Allows stakeholders to take photographs in response to a prompt. These can situate environmental resource use within existing energy and concerns (see Box 1.3)

and communities often assume a knowledge deficit or the need to "teach" communities because they lack some fundamental information. Situated approaches to research should focus on enabling integrative and translational knowledge exchange and production (Armitage *et al*., 2009; Wehn *et al*., 2018). When conducted in this way, situated research methods thus serve two functions: (1) they can elicit better understandings and knowledge about catchments and water that can be used to inform decision-making; and (2) they can open a space for public and active participation. The methods that we emphasise in this project are specifically chosen because they do not decouple research from engagement and participation (Box 1.3).

For this project, we made multiple visits to each of the three field sites, with the purpose of:

- establishing relationships necessary to push the research to its ultimate aims;
- conducting interviews with relevant individuals and representatives of relevant organisations, including GWSs;
- recording local characteristics and differences among the field sites;
- identifying key issues and areas of concern to refine our data collection and analysis.

This project focuses on a relatively small number of sites (three) in order to gain a more in-depth knowledge of both the histories and development of GWSs, and the challenges of protecting source waters. Refining the focus in this way enables a deeper understanding of how variables such as geology, ecology, agricultural policy and land use change, and institutional politics relate to one another and shape outcomes in relation to the UN SDGs. There are three points worth highlighting in this regard.

By focusing on three sites that were involved in source water protection we were able to use a common problem (i.e. protecting water quality) as a means of learning about how different geological, environmental, land use, cultural and social factors intersect and produce different concerns and challenges for GWSs. It was only by focusing on these three sites that the project was able to draw out more nuanced insights into the differences between them and how these influenced the trajectories of the projects involved.

An essential part of in-depth, social research is time. It is necessary to spend time with people to develop relations of trust, to build rapport and to gain insight into their relationships and their knowledge of the places where they live and work. It is only by spending time with people in these places that the richness of their knowledge can come to the surface. This is a basic principle and motivation for ethnography, a method most often associated with anthropology. Ethnography is of particular benefit when trying to understand the attachments that people have to the places where they live, the work they do, and the communities they are a part of. Ethnographic research can apply to communities of scientists, as much as to a community in rural Ireland.

Representing and communicating the findings of our research on the project website, often in exploratory visual ways, has helped our analysis and has created opportunities for ongoing feedback from our participants. Given the great variety and complexity of

Box 1.3. Visual methods to foster participation and new information

After initial research trips to the field sites, it became apparent that the individuals we were meeting interacted with the water in their catchments in different ways – catchment scientists, caretakers and managers of GWSs, local ecologists, farmers, anglers and local residents who simply enjoyed the beauty of the lake or river. The different interactions these individuals had with the water gave rise to different ways of experiencing, perceiving and knowing the water and the catchment more generally. To better elicit and capture these different ways of knowing the catchment, the project undertook a participatory photography project with funding from the Irish Research Council.

Autophotography is a method in the social sciences that asks research participants to respond to themes or questions through their own vantage point using images taken by a camera. These methods give individuals a way of representing their perspective visually, and can help them form, solidify and share connections to and relationships with places and their communities (Johnsen *et al.,* 2008; Lombard, 2013).

For each autophotography project, we provided a small number of community members with disposable cameras and asked them to take photographs that addressed a prompt about their water. This exercise was successful in getting individuals and communities to think about their relationship to water differently. Through interviews with participants about their photographs, we found that these photos tell stories of wider concerns: stories of place, landscape and identity that often exceed a concern for water. This kind of visual method helps generate new connections between natural resource use and existing forms of care and everyday experience. It also offers individuals a different way to share their expertise from their own vantage points, valuing their differences and unique perspectives. This method helps us build linkages between water and other domains of life that people care about, be it history, health, identity or livelihoods.

After we completed an autophotography pilot project in Monaghan, we were awarded supplementary funding for this project by the Irish Research Council. This funding enabled us to purchase cameras, develop photos, transcribe interviews and organise exhibitions of the photos in all three field sites.

the social, natural and technical relationships that are involved in water infrastructures and source protection, it is important to find ways of bridging personal and professional differences. This is as true within academia, where there is often a divide between the physical and social sciences, as it is outside it, where research can struggle to connect with people and be policy relevant.

We have released 35 photo galleries, which illustrate and publicise what GWSs look like and the areas they are located within. We have released 12 blog posts on a range of topics, including those covered by our desk-based research. Two of our blog posts include interactive maps. The first is a discussion of spatial extents used in Irish spatial data, particularly but not only in water management, and the challenges that these pose to civil servants and scientific researchers (see Box 1.1). The second is a map of Ireland's GWSs using data from the NFGWS. This involved several discussions with NFGWS employees about the accuracy, provenance, collation and manipulation of these data. A third presents an interactive diagram of the Polecat Springs GWS treatment plant as a way of discussing a range of the challenges and issues that schemes encounter, and the forms of knowledge and expertise that are needed to address them. And, finally, we have published four timelines related to the history of GWSs; national and EU-level water policy; the relations between policy and GWS events through time; and national and European agricultural policies beginning in the 1800s.

2 History and Policy Overview

2.1 Documents Consulted

To guide the selection of case studies and methodological approach to field-based research, the desk-based research established a baseline of knowledge about the GWS sector in Ireland. This work can be divided across three time periods in GWS history:

1. a history of GWSs circa 1960s/1970s and the social, economic and political processes that drove their formation;
2. an account of GWSs circa 1990s/2000s and the social, economic, environmental and political processes that drove design–build–operate (DBO) projects, amalgamations and other upgrades, and research on the sector;
3. a contemporary understanding of the problems GWSs face today regarding maintenance, responses to contaminants and conformance to national and EU-level regulations.

Our desk-based research identified the importance of source protection for the future of GWSs and the significance of understanding how source protection is shaped by social, economic and political processes that have long and specific histories within Ireland and within particular localities. Our fieldwork builds on this knowledge to provide grounded accounts of the social, ecological and regulatory issues that complicate source protection within the GWS sector and will provide useful knowledge for the sector in meeting future challenges. This research has involved analysis of several data sources and its preliminary analysis has been documented in several outputs.

The records of the Irish Countrywomen's Association (ICA) and the Turn on the Tap movement, located in the archive of the National Library, provided a look into the early history of the GWS sector. These documents included records from meetings and presentations from the late 1950s until the late 1970s that the ICA and government agencies organised. They provide information on the debates, concerns and pressures surrounding the establishment of GWSs, and the role of rural life, and women, in these efforts.

The NFGWS website is home to extensive historical data on GWSs. It provides a broad overview of the sector and has helped us to understand why the Federation was established, and the kinds of work that it undertakes to educate GWSs and engage with national water policy.

The *Rural Water News* and the annual reports of the NFGWS offer information on the activities undertaken by GWSs over the last 15+ years. These documents provide extensive information about the history of the DBO process, the rationalisation and amalgamation of GWSs, the Federation's policy positions throughout the restructuring of the public water sector and the pilot schemes undertaken by the Federation.

In order to understand the shift to GWS regulatory compliance, we conducted a review of the Environmental Protection Agency (EPA) drinking water reports. This helped us to understand how the sector has responded to drinking water regulations. These documents also helped us to understand the state response to the 2007 outbreak of cryptosporidiosis in Galway and the development of the remedial action list. The research team undertook a targeted policy review to understand important environmental policy and water policy regulations of the last two decades. The websites of the EPA, the Health and Safety Executive (HSE) and the CSO, and the Irish Statute Book, provide primary documents, data, and policy analysis around five key areas: the EU Drinking Water Directive (1998), the EU WFD (2000), the Irish Water Policy Act (2007), the establishment of Irish Water (2013) and land use change and agricultural policy.

2.2 History of Group Water Schemes

When water supplies were first developed, urban areas were the first to receive pipes, and many Victorian-era mains and pipes remain in the public network (Nelson, 2018). Rural areas lacked piped water until the mid- to late 20th century but in many areas were supplied by GWSs rather than the public network. Piped water is supplied in Ireland by the public water supply (83%), private wells and small supplies (11%) and GWSs (6%) (EPA, 2019). Until recently, each of the 34 local

authorities were responsible for public water supplies. The Water Services Acts of 2007 and 2013 changed this incrementally. In 2007, although local authorities retained responsibility for the delivery of public water, the EPA gained authority to enforce drinking water standards, expanding on its previous advisory role. The public sector underwent significant reorganisation in 2014. Operation and management of public water were consolidated under a new semi-state utility, Irish Water, in part to meet the conditions of Ireland's bailout during the global financial crisis. Domestic water charges based on metered usage were put in place, although these were later reversed (Bresnihan, 2016), and the EPA became the regulator of Irish Water (Brady and Gray, 2016), with the authority to issue directives to upgrade facilities to protect water quality. GWSs stayed under the purview of the local authorities.

GWSs were developed in the years following the electrification of rural Ireland. In the late 1950s, many parts of rural Ireland still lacked access to piped water. Many groups pursued funding for the development of rural services. For example, in the 1960s, the ICA organised the "Turn on the Tap" campaign to encourage the provisioning of water to rural Ireland. In the end, however, it was not quality of life arguments that tipped the scales and incentivised greater provisioning of government grants to facilitate these rural water schemes (Daly, 1997). Economic arguments about the benefits of rural water convinced, particularly, the Department of Agriculture to invest in rural water supplies, and the government provided capital grants to help establish GWSs. Support, however, was limited, and often voluntary labour was required to dig and lay pipes and manage the water networks.

Expansion in the 1960s in many cases was linked to creating new opportunities for tourism. However, by the 1970s, incentives to develop schemes were rooted in agriculture. Following Ireland's joining the EEC in 1973, piped water had immediate benefits, increasing yields, particularly from dairy cows (B. MacDonald, NFGWS, 2018, personal communication), that helped usher in an era of more intense agricultural production. Although many were originally hesitant about GWSs, farmers were often those who donated water sources to GWSs and contributed to their upkeep in the early years. By the 1990s, GWSs supplied water to 29% of rural areas (Deane, 2003) for domestic and commercial use. GWSs can connect from as few as two households to as many as over 1000 (Brady and Gray, 2010), and can meet a mix of domestic, farm and commercial needs. In the last 20 years, some GWSs have undergone significant changes with the assistance of state funding and the NFGWS.

Two developments in the 1990s would reshape GWSs' relationship to the state and their water systems. In 1996, under pressure from the 1990s anti-water charges movement, the government abolished domestic water charges within the public water network. Those served by GWSs viewed this decision as unfair, as it meant that the provision of water to those on the public water network was being funded out of general taxation, while their water services continued to rely on the collection of water charges and/or voluntary labour. In response, in 1997, GWSs organised to form the NFGWS, a representative organisation that operates as an intermediary body between the state and GWSs. Since 1997, the NFGWS has negotiated for increased state funding for rural water supply upgrades, operational subsidies, research on source water protection and source water protection strategies. With these sources of funding, the NFGWS has encouraged GWSs to adopt management strategies to meet compliance requirements that have become increasingly onerous since the late 1990s.

In the mid-1990s, alarming reports from the EPA found that Ireland was consistently failing drinking water standards. In 1998, 42% of GWSs failed to meet standards for human consumption (Anon., 2000). Many rural supplies did not have adequate treatment facilities in place and faced strains from the growing agricultural sector's impact on source waters. The 1998 EU Drinking Water Directive imposed further pressure, as it set new parameters for water quality, accompanied by threats of prosecution and fines from the EU if these were not met. The EU held the Irish state responsible for these compliance issues within GWSs and sought ways of funding their remediation.

Since 1998, the resulting Rural Water Programme has funded GWSs to reorganise, upgrade and enhance their efficiency in providing clean drinking water. This Programme grew out of recognition that responsibility for delivering water supply in rural Ireland was shared "between the local authorities and the private group scheme sector" (Circular L4/98; NFGWS, 1998) and

that a new approach was needed to manage water quality concerns. It identified strategies to address non-compliance and then incentivised GWSs to implement these strategies by providing substantial funding and the endorsement of the NFGWS, particularly with respect to water treatment. The institutional relationships these changes precipitated would provide the context for GWSs' alternative way of materialising water politics.

Rather than incorporate all non-compliant GWSs into the public water supply, the government gave them the option to rationalise and upgrade water treatment through a strategy seen as the quickest way to achieve compliance, namely DBO projects (see Figure 2.1). With the encouragement of the NFGWS, many GWSs formalised new relationships with private water service firms that would design, build and operate water treatment facilities under 20-year contracts. GWSs continued to maintain source water and networks for water delivery. The NFGWS encouraged some GWSs to "bundle", allowing multiple schemes to utilise one water treatment facility while maintaining their own networks, whereas others were encouraged to amalgamate and become one larger GWS (NFGWS, 2004). Both strategies were seen as being a more economical way to approach the future of water services (NFGWS, 2004).

This move to modernise by teaming community-operated enterprises with private water infrastructure and services firms was backed with financial incentives from the government and the NFGWS. The state covered 100% of the capital costs of DBO schemes, along with 85% of the operating costs (Brady and Gray, 2010). User charges and meters helped cover the remaining costs of these changes. Most projects were negotiated and started in the early 2000s, with the last significant bundles agreed in 2009. By 2009, more than 42,000 households were supplied

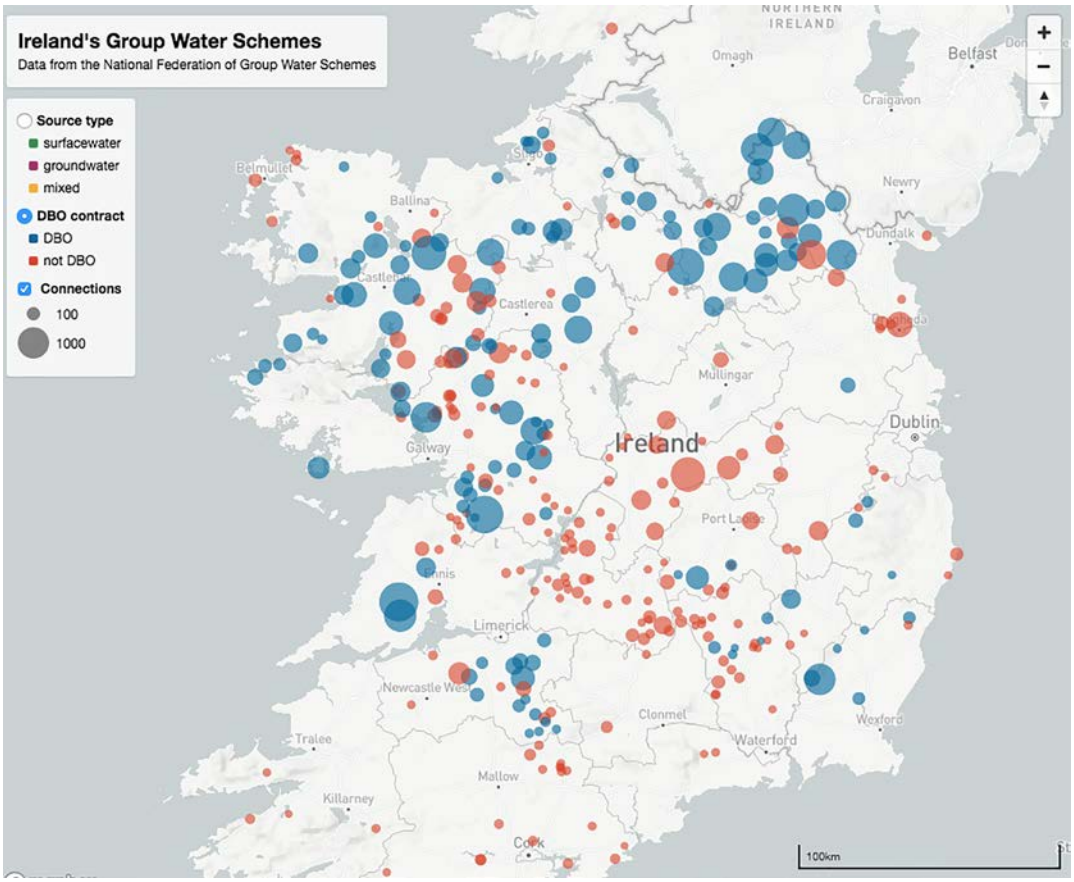

Figure 2.1. Map of the distribution of GWSs, with DBO schemes in blue and non-DBO schemes in red. For an interactive version of this map, visit: https://conifer.rhizome.org/MULibWeb/waterschemes/http://waterschemes.ie/2019/05/07/mapping-irelands-group-water-schemes/

with water by GWSs that had undergone bundling upgrades (NFGWS, 2009, p. 1). These efforts to encourage GWSs to amalgamate and rationalise have continued to be a key strategy pursued by the NFGWS to meet compliance requirements and, more recently, to become more resilient.

Connections between the catchment area, agricultural pollution and drinking water quality were magnified by the new financial arrangements and responsibilities created by the DBO upgrades. Under DBO service contracts, water treatment companies are responsible for the quality of the treated water only when the quality of the source water meets an initially agreed level. Many service contracts were agreed to on the basis of a few, often too few, samples, with the result that GWSs have often found themselves responsible for the quality of the source water, which has raised their own operational costs. In response, the NFGWS, in partnership with the National Rural Water Services Committee, engaged in research to manage the link between intensive forms of animal-based agriculture, source water quality and the costs of water treatment in an effort to reduce costs for all users. In 2005, in collaboration with the Dundalk Institute for Technology, it entered into a multi-year research project, the National Source Protection Pilot Project, to identify and remediate points of source water pollution. Using the catchment as a way of conceptualising and addressing drinking water quality, the project has worked with specific understandings of the hydrological cycle drawn from the WFD and reframed drinking water treatment by "[m]oving from a treatment philosophy to a protection philosophy" (Lianne *et al*., 2011).

The pilot project highlighted connections between water systems, agricultural practices, farm policy, communities and landscapes. The agricultural sector's contribution to water pollution has unequivocally been identified as the main source of pollution through slurry spreading and fertiliser use, as well as through soil compaction and nutrient loss. In the light of the project's findings, the NFGWS has encouraged farmers to install fencing to prevent animals and their faeces from entering waterways and educated farmers on better practices to protect water supplies from agricultural slurry. It has developed education programmes for schoolchildren to learn about the broader catchment area, the hydrological cycle and its contributions to their drinking water. The NFGWS also identified new areas of research to protect source water from septic tank pollution though a community-led septic tank-desludging initiative in collaboration with the EPA and the Geological Survey of Ireland (GSI).

The pilot project also highlighted the need to delineate source water catchments for surface water sources and zones of contribution (ZOCs) for groundwater sources, through catchment mapping, to fully understand the complexities of source water. Much of this work has now been completed on regulated, privately sourced GWSs as the essential first phase of source protection works. Recently, the next phase of work (developing an integrated catchment management plan for the delineated source catchment/ZOC) has come together in the second National Source Protection Pilot Project (phase II), which is being run as two separate projects, one focusing on groundwater and the other on surface water. These two projects feature as two of this project's case studies.

2.3 Policy Contexts

2.3.1 Water

GWSs operate within policy contexts that have helped to shape their approaches to source protection and operations. We have used interactive tools on our website throughout our research to understand these relationships and make these insights available to others. Timelines, maps and interactive graphics intertwine historical, political, economic and geological processes that shape water management, source protection and the work that GWSs do. These tools make sense of what are highly complex and often opaque relationships between policy, land use and water, relationships that are and were intuited by individuals we worked with during our fieldwork. Together these processes shape GWSs' current activities and the challenges and opportunities they face, and have lessons for efforts to advance the UN SDGs. The provision of clean drinking water is an issue of both water quality and water quantity that enrols legacies of infrastructural (under)investment, economic policies and contradictions between growth-led development and sustainable water systems. Thus, understanding how drinking water, environmental water policy and agricultural policy are connected is important.

The 1998 Drinking Water Directive and subsequent changes to Irish water policy in the 2000s facilitated important changes in the public and GWS sectors. In addition, the 2000 WFD dramatically reshaped water governance across the EU. The WFD embraced the wider hydrological cycle in water management and pursued an integrated approach to river basin management focused on the health of ecological systems. Rather than govern water bodies by administrative boundaries (states and counties), RBDs were introduced as spatial units to manage water resources, accounting for the hydrological cycle. Ireland has implemented two RBMPs, each subject to a 5-year cycle. Under the current RBMP, the Second RBMP (2018–2021), Ireland has embraced an ICM approach to the management of water systems through ecological rather than political boundaries. Since 2016, Ireland has been pursuing extensive efforts to manage water through the Local Authority Waters Programme, which we discuss in relation to the Lough Carra (Mayo) field site in Chapter 3.

2.3.2 Agriculture

Agriculture has been an important consideration for GWSs since their inception. Although some farmers were at first hesitant, many donated land and assisted in the development and upkeep of GWSs in the 1960s and 1970s. Agricultural pressures on water quality have grown in many areas as agriculture intensified following Ireland's joining the EEC in the early 1970s. These pressures can negatively change the quality of GWSs' source waters, affecting the kinds of treatment needed to ensure that water is safe to consume. There have been efforts, some led by the NFGWS, to change agricultural practices to diminish these impacts. Thus, to understand the work that GWSs do, we also need to trace the policies and pressures that shape agricultural land use.

Agricultural policy has had a dramatic impact on the Irish landscape and Irish economy. The history of agricultural policy is long, vast and varied. We start our timeline in the late 1800s, although it spans centuries, rooted in the history of land tenure in Ireland. Our goal is to draw together relevant events and circumstances that resonate in Irish agriculture as practised today. Current agricultural practices and policies are shaped by local, national and international policies and are driven by international trade, geopolitics and environmental policies. Although this timeline is far from comprehensive, we have represented key happenings in this history, with an eye towards important changes in the dairy industry and the growing significance of agri-environmental schemes. These schemes provide farmers with payments, assistance and other benefits for implementing environmental work.

Farmers are subject to a complex web of regulations that stipulate land use practices and reporting requirements and which can be the basis on which agricultural subsidies are given and taken away. Such regulations include EU and national regulations that set out not only agricultural policies but also policies impacting water quality, biodiversity, conservation and the use of hazardous chemicals, among others. Although larger, consolidated farms are becoming more common, many of those who still farm do so part-time, and farm payments make up an important part of their annual income.

The most significant agricultural policy in the EU is the Common Agricultural Policy (CAP), which dates to the development of the EEC and was created to assist farmers and stabilise food prices in response to food shortages following the Second World War. The CAP was a major incentive for Ireland to join the EEC in 1973. Previously dependent on British markets, EEC membership opened up new markets to Irish farmers and accelerated shifts towards more intensive and industrial agricultural practices. Since it was first introduced, the CAP has been revised numerous times, often in response to contradictions within Europe's agricultural sector. Changes to the CAP over the years can also be linked to broad changes in Ireland's agricultural productivity and configurations of its agricultural and agri-foods sector, but it is also linked to farm-scale decision-making, particularly incentive schemes to encourage farming practices through direct payments to farmers. The CAP revision in 2003, for example, sought to address problems of overproduction, environmental impacts of agriculture, and sustainability and rural decline across EU Member States. The 2003 revision split the CAP into two pillars. The first continues direct payments and market measures, a key component of the CAP since its inception in the 1960s. Access to direct payments, however, is now linked to meeting environmental regulations (cross-compliance). The second pillar involves rural development policy to

promote sustainable land use and farming practices. Under the second pillar, substantial funding is available for rural development, especially to support community environmental initiatives and agri-environmental schemes. The funding streams supported by the second pillar of the CAP are those that the Lough Carra Catchment Association (LCCA) is currently pursuing in its efforts to fund agri-environmental schemes to remediate agricultural pollution on Lough Carra. Within Ireland, this has led to multiple cycles of community development funding and agri-environmental schemes to incentivise farmers to implement farm-specific plans around environmental goals.

Agri-environmental schemes are the main tool used to incentivise farmers to take action to improve the environment. Their existence pre-dates even the 2003 CAP revision, as they have been required of EU Member States since 1994. Council Regulation (EEC) No. 2078/92 makes it compulsory for EU Member States to offer such schemes. Although the state must provide agri-environmental schemes, farmers can voluntarily decide if they wish to participate. Incentives to participate include small funds, upgrades to equipment, access to building materials and analysis and advice surrounding farm management practices. Land use decisions are also taken in a context in which the Irish government is also pursuing policies to expand the agricultural sector. Although it promises to promote sustainable growth, the government's Food Wise 2025 policy has set ambitious targets to increase exports by 85%, to increase value added by 70%, to increase primary production by 65% and to create 23,000 jobs. Agriculture in Ireland is dominated by dairy and beef farming, and the policy is expected to expand herd size by 7% if fully implemented.

These policies shape the context of our three field sites:

1. Upper Dromore River Surface Water Source Catchment of the Stranooden GWS, County Monaghan, part of the NFGWS Source Protection Pilot Project, phase II;
2. groundwater ZOCs from GWSs in the Rathcroghan uplands, County Roscommon, also part of the NFGWS Source Protection Pilot Project, phase II;
3. the LCCA, County Mayo, a community organisation around a lake listed as an area for action under the Second RBMP.

3 Field Sites

3.1 Justification for the Chosen Sites

The field sites in Counties Monaghan, Roscommon and Mayo were selected for the presence of an active and ongoing catchment protection project. In Monaghan and Roscommon this has been driven by the NFGWS, with involvement from one (Stranooden) and five (Corracreigh, Mid Roscommon, Oran Ballintubber, Peake Mantua and Polecat Springs[1]) GWSs, respectively. In addition, Dundalk Institute of Technology is working with the Stranooden Surface Water Protection Project, and the GSI is working with the Roscommon Groundwater Protection Project. Mayo stands in contrast to these source protection efforts. The LCCA has emerged from citizen science and community organising, rather than from top-down piloting. Members from the two GWSs that abstract from the lake (Lough Carra and Robeen) are involved in this organisation. These sites vary considerably in their geography, geology and history, and so demonstrate the broad range of challenges encountered in source protection in Ireland.

Before describing the sites in greater detail, it is important to specify why we decided to focus on source protection. At the level of the project, source protection is closely tied to SDGs 6 and 15, and so allows us to address the core demands of the funding call. At its most concrete, source protection helps to provide safe and affordable water by reducing concentrations of pollutants in raw water and so decreasing the cost of producing potable water through treatment. This is a clear connection to SDG 6, which aims to ensure the availability and sustainability of water and sanitation for everyone. SDG 15, which promotes the sustainable use of terrestrial ecosystems, is also addressed by our focus on source protection. Here, the important point is the shift from a single function (i.e. water treatment) to a more holistic conception of where water originates from, and what it comes into contact with. Done properly, source protection contributes to sustainable practices for using and managing freshwater systems, as well as the provisioning of affordable, clean drinking water.

Choosing to focus on source protection also brings our research into close alignment with the concerns of our interlocutors. Through our discussions with the NFGWS, it became clear that source protection has come to play a central role in its strategic positioning of the GWS sector in the mid- to long term. There are several reasons for this. Successful source protection decreases the cost of raw water treatment and has the potential to offer a greater return on investment than plant upgrades and continually rising operating costs. GWSs are more embedded in communities than Irish Water, and arguably have a greater interest in promoting behaviours that contribute to local social and environmental sustainability. Following on from this, it is also clear that the NFGWS connects such local action with national environmental and agricultural policies, and, indeed, with global issues of biodiversity loss and climate change. Source protection is thus not only a matter of economics, community and conservation, but also raises ethical and normative questions regarding the relationship between human societies and the natural world. Given the importance of the NFGWS and its interest in pursuing source protection, selecting this as our topic helps ensure that our work is timely, relevant and useful.

Together the three field sites give us access to eight GWSs involved in source protection. They demonstrate many of the innovations of GWSs in addressing SDGs 6 and 15, challenge us as social scientists to make considered observations and analysis, and help ensure that our research is meaningful for policymakers, practitioners and academics. In the following sections we introduce the sites in greater detail, and discuss their physical geographies, geologies, histories of land use and relationship to the NFGWS. The differences between the projects allow us to draw out some of the barriers

1 Eight GWSs were involved in this phase of the NFGWS source protection project across Roscommon and Westmeath but these five GWSs share the Rathcroghan uplands catchment.

and limits that source protection faces in Ireland, now and in the future.

3.2 Description of the Field Sites

3.2.1 Upper Dromore River Surface Water Source Catchment of the Stranooden GWS, County Monaghan

Stranooden GWS was founded in 1979. In 1996 it built its own treatment plant, which began operating in 1997. In 2004, Veolia took over plant operations as part of the Monaghan DBO bundle, which included another 12 GWSs, private schemes and three small public supplies (NFGWS, 2004). Given its central location, the scheme was chosen as the base of Veolia's operations in the county. Stranooden GWS today serves approximately 1120 domestic connections between Monaghan town and Rockcorry. It sources their water from White Lough near Ballybay, which is then pumped approximately 10 km to the treatment plant and reservoir in Corcaghan (see Figure 3.1). The scheme's members live north of the White Lough catchment, with only the upper subcatchment overlapping the distribution network. The Upper Dromore River Basin Surface Water Source Protection Pilot Project takes place on the doorstep of the NFGWS. It is tasked with assessing and taking action to improve the source waters of the Stranooden GWS. The scientist leading the project is Patrick McCabe.

The physical landscape of the region is dominated by rolling drumlins, formed between 75,000 and 10,000 years ago. Deposits of till left by glaciation render the soil clay rich and poorly draining. Water remains on the surface for long periods of time and the land is highly susceptible to flooding. A string of low-lying lakes extend from Rockcorry to Castleblayney, connected by an extensive system of streams and rivers.

Monaghan has a history of intensive agriculture and, more recently, intensive forestry, which has left few remaining pockets of native woodland. Agricultural land use practices have a significant bearing upon water quality in the region, so it is worth discussing in greater detail how practices have changed. The steady growth and intensification of livestock farming in Monaghan has had a detrimental impact on the quality of surface water. Paleolimnological research on the county's drumlin lakes (Carson *et al*., 2015; Chique *et al*., 2018) link the production and spreading of organic waste to problems of eutrophication and related changes in insect life. This is not a recent

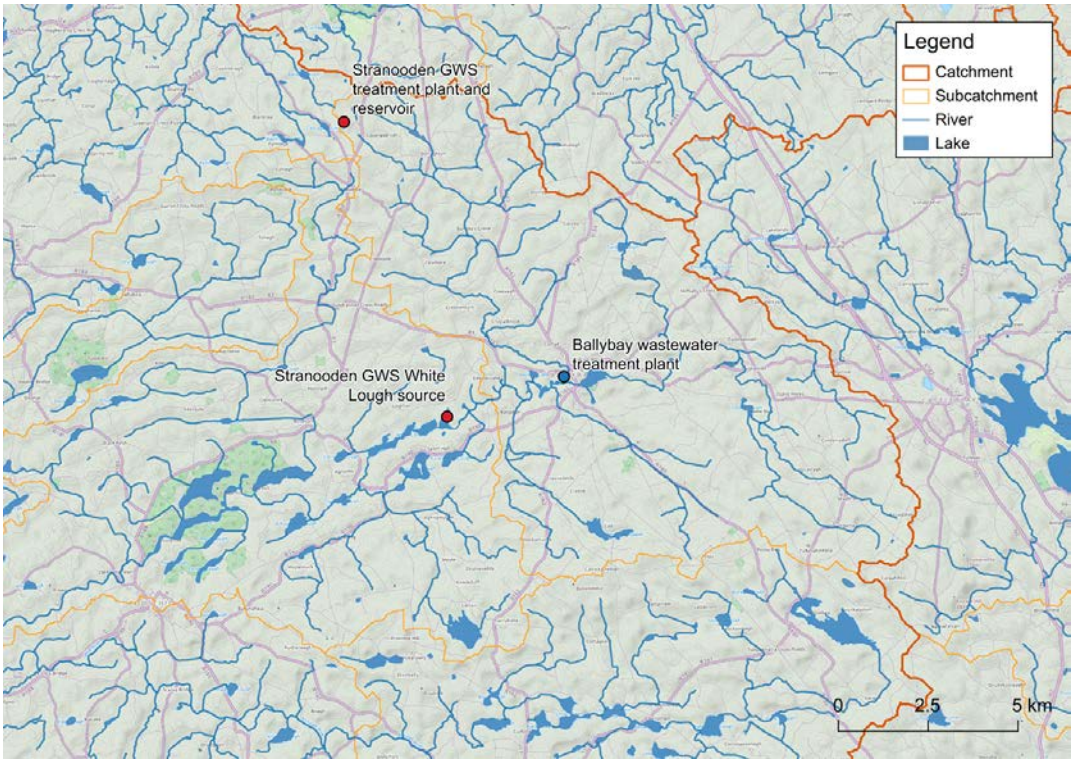

Figure 3.1. Map of the Stranooden GWS, its abstraction point, catchment and river system.

phenomenon but one that has worsened since the 1970s, particularly in catchments without measures to manage, slow or decrease the spread of nutrients.

GWSs have been affected by this decline in surface water quality. For his master's thesis, Patrick McCabe investigated four lakes used as GWS source waters: Kilcorran Lough, Moynalty Lough, White Lough and Lough Antraicer. The first three are all shallow, low-lying lakes that receive large annual sediment deposits. Analysis of core samples taken from these lakes revealed recent increases in total phosphate levels and total concentrations of chlorophyll and carotenoid. These measures can be used as evidence of the correlation between farming practices and changes in water quality.

The Stranooden GWS treatment plant is able to manage some, but not all, of the threats posed by farming activities in the White Lough catchment. The plant uses a combination of flocculation, dissolved air flotation and sand filtration to remove suspended organic solids. As such, it has the ability to deal with some fluctuation in the turbidity and colour of its raw water. Having said this, the scheme does occasionally have issues with trihalomethanes (THMs), which are formed when water high in organic content is treated with chlorine. Long-term exposure to THMs may lead to an increased risk of certain kinds of cancer. This was not the concern that prompted the source protection project, however. Rather, it was concentrations of MCPA (2-methyl-4-chlorophenoxyacetic acid) above national regulatory limits found in samples of treated water taken by Monaghan County Council in 2017 and 2018. MCPA is a selective herbicide often used to kill reeds and rushes in fields and along the edges of waterways. Although it is considered toxic to aquatic life, the World Health Organization does not consider it a dangerous carcinogen and recommends a maximum concentration 10 times above what has been found in the Stranooden GWS water. Although MCPA can be removed using granular activated carbon filtration, its installation is expensive and unlikely in the case of Stranooden GWS.

During the first year of the project, Patrick McCabe repeatedly took samples at various locations in the White Lough catchment and walked subcatchment waterways that overlap the GWS distribution network, all the while meeting the farmers who own and work that land. His focus was on identifying and recording threats to the scheme's raw water. Agricultural practices are not the only such threats. Others include the Ballybay Wastewater Treatment Plant, domestic pesticide use and mismanaged septic tanks. Remedial actions have begun to address these threats. Formally, these include free rush removal for farmers, removing animal access to the river, the encouragement of septic tank desludging (as part of a programme established by the NFGWS), and outreach and education at local national schools. Informally, through meeting community members and discussing his day-to-day work, he is also raising public awareness of threats to the catchment.

3.2.2. Groundwater ZOCs from GWSs in the Rathcroghan uplands, County Roscommon

The second strand of the NFGWS Source Protection Pilot Project is based in County Roscommon. Since the early 2000s, the Federation has worked closely with schemes in the county to address problems of water quality. Its activities have taken two related forms.

First, small schemes have rationalised their organisational structures and amalgamated their physical networks. In the early 2000s, three schemes east of Elphin (the Aughrim, Boheroe/Corbally and Creeve GWSs) were merged into a single scheme, Polecat Springs GWS, which now has more than 474 domestic connections. The board of the new scheme was made up of four representatives from each of the three founding schemes. By combining their assets and energies, and selecting a single source to abstract from, issues with leakage and contamination could be more easily addressed. Emphasis was initially placed on securing the supply by upgrading the network of pipes and fittings, rather than improving the quality of water through treatment. The membership felt that it was more important to have a regular supply of water they needed to boil than a sporadic supply of water that they did not.

Second, the treatment plants were upgraded, and their management and maintenance professionalised through long-term contracts with third-party providers. Although Polecat Springs GWS was the first scheme to sign such a contract (with the environmental management firm Veolia), it is not the principal DBO

scheme in the county. In early 2005, a design review for a large DBO bundle was conducted, taking into consideration no fewer than 26 GWSs. Following a period of negotiation, many of these schemes underwent rationalisation and amalgamation. In 2009, a contract was finally signed with Glan Agua. The bundle included the Corracreigh (now 354 domestic connections), Mid Roscommon (790 domestic connections) and Oran Ballintubber (385 domestic connections) GWSs, two private schemes outside the county and two public schemes (NFGWS, 2009). With generous funding from the Department of the Environment and Local Government, treatment plants were built to handle anticipated discoloration and turbidity, and the presence of micro-organisms such as *Escherichia coli*, *Giardia* and *Cryptosporidium*. A smaller scheme, Peake Mantua GWS (38 domestic connections), elected to manage its upgrades and maintenance independently of DBO.

Although these activities have strengthened the management and economies of Roscommon's GWSs, and have drastically improved the quality of their piped water, they have not fully addressed the challenge of source protection. For this reason, the NFGWS has teamed up with the GSI and the private firm Tobin Consulting Engineers to further identify and ultimately rectify threats to the source waters of five schemes in the Rathcroghan uplands, north of Roscommon town.

The issues faced by GWSs in Roscommon are shaped by the county's geography and geology (see Figures 3.2. and 3.3). Roscommon lies almost entirely in the north of the Shannon River Basin, Ireland's largest basin (11,700 km²), feeding into Ireland's longest river (with a long-term flow rate twice that of the Corrib). It receives an annual average rainfall of 1012 mm, which, in combination with its rich, dense, clay-enriched soils, means that the water table is usually close to the surface. Unlike County Monaghan, however, Roscommon does not have an extensive system of lakes and rivers. This is due to the county's geology. As with much of the middle beltway of Ireland, the bedrock of Roscommon is pure bedded limestone. This type of rock is highly susceptible to karstification (i.e. the formation of caves and groundwater drainage systems), which allows water to move quickly and in unpredictable ways beneath the surface. Nitrates are able to pass quickly from a field's surface into the underlying karst system. In areas of exposed limestone, these movements occur even more easily. To simplify, the further and more quickly water moves underground, the greater the challenge to source protection. If, for example, water originates more than 10 km from the abstraction site, which is not an uncommon occurrence in Roscommon, then it is unlikely that the groundwater system will coincide with the distribution network of the scheme or the officially designated surface water catchment. In the first case, such a flow of water is likely to bring schemes into contact with landowners whom they do not know and who will not benefit directly from altering their behaviour to minimise risk to the source water. In the second, it can undermine the efforts of existing water management organisations and their embedded practices.

There are limits to what can be known about a groundwater system, however. Because the path of the water is changed by seasonal fluctuations in rainfall and alterations in the karst structure, the models built up by geologists are incomplete and uncertain. It is only through the steady mapping of karst features, and iterative testing and observation of underground pathways, that confidence in the accuracy of the models can be increased. This can take up to 30 years of investigation, and even then periodic validation will be needed. Communicating these uncertainties to local stakeholders can be challenging.

The Groundwater Source Protection Pilot Project has begun this work. It faces a tough challenge. The geographical area covered by the project (150 km²) is extensive, and, unlike the surface water project in Monaghan, the project involves following water through a third and largely invisible dimension. Work is ongoing to secure significant points of ingress through either better nutrient management plans or installation of fencing and nose pumps to better control the movements of cattle. At one site, these source protection efforts appear to be working. The levels of coliforms per 100 mL at Ogulla Spring, an abstraction point for the Mid Roscommon GWS, were considerably lower in 2019 than in the past.

3.2.3 The Lough Carra Catchment Association, County Mayo

The source protection effort implemented by the LCCA in County Mayo is unlike the source water protection projects in Monaghan and Roscommon. In the first

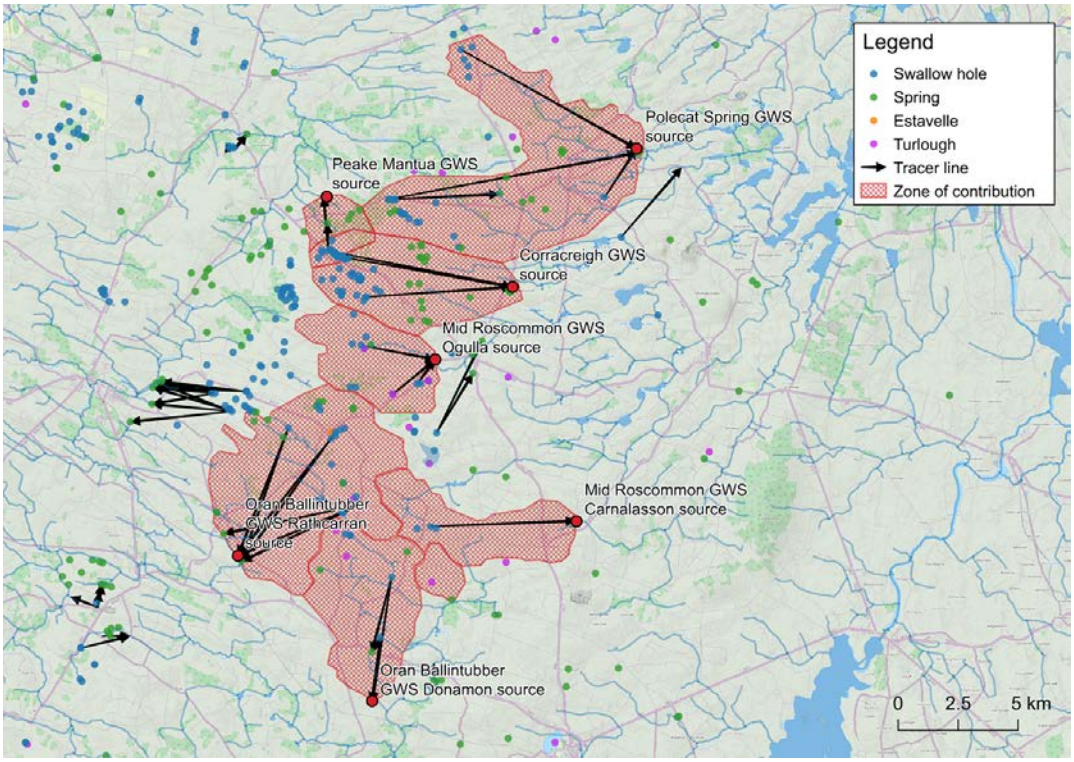

Figure 3.2. Map of Rathcroghan uplands showing the location of schemes, important karst features, tracer lines and zones of contribution.

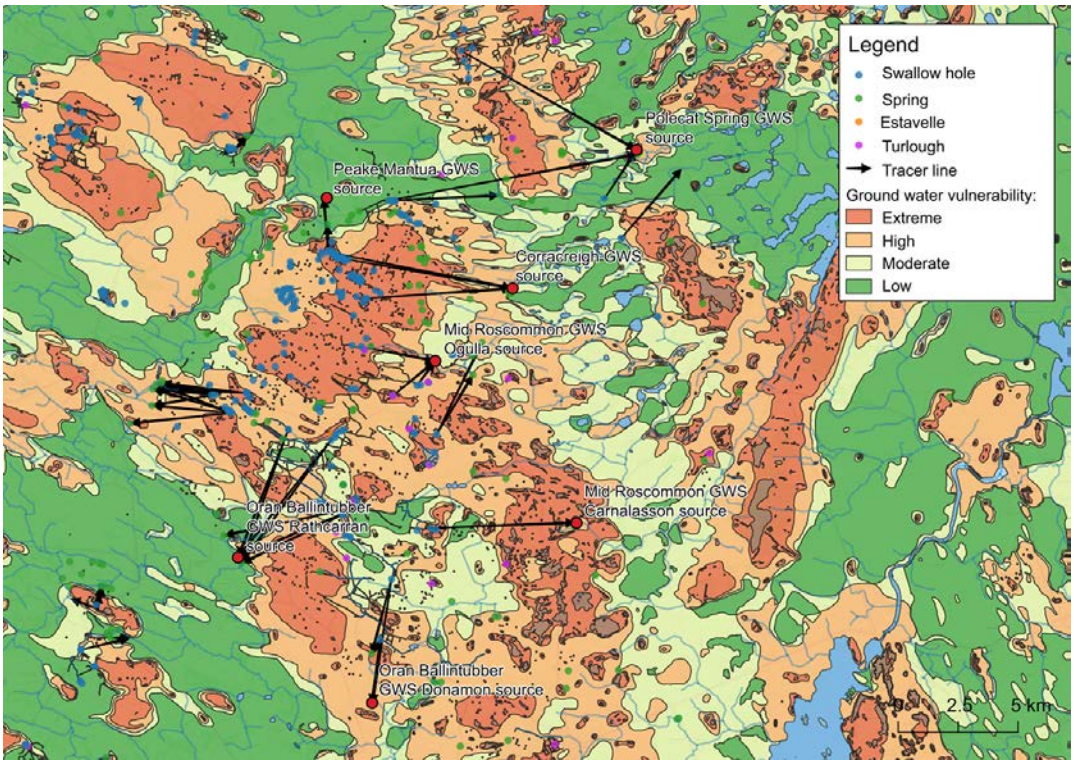

Figure 3.3. Map of Rathcroghan uplands showing the groundwater vulnerability map produced by the GSI.

instance, it is not driven by the NFGWS or by funding drawn down from central government. Rather, it has emerged as a more bottom-up campaign, run by an association whose stakeholders have various attachments to the lake. Water quality and public health are of concern, but so too are conservation, fishing, aesthetics, local history, rural development and tourism. The NFGWS has become peripherally involved in the LCCA, its representative in the north-west attending several monthly meetings, but it is not central to the group's management or operations. Second, and following on from this, GWSs are only one type among the constellation of interested parties that the LCCA brings together. Two schemes abstract from the lake: Lough Carra and Robeen GWSs (see Figure 3.4). Some of their members are involved in the source protection efforts and, although their experiences bear upon our research, we have sought to remain faithful to their broader wants and desires. A wish for improved drinking water quality cannot be easily disentangled from other motivations. The LCCA demonstrates just how embedded GWSs are within rural life in Ireland. Studying a source protection project in which GWSs are not front and centre allows us to make comparisons and generate insights that can nevertheless inform water management policies, practices and communities in this country.

The LCCA was established in 2018 with assistance from the community management officer of the Mayo branch of the Local Authorities Water Programme (LAWPRO). Its origins, however, go back much further, as its core members have been involved in campaigning on local issues of public health and wildlife conservation for more than 15 years. With a focus on reversing the decline of Lough Carra, the LCCA has attracted a broad base of participants that includes farmers, anglers, ecologists, academics, civil servants, business owners, an artist, a retired schoolteacher and a local politician. Its focus is a single-issue campaign, without an explicit political affiliation or ideology. Before exploring its efforts in detail, it is worth considering the geography and geology of the lake, and the two schemes that use it as their source water.

Lough Carra is a marl lake known for its clear, shallow water, white bottom and fighting brown trout. It is located between Galway city and Castlebar, north of Loughs Corrib and Mask. It is the smallest of these three lakes, and when seen with satellite imagery, the

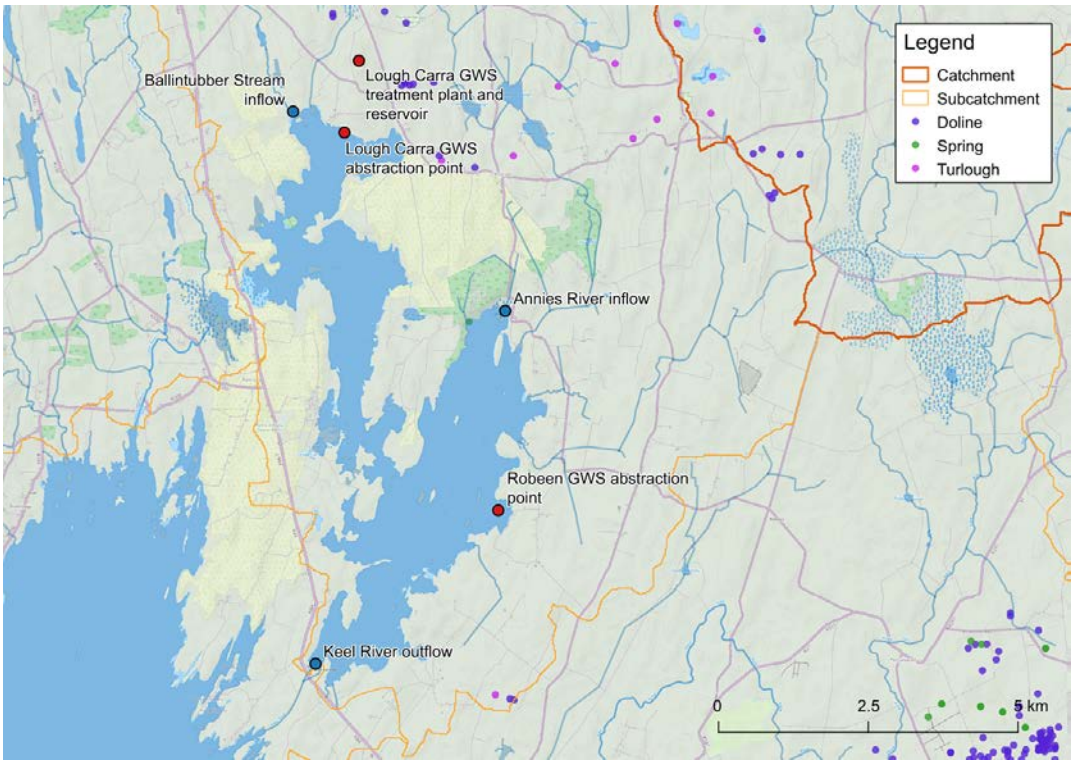

Figure 3.4. Map of Lough Carra showing important surface water and groundwater features, and the abstraction points of the Lough Carra and Robeen GWSs.

least distinct, its green tinge, a result of krustenstein growth on its shallow bed, causing it to fade into the surrounding farmland. Whereas the LCCA uses "catchment" as an organising concept, for state agencies such as LAWPRO and the EPA, Lough Carra is part of a larger catchment area that includes Lough Mask. Lough Carra is composed of two wings, a north-west, whose main inflow is the Ballintubber stream, and a south-west, which also receives water from the Annies river. The main outflow is the Keel river, which flows into the Mask. The two lakes lie on karstic limestone, so are believed to be connected by a single underlying aquifer (see Figure 3.5). Despite their entwined geophysics, LAWPRO held two public consultations for the catchment, one for each of the communities on Lough Carra and Lough Mask.

The two schemes that abstract from Lough Carra are significantly different. Robeen GWS serves around 263 domestic connections, with water pumped directly from the lake (and only minimally treated with chlorine). It is not part of a DBO project and its caretaker works only a few hours a week to maintain the pipes and add new connections. One of the scheme's board members is co-treasurer of the LCCA. At this moment, it is unclear whether or not Robeen GWS will continue to exist. The households it supplies are currently on a boil water notice for *Cryptosporidium* that will not be lifted until a more rigorous process of treatment is introduced. The scheme's board is attempting to secure funding for a treatment plant. If unsuccessful, it is likely that it will merge with Lough Carra GWS. Lough Carra GWS sources its water from the north-west wing of the lake, which we have been told is less polluted than the south-west. Indeed, Glan Agua considers Lough Carra GWS to have the highest quality source water of the 13 schemes that it manages in its Mayo DBO bundle. The scheme has 600 domestic connections, a state-of-the-art treatment plant and reservoir, and a strong economic and governance structure. Its caretaker is a part-time farmer and independent contractor who works several days a week for the scheme.

The challenges faced by the LCCA are substantial. There is disagreement about where the pollution originates. People are aware of the impact of intensive agriculture but are reluctant to blame specific farmers. Many were born into farming families, are related to the big farmers or are part-time farmers themselves. Agriculture is considered the lifeblood of the local economy, not only for what it produces but also for the associated businesses it supports. Whenever the spectre of agricultural pollution is raised during

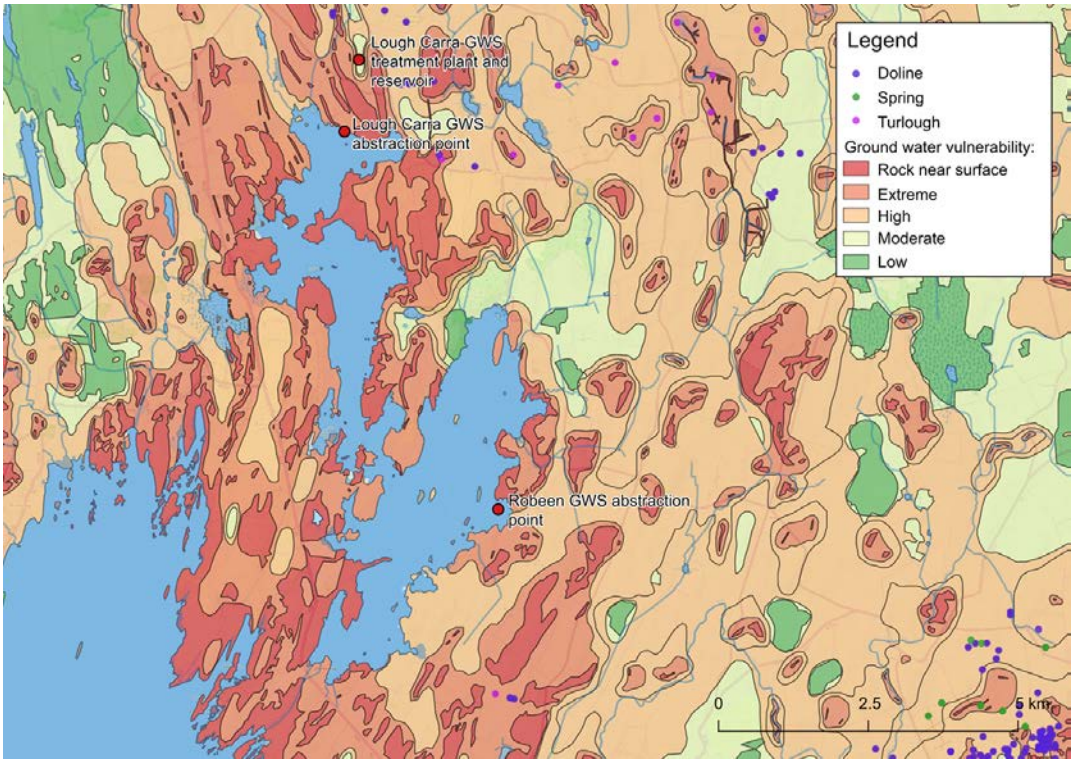

Figure 3.5. Map of Lough Carra showing the groundwater vulnerability map produced by the GSI.

meetings, the discussion inevitably turns towards the observation that everyone is a polluter.

It has proven difficult to have the lake's decline recognised by central government authorities. Members of the LCCA often speak of how the lake used to appear. Memory is not often regarded as a sound basis for scientific evidence, however, especially when the person remembering speaks not from expertise but from familiarity. But it is not only memories that local campaigners have brought to bear. They have found old letters and poems that speak of the white lake bottom. They have compared old and recent photographs of the lake. They have moved stones from place to place, to track the growth of krustenstein. They have documented and publicised events of acute pollution. They have even collaborated with Trinity College scientists, who, in 2002, took core sediment samples of the lake that clearly show the rise in total phosphate levels since the 1950s (Donohue *et al*., 2010). All of this, they have published in a book called *Lough Carra* that both celebrates the natural beauty of the lake and bemoans its deterioration (Huxley and Huxley, 2015). And yet, despite this and other evidence (King and Champ, 2000), the EPA until recently considered the lake to be of "good status", the second highest quality afforded a water body under the WFD (Ward, 2018).

The efforts of campaigners and scientists have proven insufficient to resolve institutional uncertainty concerning the quality of the lake. Representatives from the EPA have recognised that there are limits to the testing methodology that they used to assess the lake. They have opened up their data to members of the LCCA and have worked with them to ease worries about procedural irregularities. The Second RBMP has brought a new focus on the Lough Carra and Mask catchment, as it has been identified as a Priority Area for Action. LAWPRO catchment scientists are currently working to improve their understanding of the lake, with a long-term management strategy in mind. The GSI has begun mapping karst features and developing a model of how groundwater contributes to the lake's seasonal eutrophication. These efforts take time, however, and, despite support for scientific assessment, it is not clear that more data necessarily translate into effective action and policy change (see Box 4.1).

Perhaps the greatest challenge faced by the LCCA is knowing what action it can take, in the absence of state intervention, to improve the quality of the Carra. It used private donations from members and local angling groups to purchase a solar-powered feeder. This has been installed as a proof of concept to limit cattle access to the lake. It is investigating the possibility of using biochar to filter water entering Lough Carra at the Ballintubber stream and Annies river. It has engaged in an education programme with local schools, distributing information about the water cycle and everyday causes of pollution. It is producing a booklet about Lough Carra and its decline. By far the bulk of its energy, however, has been invested into a bid for a multimillion euro remediation programme. In late 2018, the LCCA secured LEADER funding, under the rural environment theme, to pay an environmental consultant to write an application for EU LIFE funding. Competition for LIFE funding is tremendous. LCCA was unsuccessful in its first application (2019) but has received feedback from the European Commission and is set to submit a full proposal for a LIFE project in February 2021. Despite the number and variety of its proposed actions, selected in part to satisfy the requirements of the LIFE funding process, none explicitly addresses the economic forces and government policies that are driving agricultural intensification.

4 Analysis

4.1 Drinking Water Provision

GWSs are seen to be a highly innovative area of water management in Ireland. Over the past 20 years, they have had great success in addressing concerns with water quality and reliability. This has occurred through a range of activities that include self-education and skill sharing; networking and alliance building; novel forms of managerial and economic restructuring; upgrades to water treatment facilities; adoption of digital technologies; and the rationalisation and professionalisation of everyday operations. It is important to realise that an underlying infrastructure has both allowed this to occur and been reinforced by its success. This is not simply a technological infrastructure, but one that is also composed of people and their passions, knowledge and social relations. We have often been told that the sector has a strong sense of community. It is this aspect of its success that we believe to be its most important innovation.

Innovation is usually understood in terms of the newness or originality of something – especially a technology – that serves to drastically improve output, quality, productivity or efficiency. A word often heard alongside innovation is disruption (see Russell and Vinsel, 2016). The innovation of the GWSs is of an entirely different sort. It is not the originality of their technology that makes them innovative. Telemetry and SCADA (supervisory control and data acquisition) systems are not cutting edge, even in drinking water management. Rather, it is the adoption of tried and tested technology made feasible by central government support, a willingness to learn from others and a strong network of relationships. This has been necessary not to continually improve but to maintain: to ensure that the taps keep running, the water is drinkable and the organisation is economically, socially and environmentally sustainable. In many ways, GWS innovation is the very opposite of disruption.

The material changes undertaken by GWSs over the past 20 years are not understandable without an appreciation of the context in which they have occurred. Public water services are currently undergoing a protracted process of centralisation and rationalisation, with the establishment and transition to a single, national utility, Irish Water. Although this may have been necessary, it is important that the water sector does not lose sight of the specificities of technological applications, the environments in which they are installed and the people who use and adapt them. It is for this reason that we stress a more expansive definition of water infrastructures and innovation that moves beyond technological solutions.

Water infrastructures are not inert artefacts or systems devoid of history and geography. They involve particular and active inter-relationships between water, landscape and technology. They are built and sustained by people, their practices, tacit knowledges and specialised expertise. They require local communities of place and global communities of practice. They flourish through proper structures of representation and support.

We do not offer this reconceptualisation as a way to champion localism. The success of GWSs has required national-level organising and international knowledge exchange. What we want to stress is the way in which best practices and global technologies are situated in multiple and specific ways. Our hope is that a revised concept of water infrastructures can illuminate how this occurs, without slipping into idealisation of either the local and particular or the general and standardised.

Similarly, it is important not to heap blind praise upon the GWS sector. While the schemes we encountered are different, sometimes in profound ways, they share a social embeddedness that is attentive to particular features of people and the environment and that is carried out through a collective, even communitarian, ethos. It is easy to romanticise this embeddedness. As discussed below, however, it is not always positive, but can be abused and lead to problems. When it works, it is often because it is well remunerated and highly organised. In other words, the success of GWSs is not simply a result of voluntary labour, local knowledge and a community orientation. These valuable social relations require technical, institutional and financial support.

Against the breakdown of public water infrastructure, calls are being made for new and innovative solutions to drinking water provision. The innovation that stems from the GWS sector is quite different from what is generally thought of as innovation. GWSs have succeeded through a combination of digital technologies, advanced water treatment processes and an approach to water management that is infused with an ethos of community. They have prioritised not novelty or disruption, but maintenance and continuity. What the GWS sector makes explicit is that successful water infrastructures require particular forms of work (maintenance and care), technical knowledge (situated) and governance (responsive) if they are to function well. In the sections that follow, we explore each of these characteristics in turn.

4.1.1 Care and maintenance

Through paid and unpaid forms of work, many people are involved in managing and maintaining GWSs. This has always been the case. Schemes were founded on voluntary, collective labour. It took effort to bring people together, to gain funds, and to organise and build the infrastructure: to identify a source, dig trenches, lay pipes and install pumps. While treatment and maintenance is, for the majority of GWSs that we have interacted with, very different today, it still requires a hands-on approach.

Perhaps the most significant change in the quality and distribution of work has been the outsourcing of water treatment to private companies. Over the past 20 years, the total number of schemes has fallen dramatically as a direct result of NFGWS policies of rationalisation and amalgamation. This has made it logistically and economically feasible for third-party contractors, such as Veolia and Glan Agua, to take on bundled, 20-year DBO contracts to plan, oversee and execute the construction of treatment plants and reservoirs, and then manage and operate water treatment processes. With the outsourcing of treatment, more people are involved in delivering water and their labour is more specialised.

Despite this professionalisation, it remains the case that a well-functioning scheme is dependent on the ambition and energy of a few key individuals. The work they perform is remunerated in some cases, but in others is voluntary and rooted in values of community and care. Every GWS has a manager and a caretaker. In some cases, the same person may fulfil both roles, but in most cases they are two separate positions and they are two very different roles. The former is responsible for the financial operations and regulatory compliance of the scheme, including interacting with the NFGWS around funding schemes under the Rural Water Programme; the NFGWS has a clear policy of encouraging schemes to employ professional managers where viable. The latter, caretaker, role is centred on the day-to-day operations of the scheme, including checking the network, ensuring that leaks are fixed and water charges are collected. In addition to the manager and caretaker, each GWS has a voluntary board or committee that provides important leadership, governance and oversight to the GWS manager or caretaker on behalf of the members.

Given their importance to the GWS sector, it is worth elaborating on the values of community and care. To a certain extent, the significance of community should be self-evident. The work of maintaining the scheme is done for others, for the wider community of which the scheme a part. Given the co-operative structure of most schemes, their operations cannot be simply described as a simple transactional logic in which a company provides a product to a customer. The relationship is much more iterative and mutually supporting. Having said this, it is also the case that much of the work is unspectacular and in service of simply keeping the water flowing. As was often said to us, maintenance is invisible right up until the point that the water fails, and people complain. What caretakers do is rarely celebrated – except by those who know, or who work closely with them. So why do they do it at all? The answer is a simple one: because they care. It is no coincidence that key individuals in GWSs are called “caretakers” – they are those who take care of the scheme. Caretaking is not about private, monetary gain, but about continuously ensuring that things work well, especially those things that are in the background and part of the everyday. Many engaged in care work find the consequences of their labour rewarding in and of themselves. In caring for children, the sick and the elderly, this is about developing relationships and making people happy. In the case of GWSs, it can be found in reducing leakage, or developing one’s knowledge of the pipes – there is often tremendous pride in this.

Because their work is often invisible and fills up their afterhours, caretakers are sometimes taken advantage

of. They can be poorly paid or work longer than what they are paid for. This is unsurprising. Care work is often undervalued in our society. But caretakers are themselves not without power. Given the amount of specialised and local expertise that these individuals build up, they often make themselves indispensable to the scheme.

Community and care inform the way in which maintenance and repair are conducted. Maintenance and repair involve continuous attention. Caretakers are not simply reactive, but actively seek out problems so that they do not get worse. Several caretakers in Roscommon check the bulk meter data first thing every morning. They look for unexpectedly high levels. These may indicate something innocuous, such as a tap being left running on a farm. But they might also provide the first inkling of a leak that will mean wastage and drops in pressure further along the line. To some extent, this disposition to care about the maintenance of water infrastructure is what drives GWS members to take an active role in source water protection. Good caretakers can see the big picture and prioritise activities that anticipate future challenges.

Maintenance and care are different from innovation as it is typically understood. They are not new and spectacular, but precisely the often forgotten, less acknowledged work of keeping things together, ensuring that things work. Even as they support and allow more visible forms of innovation, they are themselves undervalued and underfunded – this is the case in public water systems not just in Ireland but around the world. Investment in maintenance does not win elections or garner media attention. And yet, over the past 20 years, it is the work of caring and maintaining that have allowed GWSs to make tremendous advances. It is true that they have new treatment facilities and state-of-the-art technologies, both of which demand highly specialised expertise. But these systems would not have come about without the slow, constant work of learning about water systems, source waters and funding schemes, dealing with independent contractors and private water companies, and installing meters and new connections. These tasks are not linked to funding and election cycles but are oriented towards a long-term future – they involve not grand plans but the constant, applied effort of small steps taken every day. This orientation presages the involvement of GWSs in source protection. It reimagines a rural Ireland in which people stick around and, in slow, steady ways, improve their lives and environment.

4.1.2 Standardised and situated technology

A tension often exists between the universal and the particular, and between the global and the local. Standardised measures, classifications, designs and practices are developed with the assumption that the world is pretty much the same, that problems encountered tend to repeat, to be the same, similar or of a type. If this is true, then it follows that they can be addressed through generic solutions. Best practices can be untethered from the people and places in which they are developed, circulated in documents, as products or by experts, and then be reproduced whenever and wherever they are needed. In contrast to this, some believe that problems are specific to the circumstances in which they arise, and that local, tacit knowledge is best suited to addressing them. Here, standards are regarded as a dangerous abstraction with little appreciation for the way in which things are.

For example, the drinking water standards that the GWSs are expected to comply with are developed not at the local scale, or even at the national scale, but at the regional scale of the EU. These are then translated into regulations by the institutions of the Irish government and assured through a testing and compliance regime made up of county councils, the EPA, the HSE and the individual GWSs. Drinking water standards are crucial to maintaining quality drinking water and public health – GWSs would not be where they are today without the finding of the European Court that the Irish national government is responsible for ensuring that the sector meets those standards. Nevertheless, it is important to recognise that standards set at this scale can have unanticipated effects on local communities and enterprises. They create technical, administrative and financial obstacles that assume a certain technical knowledge and expertise, introduce new data collection and processing practices and, to some extent, prefigure the size, structure and workload of an ideal, compliant organisation. It is not uncommon to hear GWS caretakers complain about the burden of testing and paperwork that EU standards and state regulations impose. These complaints are a response to real and powerful forces, and it is important that this is

recognised, rather than ignored or dismissed. The specific capacities and affordances of Irish community-managed drinking water infrastructures do not bear upon the policy decisions of the EU. That is left to the Member States and their local communities to resolve.

Our approach to this tension has been to argue that standardised technologies are most effective when they are modified to fit local settings and understood to involve unsung local supports. We have sought to approach technology through the situated knowledge and local expertise that put them to work. The best way to illustrate how this occurs is through the example of water meters.

Water meters have become a contentious technology in Ireland. When Irish Water sought to install meters as part of its transition to public water charges, it faced considerable push-back in the media and resistance in the streets. While the anti-charges movement was at heart an anti-austerity movement, there were fears that meters would extend centralised data collection and control. Many GWSs are successfully using meters to manage and monitor usage on their networks. Individual water meters provide information to scheme managers and caretakers about water usage at individual connections for both households and farms. Bulk water meters provide information on water usage within larger areas. This information is used to help identify pipes that require repair and maintenance and, in the case of individual meters, assists in the assessment of fees. Unlike in the public sector, meters have been successfully integrated into the work practices and ethos of GWSs.

Meters and charges used by GWSs are strategies that appear to align with the rationale behind the national metering and water charging policy introduced in 2014. There is, however, an important distinction. The use of metering and charges in the GWS sector served a different purpose. With respect to meters, these technologies were framed as a means of reducing costs for the scheme by making leaks visible and fixable, and were not framed, principally, as a strategy to regulate individual water use. As the *Rural Water News* reported:

> It would be a pointless exercise if vast sums were to be spent on water treatment systems, without looking closely at means whereby we can stop wastage and otherwise conserve supplies. By the same token, we would be failing in our collective responsibilities if we were to rely solely on treatment and did not examine and implement means of protecting our raw water sources.
>
> (NFGWS, 2003)

For many GWSs, water meters and charges were understood as a means of reducing costs and as a means of making the distribution of costs more equitable. Further, for some schemes, using meters to reduce leakage rates is a source of pride and accomplishment. This was the inverse of how meters and charges were perceived and effectively functioned in the mid-2010s, when Irish Water's meters were seen as a way to police individual domestic water users' consumption and raise funds.

Meters and monitoring technologies have made day-to-day maintenance easier. Bulk meters provide information about the general functioning of a scheme across a given area, but are not always located in easy-to-reach places. Bulk meters may be far below ground or located on the side of busy roads, making them difficult to regularly monitor. They may fill up with water or become overgrown with weeds. In recent years, some GWSs have installed telemetry systems on their bulk meters. These provide information about water usage that can be accessed remotely by GWS workers through mobile phone applications and computer software. This, in turn, has refashioned how monitoring, maintenance and upkeep are undertaken. Real-time information has been used to identify areas that might be experiencing unusually high usage and that might need further investigation. Accessing that information from a laptop or phone changes when and how quickly maintenance work occurs, allowing caretakers to respond to problems when they arise.

The managers and caretakers who use these systems have developed a knowledge of and feel for the data they produce. By reading usage graphs every day, they get a sense for the rhythms and flows of their schemes and can spot anomalies in the digital outputs from these systems. Unusual peaks and troughs in usage graphs can be used to identify problems and attend to them. Anthony Lee, the caretaker for Polecat Springs GWS, checks the meter readings every morning. When he sees something amiss, such as a higher than expected baseline flow rate, he will go back through the data to determine how much of a problem it is and how long it has been a problem. If it

is only a small rise in use, he may decide to wait – it could simply be that someone has left a tap running. If the problem persists, Anthony will call someone in the area with a request to inform other users and ask them to keep an eye out for any problems. With any luck, members will find the source of the problem on their own. A running tap they will turn off themselves. A leak they will inform him about. Only if nothing comes back and the high levels continue will Anthony then go out to the site himself to try to identify its cause. Anthony speaks with enthusiasm about these technologies and their significance to his work. Bulk metering and telemetry systems provide managers with a different way of understanding and relating and responding to their water infrastructures.

Individual household meters offer different ways of understanding the GWSs from bulk meters. Individual meters measure and read household and commercial usage for the purposes of assessing fees and identifying leaks. Unlike bulk meters, which are monitored regularly, individual meters may be assessed only on a yearly basis. How GWSs have incorporated individual meter reading into their activities varies, however.

For the Mid Roscommon GWS, individual household meters are read digitally. The scheme's manager, Noel Carroll, has shown us how he reads the meters by driving from box to box, recording the water usage at each connection from the comfort of his car. When he drives alongside the meter box, a hand-held device scans for a signal and chimes once the reading is complete. The process is over in a matter of seconds. A job that used to take many weeks now takes a matter of days. Although technology is crucial to how he does this, Noel has developed his own efficiencies for reading meters. When the meters were installed, each connection was photographed and recorded, and the information is now stored at the GWS's offices. But Noel has also logged the meters' locations in his memory. As we drove from house to house, he seemed to know how close he needed to be to each meter to get a reading without leaving his car or turning off the car's engine. Here, it is not the technology itself that makes the system efficient, but its combination with Noel's in-depth knowledge of the scheme.

Although many schemes have adopted this technology for individual meter readings, other schemes prefer a different approach. Some schemes use a committee of readers who manually read each meter by opening each meter's box and reading the output. This approach allows the meter readers to visually inspect each meter and gives them the opportunity to speak with the people who use the scheme. Meter reading offers the opportunity to build community among those involved with the running of the scheme and those who use it. Thus, while these schemes have incorporated meters into their activities, the way in which meters are used, and to what effect, are not uniform.

Metering technologies are standardised solutions sold by transnational companies. Despite this, our research reveals how they take on different meanings, uses and effects, and allow managers and caretakers to relate to water infrastructures in different ways. Importantly, they provide measures of how the scheme is functioning that shape not only their understandings of their water infrastructures but how they care for them. This occurs not through a universal, standardised approach, but by being situated within a broad knowledge of the scheme's members and its physical network. This helps to humanise the technology, making it useful rather than threatening. In a similar way, EU drinking water standards must undergo a period of adaptation and translation to national and local circumstances. General solutions will succeed only if they are responsive to local differences.

4.1.3 Responsive governance

The GWS sector has developed innovative forms of responsive governance, at both a national and local scale. Its experience is an illustrative example of the strengths and weaknesses of this way of managing water services.

The NFGWS acts as an organising and representative body for the sector. It operates at a range of scales and is both inwards and outwards facing. Regional development staff meet with GWS representatives, passing information and concerns back and forth through the organisation. Data are generated on scheme numbers, names, structures, connections and source locations, both by regional staff and through an annual affiliation fee form. This is used to identify challenges and inform the strategies that the NFGWS will pursue. Relevant news, knowledge and advertising are distributed within the sector in a quarterly newsletter. The newsletter

is also published on the Federation's website, along with more regular updates and sector history and information. The NFGWS encourages small GWSs to rationalise and amalgamate, so as to increase their long-term managerial and financial viability, and their attractiveness to state funders and private water management firms. It has driven the adoption of DBO contracts and the establishment of source protection measures as innovative ways of improving water quality. At a higher scale, the NFGWS liaises with national ministers, civil servants and government bodies pertinent to the sector. Most significant is its input into the Rural Water Programme of the Department of Housing, Planning and Local Government (DHPLG). Its representation extends beyond drinking water policy, however, to also consider river basin management, and issues of hydrogeology and agriculture and broader environmental concerns such as biodiversity loss and climate change. This requires reading and analysing policy documents and participating in discussions and working groups. Beyond Ireland, the NFGWS has established connections with community-managed drinking water schemes in several European countries, including Austria, Denmark and Spain (NFGWS, 2018). It stays informed about changes to EU policies, such as the Drinking Water Directive and the WFD, and considers how these may be applied in Ireland through its relationships with the EPA and LAWPRO.

The governance of individual schemes varies considerably. As has already been pointed out, some schemes have combined their management structures and outsourced parts of their operations, while other schemes have remained independent. The Lough Carra GWS is an amalgamation of several schemes and has an ongoing DBO contract with Glan Agua to provide its water treatment. By contrast, the nearby Robeen GWS has retained its organisational structure, even as it has struggled to meet water quality standards set by the national government. There are benefits and drawbacks to both approaches.

As member-run organisations, often with deep local roots and a familiarity with local issues and anxieties, schemes are often flexible and sensitive to individual difference. Several managers and caretakers said that, when non-payment arose as a result of inability to pay, the scheme was sometimes able to make arrangements with individuals to delay or even dissolve debt repayments. People sometimes fall on hard economic times, and in rural Ireland, after the 2007/2008 economic crisis, many people struggled to maintain their quality of life. It is remarkable that schemes are able to recognise and assess when this is occurring, and then take a fair, community-minded response.

GWSs can be transparent and democratic. The Polecat Springs GWS had the opportunity to lease out a parcel of land beside its reservoir to a mobile phone operator, for the purpose of building and operating a telecommunications tower, something that would not only provide a respectable and steady income stream but also improve local connectivity. Although the GWS had the legal right to enter into a deal without consulting its members, the board called a public meeting to discuss the proposal, at which they informed attendees of its merits and took a vote on whether or not it should proceed. The members voted against the proposal and it was dropped. This kind of community engagement and debate is unfortunately rare. Nevertheless, it provides an example of the ethics and attitude of which GWS governance is capable.

Fears were expressed by some of our interviewees that any shift in power and responsibility towards a higher scale of governance would have a negative effect on water management. In practice, GWS managers and caretakers were resistant to the suggestion that they might be taken over by the state. Schemes are proud of their history and legacy. More than this, however, they also believe that they are doing a better job than the public sector in securing and tending to infrastructure. Their intimate knowledge of the scheme, its technology and its members – born out of their ethic of care – would be difficult to preserve or reproduce following a centralisation of governance. This would mean a less public face for the scheme, greater scepticism about its agenda and about how it is using data-generating technologies, less knowledge about the location of pipes, their typical throughputs and more social ways of addressing potential leaks, and a more rigid approach to fee collection and dispute resolution. A less local and engaged management could also translate into less flexible and equitable service, a greater risk of bureaucratisation and a decrease in community engagement.

It is important, however, not to idealise the localism and community-based aspects of small, independent

schemes. Overemphasis on interpersonal relationships and community identity can lead to a restricted sense of parochialism and informal hierarchies. A distinction has been made to us, for example, between “rural–rural” people and “urban–rural” people, with the former embodying a positive community ethic and the latter embodying an ethic of entitlement, of expecting things to be done for them. There are multiple dangers in these identifications. At its most benign this simply reinforces the perception of a rural–urban divide, but at its worst it develops into more a pernicious protectionist and exclusionary attitude.

Small intimate groups are at a greater risk of being side-tracked by personal and professional differences, perhaps due to unavoidable clashes of personality. Even in schemes that have a well-functioning board, the importance of maintenance and repair can be undervalued. We were told by core members of a small scheme that few people are willing to put up their hand and offer to help out, and that the bulk of the unpaid labour always falls on the same shoulders. We were also told of difficulties that can arise in the collection of outstanding water charges. These may be the exceptions that prove the rule, but they are further examples of a tension we have identified throughout this research, and that is the challenge of balancing the social and communitarian values that exist within individual GWSs and the need for shared principles, protocols and standards that apply across the sector as a whole.

Other common problems with GWS governance seem to be less affected by size or professionalism. We often heard that schemes struggle to get new people involved in the board and that attendance at annual general meetings tends to be low. Board member roles are often long standing, with the ultimate outcome sometimes being a management team made up of older men. Smaller schemes have a smaller body of members to draw upon, so it is likely that this problem is more acute. But we have been told that this is a problem even for large schemes. In one countervailing example, a woman in her thirties argued that the older generation needs to be more willing to give younger members a chance. In another, the manager of the Corracreigh GWS, Thomas Rushe, described how he has sought to invest time and energy in young people who show an interest in the scheme. As widely acknowledged, there is also a clear gender imbalance within the schemes. Relatively few women sit on the boards or occupy managerial or caretaker roles. This is a legacy of the past that will be hard to change without positive action. There are exceptions to this. The manager of Corracreigh GWS until recently was a female immigrant.

A potential issue that may arise is that, having overcome problems of contamination and leakage, some schemes appear happy that all is steady and that they are able to provide their service with few worries. Although this is not a problem as such, it does reduce the likelihood of them initiating source protection efforts or engaging in education and outreach. Some schemes defy this, however. The manager of the Polecat Springs GWS, Martin Beirne, speculated about a future in which the scheme not only provides water but is involved in other forms of community infrastructure, including power and security. Recently, he has been in discussion with researchers from Trinity College and the Roscommon County Council to have solar panels installed in a field adjacent to the treatment plant (since installed). In good weather, this might be enough to run the pump, effectively turning the Polecat Springs GWS reservoir into a giant battery. This kind of social entrepreneurialism is not unique, but its presence points to the importance of the particular individuals involved.

Despite these issues, the governance of GWSs is conducted with an ethic of collectivity and equity that we believe has been crucial to their innovation and success. It has left them well positioned to attend to future challenges, all the while strengthening the fabric of rural life in Ireland.

4.2 Source Water Protection

New and ongoing source protection efforts undertaken by the GWS sector complement and intersect with new environmental projects around water management in Ireland, and directly respond to two of the UN SDGs: goal 6, clean water and sanitation; and goal 15, life on land. For regulatory, economic and environmental reasons, drinking water management involves wide-reaching consideration of the practices that affect water quality at an abstraction point. Those interested in GWS source protection have some of the same concerns as those engaged in integrated catchment management, although the water quality (drinking water vs ecological health of

water bodies) may differ. While attentive to these important differences, we use source water protection as a general term to refer to those efforts aimed at maintaining or improving the quality of ground and surface water bodies.

The Upper Dromore River Basin Surface Water Source Protection Pilot, County Monaghan, based in the Stranooden GWS, and the Groundwater Source Protection Pilot, County Roscommon, involving the GSI and the Roscommon GWS, are both part of the NFGWS Source Protection Pilot Project, phase II. While complementary projects in many respects, they are distinguished by their governance and approaches, and are situated in different physical landscapes (hydrology, geology, geographical expanse, and land uses) and social landscapes (Roscommon, Monaghan). These projects are led by individuals who are employed for their scientific expertise, although they engage local communities to varying degrees, and are strongly influenced by the NFGWS.

As a complement to this perspective, the LCCA is leading a community-led catchment project as it intersects with two GWSs. The community members and activists involved, many of whom have scientific training, nonetheless participate on a voluntary basis to implement measures to protect the future ecological health of the lake. Their efforts have important overlap with GWSs, as Lough Carra is the source of water for two GWSs, Lough Carra and Robeen GWSs. This association presents distinct issues, particularly concerning citizen science, community organising and the lake's rich ecosystem.

4.2.1 Connecting source water and drinking water

The NFGWS has been progressive in terms of seeking to position source water as part of, rather than separate from, physical water infrastructure. These connections are facilitated by the small scale of most GWSs, as a result of which the connections between source water, treatment plant, distribution network and end users are more readily perceived (than on the public system). But this should not be taken for granted either. It is important to emphasise the fact that it was communities themselves that located source waters to begin with, and again during the "bundling" stage in the 2000s, knowledge which today resides with the caretakers and managers. The ability to map the connections between "raw" water sources, treatment works, drinking water storage tanks, distribution networks and end users relies on locally specific knowledge that is, as discussed above, invaluable for managing and maintaining good water services.

It is significant that the concern for the quality of source water is connected to the capacity of water treatment infrastructures to filter out pollutants and ensure that drinking water provided is compliant. The tendency in the public water system, for example, has been to focus on technologies and infrastructures of treatment as the key point for transforming "raw" water into potable, drinking water (Bresnihan and Hesse, 2020). Despite the holistic ambition of the WFD, the institutional framework governing the provision of drinking water (Irish Water, HSE) and the protection of water sources (EPA) continues to rest on a clear separation of environmental and health considerations, mapped on to catchment and physical water infrastructures. In the case of GWSs, the risk is that a similar emphasis on water treatment (provided by private water companies) could draw focus away from the more difficult, contentious and time-consuming effort of protecting and improving source waters. At the same time, new and challenging risks associated with MCPA and microplastics, for example, that may prove difficult and/or costly to filter out at the point of treatment should militate against any complacency in this area.

The strong position of the NFGWS on these issues, as well as on related areas of climate change and biodiversity, indicates that this will not be the case. For the NFGWS, however, these issues pose a challenge that is different to that presented by rationalisation and amalgamation, for example. With treatment works in place, and funding currently available for upgrades, the incentive to protect source waters because of risks to drinking water and health are reduced. Similarly, although the costs of treatment can be reduced if the quality of the raw water is improved, such reductions are hard to demonstrate or to pass on to users on the scheme. It is for these reasons that efforts to engage communities with their catchments should not rely on economic incentives but must be part of a wider, slower shift in perceptions and values, particularly among the younger generation, that recognises the ethical, aesthetic and collective good in protecting water, land and biodiversity.

A more significant issue related to the question of scale and source protection initiatives (and discussed in more detail in section 4.2.4) is the risk of reinforcing the "local" as the scale at which action and innovation should take place. In the context of the complex, widely distributed social, political and economic drivers of changing water quality, the question of what counts as local (or global) is thus all important. Scale delimits what is relevant and irrelevant for addressing the problem at hand. How different scales are incorporated both rhetorically and through governance practices matters. In many cases, appeals to the "local scale" can be more cursory than meaningful and, rather than fundamentally shifting our approaches to water governance, they reinforce existing power structures. For example, the long-term failure of the state to upgrade urban wastewater treatment plants not only limits the efficacy of local measures to improve water quality but can also feed into a sense of cynicism and mistrust concerning the displacing of responsibility from the state to local community.

4.2.2 Qualities of water

The complexity of source water protection has become clear as the project has advanced. Source water protection depends on a confluence of factors that make every project distinct. Geology and physical geography play a significant role in determining the form and movement of water, with different karst landscapes, for example, presenting particular challenges for mapping groundwater sources and potential sources of pollutants. The form of the water bodies in question also relates to social attachment and interaction. Water that flows largely underground, out of sight, is harder to relate to than a lake, as in the case of the Carra, which is prominent in the landscape and used regularly by people for angling, boating and walking, and as a source of drinking water.

Concerns for water quality are shaped by different factors. In the Upper Dromore Catchment, MCPA and other synthetic pesticides pose a risk to drinking water, reflecting something of the farming practices in that part of the country, as well as the challenges of monitoring water quality and treating water from a public health perspective. In the Roscommon Groundwater Source Protection Pilot, the most significant issue is the relative uncertainty and unknowability of the water itself due to the geology of the region – this uncertainty in itself creates concern, while also creating a lack of focus due to the difficulty of knowing what the problems might be; protecting one area may well work, but there may be dozens of other areas that will still be influencing the quality of the drinking water at any particular spring. Finally, in the case of Lough Carra, the source water protection project began out of concern for the lake itself, a specific body of water (rather than a catchment), which in turn shapes the composition of the community involved (i.e. mostly those who use the lake) and the concerns they have.

Intersecting with the physical and land use features are the social and cultural contexts and attachments that exist within an area. It is no surprise, for example, that Lough Carra has brought together such a vibrant community catchment association. The Carra example is interesting because it highlights the different interests and connections that people have with water; water quality means different things to different groups, which can cause problems (see below) but can also be a strength. In the case of the LCCA, different interests intersect around a common concern: a desire to protect and improve the lake from the cumulative effects of pollution, largely derived from agriculture. This includes the GWSs that source their drinking water from the lake, as much as the anglers who fish on it or the artists who paint it. One of the GWSs that sources water from the lake has a robust treatment plant in place as part of a DBO project, meaning that drinking water quality is not such a pressing issue. The other, which has no treatment in place, has more of a stake in the quality of the water, which may in part explain why an individual served by that scheme is a member of the LCCA.

To talk to those who are involved in the LCCA is to be exposed to different perspectives but a shared account of how the lake has changed over the past 40 years. Those who grew up in the area recall how they played, swam or fished in its waters. Today, the streams and rivers that feed Lough Carra are clogged with weeds, reeds are thick at the river mouths, and in the summer months the water is covered in algae. The water is no longer transparent, and rocks at its bottom are covered in a green slime. Mayflies, described as once so thick you could walk across the water, are difficult to find. The birdlife has been affected, as has the quality of fishing. For those who remember how Lough Carra was in the past, these changes are upsetting. Not

only is the lake in decline but it has been for decades, making it hard to envisage how such decline might be reversed.

The importance of these different connections to water cannot be overemphasised. As discussed above, a large part of the reason why GWSs are concerned about source water protection is the knowledge that this water, and more specifically what goes into it, is directly connected to the health of the community. And, as identified in section 4.1.1, the intervention of treatment technologies through DBO contracts can in fact weaken the need to protect, or interest in protecting, source waters. Many people, including those served by GWSs, have little awareness of the connections between the water in their taps and the water in the landscape or in the clouds. Rivers and lakes are often associated with heritage, "nature" or recreation, rather than health.

The NFGWS has been innovative in leading education programmes across schools within the communities it serves. "All About Water" is a hands-on and hugely interactive source that encourages schoolchildren to explore the fascinating world of freshwater habitats and to develop an understanding of all things "wet and wild". Using a specially designed, graphically engaging workbook, the course discusses the importance of water in our everyday lives: what it is, where it comes from and how it is to be conserved and protected. Included in this is an appreciation not just of the "environmental" qualities of lakes and rivers but of how they are connected to taps and homes. The workbook is complemented by walking tours, which are invaluable in developing a geographical imagination of water and landscape. LCCA has developed a similar education programme for its area using the NFGWS's book and content, as well as input from core members in the association.

It is important to be wary of placing too much emphasis on "awareness" and "education", as this does not necessarily translate into action or power. Individuals who know about the consequences of their actions – whether that be spraying MCPA or using chemical detergents – are not necessarily going to change their behaviour (see Box 1.2). Engaging communities and the public with their catchments, or environments more generally, is not only about "raising awareness", addressing "a knowledge deficit" or encouraging behaviour change, but also includes a commitment to social transformation that should carry the potential for dissent and critique of the status quo.

Relatedly, different ways of connecting to water and communicating how it is being adversely affected should also be encouraged. Activities could include community mapping activities or participatory photography projects (see Box 1.3). Emphasising participation and local experience and expertise, such approaches would be less about educating and more about collaborative learning facilitated by educators or researchers.

The different qualities of water that people perceive and respond to are not necessarily granted equal place within catchment management. Because of the authority of the WFD and the implications for the Irish state of non-compliance, the water parameters it sets out, and the scientific methods that are aligned with them, can take on a greater power than those that might animate or concern local communities.

This situation arose in the case of Lough Carra, where concerns about the deteriorating quality of the lake were not registered within the assessment methods and status classification of water bodies within the WFD. Despite the documentation of the lake's decline over several decades, the community struggled to get the EPA to address its concerns. When the EPA first classified Lake Carra's status under the WFD, it classified it as "high". The agency was met with push-back from members of the local community, who demanded to see the data on which the classification was made and the justification for the determination. When the data were not shared to the desired extent, the community elevated its concerns about the methodology the EPA used to study the lake, which many felt was inappropriate given the uniqueness of the marl, and about the lack of monitoring on some inlets into the lake. Eventually, the EPA reclassified the lake as "good" and included the Lough Carra and Lough Mask catchment as an Area for Action under the Second RBMP. Although this has helped direct attention towards the lake, it has not allayed all the fears about the EPA and its data practices. The LCCA's concerns embody a common issue within environmental justice, namely that groups call for more data but also critique what the state perceives to be evidence of pollution and how it collects data (Walker *et al.,* 2018).

Evidently, the inability to account for different interpretations of water quality can be problematic

and reproduce an urban–rural, expert–community antagonism that is exclusionary and makes environmentalism and environmental stewardship the domain of only a few. It can also lead to unintended consequences relating to catchment management. For example, under the current WFD requirements, if one indicator goes down (e.g. because of increased presence of listed pollutant), then the overall classification of that water body will remain the same regardless of improvements in the other quality indicators. Thus, it is possible that an unexpected, one-off event (e.g. accidental release of a listed pollutant) could cancel out all of the good work invested in implementing catchment measures and improvements in that water body over a period of years. The fact that catchment scientists and managers working within this framework point to the unintended but adverse implications of the WFD assessment and regulatory framework indicates a need for a more open discussion about how the Directive can be made more flexible and responsive to different circumstances, while at the same time ensuring that the overarching goal of improved water quality is protected.

4.2.3 Situated knowledge and local expertise

Over the course of this project, we have learnt most about Ireland's changing landscape, land use, and the relationships between these and water quality, from the individuals involved in the GWSs and the LCCA. As LAWPRO and the catchments unit of the EPA continue in their efforts to connect and engage communities with their catchments, it is vital that education and awareness building are designed and implemented as a two-way, mutual exchange, rather than a one-way, top-down approach. Communities, broadly defined, should be involved in decision-making processes and outcomes, as not only is this a statutory requirement, but it can also lead to more just, equitable and sustainable decision-making (Blue, 2016). This involves generating new and better knowledge and science capable of mobilising institutional power at different scales to facilitate the actions that will be required to improve water quality.

Patrick McCabe, the scientist leading the Upper Dromore River Basin Surface Water Source Protection Pilot, is well known in the area and has a personal connection to the scheme – as a boy he had a summer job mowing the lawn around the reservoir. He also has professional qualifications suited to the position, having completed a Master's degree in Environmental Science with a focus on paleolimnology. Working with source protection demands scientific expertise, including the ability to produce and interpret sampling data, as well as strong interpersonal skills, needed to present research findings to residents of the catchment and effect changes in behaviour. He is currently based at the NFGWS offices in Monaghan town and his work feeds into its strategic thinking.

Coran Kelly is the Tobin geologist leading the Roscommon Source Water Protection Pilot. In consultation with the five GWSs involved in the project as well as representatives from the NFGWS and Roscommon County Council, he has mapped karst features in the area, identified sources of water for several of the springs used as abstraction sites and has engaged in outreach activities with local schools. Although Coran has undertaken this valuable work, engaging with individuals and communities on the ground, his task is complicated by the fact that he is based in Dublin and has other professional responsibilities that limit the number of journeys that can be made to the county.

The core members of the LCCA have been involved in campaigning on local issues of public health and wildlife conservation for more than 15 years. With a focus on reversing the decline of Lough Carra, the LCCA has attracted a broad base of participants that includes farmers, anglers, ecologists, academics, civil servants, business owners, an artist, a retired schoolteacher and a local politician. Two of the leading members, Chris and Lynda Huxley, have published a comprehensive, illustrated book on Carra, incorporating environmental and physical characteristics as well as social, historical, economic and cultural aspects of the lake. Multiple visits to Carra, including tours on and around the lake with members of the LCCA, further demonstrated the depth and extent of knowledge about the lake that exists, including detailed observations of environmental change on the lake over three decades. Combined, this knowledge cannot be dismissed as subjective or opinion.

What the work of Patrick McCabe, Coran Kelly and the LCCA demonstrates to different degrees is the importance of situating knowledge about catchments

within their social, economic and cultural contexts. There are two aspects to this that should be emphasised.

First, there is considerable knowledge about "catchments" that exceeds the methods and parameters of what is currently counted as catchment science. Although "catchment" may not be a term that is popularly used, people who have lived in an area for any amount of time tend to possess knowledge about land use and land use change, environmental change, landscape features and the connections between these localised processes and shifts in government policy.

Second, as discussed in section 5.1.2, situated knowledge is explicitly *social* knowledge, based on relations of trust, familiarity and experience. In the case of source water protection, these relationships are vital for voluntary efforts aimed at reducing sources of pollution. Because of the difficulties of getting individuals on board, and of being able to measure and prove the impacts of specific catchment measures, the fostering of shared knowledge, concerns and goals, though less measurable, can in the long run be as important for protecting water quality as one-off events or measures.

ICM in Ireland, as it has been implemented through the Second RBMP, has focused significant attention on the local level through, particularly, LAWPRO. It has sought to thoughtfully engage communities in the activities going on around its waters and "catchment" by supporting community groups, and helping to spread catchment awareness to local communities. These efforts have already had tangible benefits for the groups and individuals who have become involved.

LAWPRO officers, both community water officers and catchment scientists, are engaging with communities, albeit in different ways. Community water officers are engaging, encouraging and facilitating community groups to develop and to apply for and secure funding (see section 4.2.4). Community water officers help facilitate education and have been involved in citizen science activities and research with schools, and have offered their own expertise and guidance in helping communities achieve new goals in their own management of important water bodies.

Catchment scientists, by contrast, have less direct or sustained community involvement, at least at this stage in their work. Catchment scientists were involved in undertaking desk studies across the areas for action before doing on-the-ground rapid assessments of critical areas deemed in need of more direct attention. Catchment scientist teams have been training and working together across LAWPRO offices, and with community water officers have been leading meetings to introduce communities to their activities and larger project. These efforts have also been coupled with a new advisory group led by Teagasc, the Agricultural Sustainability Support and Advisory Programme (ASSAP), which has been holding meetings directly with farmers and will provide assistance to farmers following the assessments and recommendations of catchment scientists.

The separation of LAWPRO into the distinct work and offices of community water officers and catchment scientists reflects a familiar attitude and approach towards communities within environmental governance in Ireland. Rather than being sources of valid and valuable knowledge about their environments, local communities tend to be perceived through the lens of a "knowledge deficit". That is, community engagement events tend to emphasise education and awareness building of local communities, rather than of the scientists or experts involved in monitoring, assessment or management. Including communities from the beginning means avoiding the deficit model, in which their lack of certain kinds of knowledge is read as ignorance, obscuring the different kinds of knowledge they possess. Such knowledge can contribute to better catchment assessments and proposed solutions.

Community meetings are largely designed to disseminate findings from the scientific assessments, and to raise awareness of the work being done among the local communities. For the GWSs, this is not so much of an issue, as the NFGWS provides an important institutional means for ensuring that source water projects and treatment works are carried out with the support of the schemes and communities. LAWPRO is still developing approaches to catchment assessment and characterisation and it is hoped that this report may assist in ensuring that the knowledge base for such work is more interdisciplinary and engaged with the local expertise of people living and working on the catchment.

There are established methods and examples of participatory, community-based science collaborations,

including those that are specific to catchment management (Whitman *et al.* 2015; see also Bresnihan and Hesse, 2019). These efforts recast the roles of community members and scientific experts to develop shared understandings and actions around catchments. This is a form of research engagement that can be positively pursued in Ireland, and which can better integrate the work of scientists and communities. Through interviews with LAWPRO scientists it was suggested that training in social science or community-based methods would be valuable. For example, negotiating access to land and waterways often involves interaction with people, as does engaging with communities at a public meeting. As a start, how could these interactions be made more productive and collaborative? How could the current scientific findings produced through desk studies and catchment walks be enriched through meaningful engagement with local expertise and knowledge?

Participatory research and community science involve time, to establish relations of trust between different kinds of people and across disciplinary and methodological training and expertise. These relationships are already being developed informally and to different degrees within the three source water protection projects analysed here, but there is currently no formal training or channels for such participatory science within the work plan of LAWPRO. This is not meant as a criticism of LAWPRO, which is a new organisation undertaking innovative and important catchment assessment work. With increased financial and institutional support, including longer-term work programmes and contracts for the catchment teams, more participatory, citizen science projects could be made an integral part of their work.

While the Upper Dromore River Basin Surface Water Source Protection Pilot Project offers the best example of a combined, community-based approach to catchment management, the work of Patrick McCabe also relies on relatively informal networks and relationships. This can work in some cases, as Patrick is both a trained scientist and local resident committed to protecting water quality. Unlike scientists who come into an area, Patrick is happy and comfortable talking to and meeting with local farmers and land users. But this is a unique situation that cannot easily be replicated. More realistic and workable is the idea of building research teams, involving trained social and natural scientists and community members, as illustrated by the success of interdisciplinary, community-based catchment projects in the UK (Whitman *et al.,* 2015). This work requires financial and institutional support.

4.2.4 Assigning responsibility

A key, often contested, part of environmental governance and regulation is the assigning of responsibility for environmental degradation. Who or what is responsible for water quality problems? This question is complicated by the uncertain, non-linear pathways of diffuse pollutants and, in some cases, the prolonged periods of time over which they have accumulated. But the uncertainty and complexity of water quality and catchment management can also serve to deflect responsibility from the structural policies that have driven and continue to sustain uneven rural development and, particularly, farming. While any discussion of responsibility for water quality problems will always be contentious and sensitive, here we aim to outline how such discussions should not be ignored, as they shape attitudes and perceptions on the ground even as they are obscured by dominant institutional responses to catchment management.

Agriculture is the main source of pollution in Ireland's freshwater systems, yet the diffuse nature of this pollution and the difficulties of assigning responsibility make it difficult to manage. This challenge is particularly sensitive for rural areas and communities to deal with because farming is both a key source of income and livelihood in many parts of rural Ireland and a source of identity and culture. What we heard repeatedly from individuals in our three field sites, including farmers, is that, although pasture-based farming is the principal source of pollution, individual farmers are not to blame. Discussions of farming and its relationship to water quality (and the environment more generally) were usually placed within a wider, historical context of agricultural policy change. The water quality problems linked to farming – namely eutrophication from excess nutrients or risks from synthetic fertilisers – are the *outcomes* of agricultural policies that encouraged and facilitated increased grass production, greater herd size and larger machinery (see Box 1.2). This is a complex story that extends over decades, but what is significant is that responsibility for localised water quality problems has shifted from the individual (and the local) to

the national and European levels. This historically contextualised account thus gives rise to different responses and proposals on how the problems should be addressed. It also points to contradictions between agricultural and environmental policies that are experienced by farmers and communities on the ground.

Our research also identified a second theme related to responsibility for farming-related pollution. Although agricultural policies were targeted as the structural drivers of agricultural development, these policies benefited some farmers over others. In all three sites, individuals distinguished between those farmers and enterprises that were commercially profitable (and operating at a large, rationalised scale) and those (the majority) that were struggling, reliant on EU contributions and subsidies, and unlikely to continue in the sector. These distinctions soon became recognisable to us, embodied in the size of animal sheds and dairy parlours, herd size, size of farming machinery and the uniformity of grass fields. The distinctions that were made between different farmers were not about judging or targeting individuals for blame. It was simply about recognising that *not all farmers are equal* – in terms of size, profitability, farming practice or commitments to the environment. There was also an implicit, sometimes explicit, understanding that, while a small minority of large farmers continue to expand their operations, converting land and putting more pressure on water sources, it is not realistic to imagine that water quality issues can be addressed meaningfully. There is a contradiction, and inequity, in pursuing agricultural policies that benefit a minority of farmers, while the environmental consequences of these policies are left to the rest of the community, including smaller, part-time farmers, to resolve.

Although water protection debates often pit the environment against agriculture, environmental and agricultural interests are not homogeneous or cohesive. Location and the size of operators and their activities (dairy, beef, tillage, etc.) vary significantly and affect stakeholders' interests and the impact on them of current plans. This is important to the Irish context, in which "farmers" and "agriculture" are often discussed as if they were homogeneous, without acknowledgement of their different roles in producing water quality issues and their different interests and expectations surrounding how to manage water. While contentious, there needs to be space to discuss the power of vested interests, namely agriculture, at the same time as recognising that these interests are not the same for all farmers. Farmers do not have equal or commensurate responsibility for water quality issues or for implementing solutions, and yet they feel like they are always being "blamed".

Whether or not it is made explicit, it is the case that government policies and regulatory frameworks create winners and losers. Despite familiar claims to "win–win" outcomes, trade-offs are inescapably part of environmental governance and resource management. Rural communities understand and experience the localised effects of contradictory and unequal policies over time. Contradicting this, however, is a discursive context that places emphasis on building consent, and a message of "we are in this together" to generate feelings of responsibility and duty to one's community and waters. The corollary of this is a reluctance to produce information or make decisions that may be unfavourable to some, particularly powerful, groups in ways that disrupt the status quo. In the interest of defusing controversy, these groups end up receiving special compensation and treatment for implementing remediation. This can produce tensions and uneasiness among the wider community that it is important to acknowledge and address directly.

Arguably the clearest demonstration of this tendency to flatten differences between farmers and avoid assigning responsibility is the voluntary nature of most catchment protection measures. In the absence of stronger regulations and enforcement around pollution generated from farming activities, those involved in catchment protection activities rely on the goodwill of individuals and/or an economic incentive. This characterises efforts across both the NFGWS pilot projects and the Carra case, as well as more generally within the current approach to catchment management in Ireland (see Box 4.1).

As we have learnt through our research, one of the consequences of this emphasis on voluntary participation by individual farmers is that the farmers who get involved tend to be those farming less intensively and less commercially. This may be because they have little to lose and are happy to contribute to a community effort, or because there may be an opportunity to gain funding for participation in environmental schemes. The farmers who are less

Box 4.1. The data treadmill

In the summer of 2018, the LCCA organised meetings to address community concerns about the deterioration of the Carra, a marl lake in County Mayo, one of the best-studied lakes in Ireland. At the first meeting the chairman of the LCCA posed the question, "Do we need more science?" (Ward, 2018). By the autumn of 2018, the answer to that question was "Yes". In the subsequent months, the LCCA applied for and was awarded rural development funding to undertake a study of the lake to identify the pollution pressures, research that will support an application for EU funding for, most likely, agri-environmental schemes to incentivise farm-specific strategies to remediate agricultural pollution. Although university scientists and members of the LCCA have been documenting the decline of the lake for years, the LCCA is pursuing more data to justify interventions that fit within prevailing ideas about environmental governance in Ireland and how to measure and assess responsibility for environmental pollution. We call this logic and process the "data treadmill".

Insofar as controversial environmental management problems are seen as "uncertain", the data treadmill incentivises increasingly more data collection at more local scales of analysis so that more localised solutions to environmental pollution can be put in place. The analogy of the "treadmill" suggests that this approach to environmental governance, intentionally or unintentionally, results in the delaying of effective and meaningful action.

First, it perpetuates a narrative that effective action requires more precise data and evidence. This idea relies on the assumption that more data can provide a more "accurate" representation of complex processes, and thus help specify precise causes/flows of pollution that can be managed while defusing contention: "Critical pressures and conflicts in the catchments are often 'skirted around'" (Daly, 2014). This is most evident in current approaches to managing agricultural sources of pollution.

Second, it resolves questions of responsibility through "bespoke" approaches to environmental pollution. Once catchment scientists have identified an individual farmer as a source of pollution, they will work with the newly established ASSAP to help communicate voluntary measures with farmers on a farm-by-farm basis to implement remediation strategies. In addition to obscuring wider questions of responsibility (e.g. policy drivers), this approach also creates a significant financial and time burden in terms of amassing the quantities of data needed and arranging with individual farmers to undertake measures.

Third, it facilitates the rescaling of governance, such that communities can become tied into European funding programmes that also require the facilitation of various professionals and consultants. Although this is less relevant to the GWS sector, as catchment measures are currently fully funded, it may affect the GWS sector down the line (the DHPLG has made it clear that it will not be in a position to fund significant catchment measures for all GWS source waters). Channelling community catchment efforts towards EU funding programmes such as LIFE or the European Innovation Partnership means that the state is by-passed as a key stakeholder in the protection and management of catchments, and communities are made to vie for highly competitive funding streams. Our point here is not that funding is all bad but rather that public engagement should be not be overly determined by it and the restrictions it carries.

likely to get involved in catchment protection measures (particularly those that require setting aside land for buffers) are those who are farming most intensively and commercially. These are precisely the farms that may be contributing most to the water quality problems through larger applications of slurry and/or fertiliser run-off. It is unrealistic to imagine that these farmers will voluntarily shift from intensive farming practices, particularly when they are being trained in intensive farming and rewarded by government policies and agricultural agencies. Thus, a limitation of a voluntary approach to catchment management within the context of Ireland's agricultural policies is that it places the burden on smaller, less commercially viable, farmers, while larger farmers are encouraged to legally pollute. Not only does this avoid the root of the problem, it

can also lead to cynicism and frustration among those involved in these community-based efforts.

Environmental goals such as improved water quality cannot be separated from fundamental considerations of the legacies of agricultural policy and current agricultural policies that reward certain agricultural sectors and farmers at the expense of the environment and alternative land use and food production systems. Through our many interactions with people, including farmers, who live in these rural communities, it was clear that they want both healthy environments, including good water quality, and sustainable, secure livelihoods. They should not have to choose between these. By ignoring contradictions in policy and refusing to recognise that they generate winners and losers, such policies can undermine the legitimacy of the government as a key stakeholder in environmental resource management.

As this project has delved into issues of water provisioning and protection in parts of rural Ireland, the connections between the viability and sustainability of these water-related activities and wider questions of rural development and livelihoods have become clearer. In response to the question, “What is the greatest challenge facing the sustainability of your GWS?”, the most common response from caretakers and managers involved in the day-to-day management of water schemes was the loss of people from the area and the lack of people coming forward to continue the work needed. This related to the need for water connections (and the money associated with this) but also, more significantly, to changes within the community, particularly the loss of young people. It is significant that, in our research, critics of this industrial model of farming included farmers as well as non-farmers.

The lack of economic opportunities in rural areas is particularly tied to changes in farming and a recognition that the industry is not providing for rural communities as it once did. At the same time, the principal source of pollution in water bodies was in all three cases understood to be intensive agriculture. Patently there are no simple or quick fixes to these intractable problems that have been developing over decades, but there is clearly a need to have more robust, honest and substantial debates about the close relationships between farming/land use practice, the environment and government policies. The solutions to these problems will not be found through voluntary, individual or local efforts alone.

5 Conclusions and Findings

GWSs complicate divisions of public and private, state and non-state, catchment and infrastructure in their relationships to their communities, their waters, their environments and the government. Since the late 1990s, a form of community-operated water enterprise has continued to endure in the face of demanding regulatory requirements and changing environmental conditions. Ireland's GWSs have sought new investments and state resources, while still maintaining their collective ethos. This is particularly interesting in the context of wider transformations in the national water sector, which itself has dealt with issues of non-compliance, decaying infrastructure, and the need for investment and rationalisation.

GWSs are community enterprises that have survived as an alternative to state enterprise in Ireland's water sector system by continually refashioning themselves. Although reliant on the state, they are self-organised, separate from, but entangled with, broader processes within Ireland's water sector and economic development. As positive as their flexibility sounds, it also reflects their perennial vulnerability. Just as the public water network relies on public funding, GWSs also rely on the state-funded Rural Water Programme. As much as GWSs engage in source water protection schemes, the government's agricultural policies ensure that any progressive measures to reduce agricultural impacts need to be understood within a context of Irish policies to grow the agricultural sector.

Our findings support the work of the NFGWS but are also intended to inform wider discussions and activities that involve the EPA, LAWPRO, local authorities, Irish Water and the National Water Forum, among others. LAWPRO, for example, is very new and, from our own research interviewing LAWPRO officers, attending community and operational meetings, reviewing catchment newsletters, and interviewing and working with several communities concerned about their water, we can see that its work aims to develop innovative catchment assessments and measures. This is an opportune time to provide constructive reflections on the work currently being undertaken, as there is clearly an openness and willingness to develop methods and approaches to advance participatory catchment management.

5.1 Innovation in Drinking Water Provision (SDG 6)

Over the past 20 years, the GWS sector has transformed itself by successfully addressing problems with water quality and leakage. While issues remain, particularly among the smaller schemes with ageing board members, they have become a leading example of good practice in drinking water provision in this country, in many respects outperforming the public sector. This report has sought to understand what it is about GWSs that has allowed them to innovate in this way. Three themes have been identified and explored: that they care for their water infrastructures; that they have combined standardised technologies and practices with a deep knowledge of people and place; and that they have developed a responsive disposition to governance. These innovations deserve to be recognised and respected by state institutions. This means acknowledging that they take time and require continuous, long-term support.

5.1.1 Care and maintenance

The care and maintenance of water infrastructures is often unspectacular and ongoing. This can be thought of as innovative.

In an era of infrastructural failure, when innovation is usually taken to mean disruption, GWSs demonstrate the importance of taking the time to maintain community, the environment and technology. Water infrastructures require slow, patient and careful work if they are to function as a substrate for rural life and economy. This form of work must receive recognition and remuneration. Understanding and recognising the maintenance of people and pipes, both in policy documents and in more public forums, is one way of honouring GWS managers and caretakers. Recognition is crucial to promoting such work.

5.1.2 Standardised and situated technology

GWSs are adopting and adapting to standardised regulations and technologies. This works best when it operates as a two-way exchange between regulators and technologies and the specific needs, knowledge and ethos of the places and communities where they are being implemented.

Performance and design standards are an important way of improving the delivery and viability of clean drinking water. The GWS sector recognises this and has been successful in shaping their design and adapting its implementation to fit local needs and demands. This two-way relationship should continue and where possible be strengthened. It should not be assumed that data and technology are a replacement for local knowledge and labour. Individual and bulk water meters and telemetry have succeeded precisely because they are being used to supplement the specific needs and knowledge of managers and caretakers, and extend the community ethos of the GWS sector.

5.1.3 Responsive governance

GWSs, facilitated and represented by the NFGWS, have developed responsive forms of governance, which enable them to account for social differences and needs, as well as changing regulatory, environmental and financial demands.

The GWS sector offers an example of multi-scale governance practices based upon an ethos of local community and equity. GWSs are capable of fairness, transparency and democracy, over and beyond what would be expected from a public service. However, the focus on local, particularly rural, community identity can also generate problems, including an aversion to conflict (particularly with private landowners and agricultural interests).

5.2 Innovation in Protecting Freshwater Sources (SDG 15)

The three source water protection projects covered in this report are working within challenging contexts to do what they can to protect and improve the water bodies they depend on and care about. As emphasised throughout this report, local initiatives are always tied to and shaped by policy and economic contexts over which they have little power. They also operate within social and cultural contexts, which in rural parts of Ireland are closely tied to farming and land.

Working within these contexts, the three projects demonstrate the significant commitment that exists at a local scale for addressing what are clearly understood to be problems with deeper and wider roots than their catchment or community covers. These projects succeed in “holding up a candle”, as one respondent put it; they are neither oblivious to the scale and complexity of the problems they face nor resorting to apathy and resignation. This is perhaps one of the most telling and inspiring features of these projects. For some, including the NFGWS, this place-based work is understood as a small contribution to a wider societal and political shift that is happening as the risks of climate change, and other environmental threats, begin to hit home and affect rural communities.

5.2.1 Connecting source water and drinking water

The NFGWS has been progressive in terms of seeking to position source water as part of, rather than separate from, physical water infrastructure. But source water protection and water quality are not just local issues. While community participation and action is vital, there is equally a need to avoid overburdening local communities with complex problems that have origins in institutional and economic contexts beyond their control.

The connections between source water, treatment plant, distribution network and end users are more obvious in the case of GWSs than the public system. This is not just a function of the local scale of GWSs. GWSs do not operate in accordance with the same institutional and regulatory frameworks that separate freshwater systems and the drinking water system, with the focus on treatment works as the key point of intervention for transforming “raw” water into potable, drinking water. These are institutional and regulatory legacies that Irish Water and relevant agencies are aiming to address.

In the case of GWSs, there is a risk that an emphasis on water treatment could draw focus away from the more difficult, contentious and time-consuming

effort of protecting and improving source waters. With treatment works in place, and funding currently available for upgrades, the incentive to protect source waters because of risks to drinking water and health is reduced. Similarly, although the costs of treatment can be reduced if the quality of the raw water is improved, such reductions are hard to demonstrate or to pass on to users of the scheme. It is for these reasons that efforts to engage communities with their catchments should not rely on economic incentives, but must be part of a wider shift in perceptions and values associated with the protection of water, land and biodiversity.

Focusing too much on the geographical boundaries of the catchment as a "natural" phenomenon, or the GWS as a "local" community, can obscure how decisions and processes that take place outside those boundaries affect local water quality. Water is at once global and local, influenced by global climate changes, international and national economic policies and trade, and local social relations and practices. While approaches to source water protection may call for flexibility and place specificity, a local lens to water governance can place all the responsibility for action on specific places, communities and individuals. This can obscure how pressures and processes that operate at national and international scales prescribe local decision-making and possibilities for action – such as economic policies, funding and regulation.

5.2.2 Qualities of water

GWSs, and the LCCA, demonstrate the varied qualities of water that people perceive, relate to and value. The connections are the basis of why people care about water and may become involved in protecting it. These different qualities and concerns should be incorporated within source water protection projects from the beginning and recognised for their potential scientific merit.

Connections to water in catchments vary depending on concerns about health, recreation, physical geography and geology, and land use. The importance of these different connections to water cannot be overemphasised. Rather than focusing on educating people about their catchments, more effort should be made to create collaborative, mutual learning between certified scientific experts and local, non-certified experts. The incorporation of local knowledge can contribute to better catchment assessments and proposed solutions (see below).

5.2.3 Situated knowledge and local expertise

Local communities involved in source protection, such as GWSs or the LCCA, possess rich, wide-ranging knowledge about the places where they live. This knowledge should be understood as a different form of expertise that can work with established scientific methods to generate more rigorous and critical insights into water-related issues.

The knowledge that people possess about the places where they live and work is not easily categorised or even articulated; it is not data waiting to be included within existing scientific assessments. There are, however, established methods for participatory, community-based science, including those that are specific to catchment management. These efforts recast the roles of community members and scientific experts to develop shared understandings and actions around catchments. This is a form of research engagement that can be positively pursued in Ireland, and which can better integrate the work of scientists and communities.

Participatory research and community science involve time, to establish relations of trust between different kinds of people and across disciplinary and methodological training and expertise. Institutional and financial supports for participatory, community science projects are thus essential and need to be separated from short-term projects that force groups to chase funding for the next step in their process. Participatory approaches could be worked into the existing activities of LAWPRO, which is already organising catchment walks and assessments, but without input from local communities. Providing more funding through existing research channels can also foster the development and dissemination of participatory and innovative methods.

5.2.4 Assigning responsibility

Source water protection is a complex and contentious area of water governance, as the protection of common goods can come into conflict with private interests relating to land use and farming. These tensions need to be acknowledged, not obscured, while at the same time recognising that these

relationships are sensitive and require more contextual understandings of rural development and sustainability.

While any discussion of responsibility for water quality problems will always be contentious and sensitive, such discussions should not be ignored, as they shape attitudes and perceptions on the ground even if they are obscured by existing approaches to catchment management. GWSs and the NFGWS provide a relatively unique position in the institutional landscape of Ireland in this respect – rural and community based but developing new discourses around environmental protection that look to the future while also recognising the deep cultural, social and economic attachments to certain models of farming. There is no easy solution or overnight policy that will resolve these contradictions, but the NFGWS, as well as organisations like the LCCA, are working to change perceptions, build networks and foster shared, place-based knowledge. Creating alternative rural livelihoods and economies will take time and will require state support in the form of funding and enabling institutional conditions.

It is necessary to emphasise the importance of regulation in fostering trust and accountability of state stakeholders in facilitating water governance. We recommend the enforcement of regulation to meet water quality goals rather than relying heavily, as is currently the case, on voluntary adoption of measures and schemes. Decentralised and voluntary measures have become more common in many of the approaches to ICM currently being pursued in Ireland. However, the contradictions between agricultural and environmental policies, and the failure and lack of trust in institutions to enforce existing regulation, can undercut these voluntary measures.

A focus on funding within catchment management reflects real institutional constraints, but it also channels these projects to particular models of organisation, forms of knowledge and goals that align with the requirements of particular funding bodies and programmes. These models underpin incentive-based and community-based approaches. Most significantly, however, they help perpetuate cycles of funding and data that are self-reinforcing, recast the content of community concerns and can further facilitate forms of precarity that are always tied to the next funding source. The argument here is not that source water protection does not need funding and other institutional supports from the state, but that it should not be so reliant on highly competitive, European funding programmes.

References

Anon., 2000. Dirty drinking water. *Irish Times*, 13 December 2000. Available online: https://www.irishtimes.com/opinion/dirty-drinking-water-1.1120913 (accessed 9 June 2020).

Armitage, D.R., Plummer, R., Berkes, F., Arthur, R.I., Charles, A.T., Davidson-Hunt, I.J., Diduck, A.P., Doubleday, N.C., Johnson, D.S., Marschke, M., McConney, P., Pinkerton, E.Q. and Wollenberg, E.K., 2015. Adaptive co-management for social-ecological complexity. *Frontiers in Ecology and the Environment* 7(2): 95–102.

Blue, G., 2016. Framing climate change for public deliberation: what role for interpretive social sciences and humanities? *Journal of Environmental Policy & Planning* 18(1): 67–84. https://doi.org/10.1080/1523908X.2015.1053107

Brady, J. and Gray, N.F., 2010. Group water schemes in Ireland – their role within the Irish water sector. *European Water* 29: 39–58.

Brady, J. and Gray, N.F., 2016. Reform of the Irish water sector: opportunities and challenges. *Proceedings of the Institution of Civil Engineers – Water Management* 170(4): 165–174.

Bresnihan, P., 2016. The bio-financialization of Irish water: new advances in the neoliberalization of vital services. *Utilities Policy* 40(June): 115–124.

Bresnihan, P. and Hesse, A., 2019. *Public Engagement in Water Governance. Report to The Water Forum*. Available online: https://thewaterforum.ie/app/uploads/2020/03/Water-Forum_Public-Participation_Bresnihan-and-Hesse_2019.pdf (accessed 5 October 2020).

Bresnihan, P. and Hesse, A., 2020. Political ecologies of infrastructural and intestinal decay. *Environment and Planning E: Nature and Space*. https://doi.org/10.1177/2514848620902382

Carson, A., Jennings, E., Linnane, S. and Jordan, S.N., 2015. Clearing the muddy waters: using lake sediment records to inform agricultural management. *Journal of Paleolimnology* 53(1): 1–15.

Chique, C., Potito, A.P., Molloy, K. and Cornett, J., 2018. Tracking recent human impacts on a nutrient sensitive Irish lake: integrating landscape to water linkages. *Hydrobiologia* 807(1): 207–231.

Daly, M., 1997. The state, Irish women & running water. In O'Dowd, M. (ed.), *Women and Irish History*, Wolfhound Press, Dublin, pp. 206–219.

Daly, D., Archbold, M. and Deakin, J., 2014. Water Framework Directive implementation and integrated catchment management. Paper presented at the Irish National Hydrology Conference, 11 November, Tullamore, Co. Offaly.

Deane, B., 2003. An evaluation of group water schemes in the Republic of Ireland. Master's Thesis. University College Dublin, Dublin.

Donohue, I., Leira, M., Hobbs, W., León-Vintro, L., O'Reilly, J. and Irvine, K., 2010. Rapid ecosystem recovery from diffuse pollution after the Great Irish Famine. *Ecological Applications* 20(6): 1733–1743.

EPA (Environmental Protection Agency), 2019. *Water Quality in Ireland, 2013–2018*. EPA, Johnstown Castle, Ireland.

Fitzpatrick, D., 1980. The disappearance of the Irish agricultural labourer, 1841–1912. *Irish Economic and Social History* 7(1): 66–92.

Forsyth, T., 2004. *Critical Political Ecology: The Politics of Environmental Science*. Routledge, London.

Haraway, D., 1988. Situated knowledges: the science question in feminism and the privilege of partial perspective. *Feminist Studies* 14(3): 575–599.

Harding, S., 2000. Democratizing philosophy of science for local knowledge movements: issues and challenges. *Gender, Technology and Development* 4(1): 1–23.

Huxley, C. and Huxley, L., 2015. *Lough Carra*. Carra Books, Castlebar, Ireland.

Johnsen, S., May, J. and Cloke, P., 2008. Imag(in)ing "homeless places": using auto-photography to (re)examine the geographies of homelessness. *Area* 40(2): 194–207.

King, J.J. and Champ, W.S.T., 2000. Baseline water quality investigations on Lough Carra, western Ireland, with reference to water chemistry, phytoplankton and aquatic plants. *Biology and Environment: Proceedings of the Royal Irish Academy* 100B(1): 13–25.

Landström, C., Becker, M., Odoni, N. and Whatmore, S.J., 2019. Community modelling: a technique for enhancing local capacity to engage with flood risk management. *Environmental Science & Policy* 92: 255–261.

Lane, S.N., Odoni, N., Landström, C., Whatmore, S.J., Ward, N. and Bradley, S., 2011. Doing flood risk science differently: an experiment in radical scientific method. *Transactions of the Institute of British Geographers* 36(1): 15–36.

Lianne, S., Jordan, S., McCarthy, V., Jennings, E., Carson, A., Sweeney, N., Wynne, C. and McDonald, B., 2011. *National Source Protection Pilot Project at Churchill & Oram Group Water Scheme, County Monaghan: Final Report 2005–2010*. Dundalk Institute of Technology, Dundalk, Ireland.

Lombard, M., 2013. Using auto-photography to understand place: reflections from research in urban informal settlements in Mexico. *Area* 45(1): 23–32.

NFGWS (National Federation of Group Water Schemes), 2003. *Rural Water News*, Summer 2003. Available online: https://nfgws.ie/wp-content/uploads/2018/10/Summer-2003.pdf (accessed 9 June 2020).

NFGWS (National Federation of Group Water Schemes), 2004. *Rural Water News*, Summer 2004. Available online: https://nfgws.ie/wp-content/uploads/2018/10/Autumn-2004.pdf (accessed 9 June 2020).

NFGWS (National Federation of Group Water Schemes), 2009. *Rural Water News*, Summer 2009. Available online: https://nfgws.ie/wp-content/uploads/2018/10/Summer-2009-RWN-Magazine.pdf (accessed 9 June 2020).

NFGWS (National Federation of Group Water Schemes), 2018. *Rural Water News*, Winter 2018. Available online: https://nfgws.ie/wp-content/uploads/2018/10/Winter-2018-final-web.pdf (accessed 9 June 2020).

Nelson, L., 2018. Running on empty: Ireland's water crisis. *The Times*, 11 March 2018. Available online: https://www.thetimes.co.uk/article/running-on-empty-irelands-water-crisis-59bsplzj0?t=ie (accessed 5 October 2020).

Nightingale, A.J., 2016. Adaptive scholarship and situated knowledges? Hybrid methodologies and plural epistemologies in climate change adaptation research. *Area* 48(1): 41–47.

McCormick, S., 2007. Democratizing science movements: a new framework for mobilization and contestation. *Social Studies of Science* 37(4): 609–623.

Mellander, P., Jordan, P., Wall, D., Melland, A., Murphy, P., Mechan, S., Shine, O. and Shortle, G., 2014. Groundwater vulnerability in agricultural karst landscape. *Teagasc Research* 9(2): 38–39.

NFGWS (National Federation of Group Water Schemes), 1998. Rural water programme. Circular L4/98. Available online: https://nfgws.ie/wp-content/uploads/2019/03/CircularL4-98.pdf (accessed 15 December 2020).

OECD (Organisation for Economic Co-operation and Development), 2015. *OECD Studies on Water: Stakeholder Engagement for Inclusive Water Governance*. OECD Publishing, Paris. Available online: https://www.idaea.csic.es/medspring/sites/default/files/Stakeholder-engagement-for-inclusive-water-governance.pdf (accessed 5 October 2020).

Rhoads, B.L., Wilson, D., Urban, M. and Herricks, E.E., 1999. Interaction between scientists and nonscientists in community-based watershed management: emergence of the concept of stream naturalization. *Environmental Management* 24(3): 297–308.

Russell, A. and Vinsel, L., 2016. Hail the maintainers. *Aeon*. Available online: https://aeon.co/essays/innovation-is-overvalued-maintenance-often-matters-more (accessed 3 September 2019).

Singleton, S., 2000. Co-operation or capture? The paradox of co-management and community participation in natural resource management and environmental policy-making. *Environmental Politics* 9(2): 1–21. https://doi.org/10.1080/09644010008414522

Walker, G., Devine-Wright, P., Hunter, S., High, H. and Evans, B., 2010. Trust and community: exploring the meanings, contexts and dynamics of community renewable energy. *Energy Policy* 38: 2655–2663.

Ward, M., 2018. Time is running out for Lough Carra. *Irish Times*, 7 June 2018. Available online: https://www.irishtimes.com/news/science/time-is-running-out-for-lough-carra-1.3513993 (accessed 9 June 2020).

Wehn, U., Collins, K., Anema, K., Basco-Carrera, L. and Lerebours, A., 2018. Stakeholder engagement in water governance as social learning: lessons from practice. *Water International* 43(1): 34–59.

Whitman, G.P., Pain, R. and Milledge, D.G., 2015. Going with the flow? Using participatory action research in physical geography. *Progress in Physical Geography: Earth and Environment* 39(5): 622–639.

Abbreviations

ASSAP	Agricultural Sustainability Support and Advisory Programme
CAP	Common Agricultural Policy
CSO	Central Statistics Office
DBO	Design–build–operate
DHPLG	Department of Housing, Planning and Local Government
EEC	European Economic Community
EPA	Environmental Protection Agency
EU	European Union
GSI	Geological Survey of Ireland
GWS	Group water scheme
HSE	Health and Safety Executive
ICA	Irish Countrywomen's Association
ICM	Integrated catchment management
LAWPRO	Local Authorities Water Programme
LCCA	Lough Carra Catchment Association
MCPA	2-methyl-4-chlorophenoxyacetic acid
NFGWS	National Federation of Group Water Schemes
RBD	River basin district
RBMP	River Basin Management Plan
SDG	Sustainable Development Goal
THM	Trihalomethane
UN	United Nations
WFD	Water Framework Directive
ZOC	Zone of contribution

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL
Tá an Ghníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaol a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ó éifeachtaí díobhálacha na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialú: *Déanaimid córais éifeachtacha rialaithe agus comhlíonta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.*

Eolas: *Soláthraímid sonraí, faisnéis agus measúnú comhshaoil atá ar ardchaighdeán, spriocdhírithe agus tráthúil chun bonn eolais a chur faoin gcinnteoireacht ar gach leibhéal.*

Tacaíocht: *Bímid ag saothrú i gcomhar le grúpaí eile chun tacú le comhshaol atá glan, táirgiúil agus cosanta go maith, agus le hiompar a chuirfidh le comhshaol inbhuanaithe.*

Ár bhFreagrachtaí

Ceadúnú
Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaol:
- saoráidí dramhaíola *(m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola)*;
- gníomhaíochtaí tionsclaíocha ar scála mór *(m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta)*;
- an diantalmhaíocht *(m.sh. muca, éanlaith)*;
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe *(OGM)*;
- foinsí radaíochta ianúcháin *(m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha)*;
- áiseanna móra stórála peitril;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil
- Clár náisiúnta iniúchtaí agus cigireachtaí a dhéanamh gach bliain ar shaoráidí a bhfuil ceadúnas ón nGníomhaireacht acu.
- Maoirseacht a dhéanamh ar fhreagrachtaí cosanta comhshaoil na n-údarás áitiúil.
- Caighdeán an uisce óil, arna sholáthar ag soláthraithe uisce phoiblí, a mhaoirsiú.
- Obair le húdaráis áitiúla agus le gníomhaireachtaí eile chun dul i ngleic le coireanna comhshaoil trí chomhordú a dhéanamh ar líonra forfheidhmiúcháin náisiúnta, trí dhíriú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhramhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a ídíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Uisce
- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uiscí idirchriosacha agus cósta na hÉireann, agus screamhuiscí; leibhéil uisce agus sruthanna aibhneacha a thomhas.
- Comhordú náisiúnta agus maoirsiú a dhéanamh ar an gCreat-Treoir Uisce.
- Monatóireacht agus tuairisciú a dhéanamh ar Cháilíocht an Uisce Snámha.

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol
- Monatóireacht a dhéanamh ar cháilíocht an aeir agus Treoir an AE maidir le hAer Glan don Eoraip (CAFÉ) a chur chun feidhme.
- Tuairisciú neamhspleách le cabhrú le cinnteoireacht an rialtais náisiúnta agus na n-údarás áitiúil *(m.sh. tuairisciú tréimhsiúil ar staid Chomhshaol na hÉireann agus Tuarascálacha ar Tháscairí)*.

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn
- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis cheaptha teasa a ullmhú.
- An Treoir maidir le Trádáil Astaíochtaí a chur chun feidhme i gcomhair breis agus 100 de na táirgeoirí dé-ocsaíde carbóin is mó in Éirinn.

Taighde agus Forbairt Comhshaoil
- Taighde comhshaoil a chistiú chun brúnna a shainaithint, bonn eolais a chur faoi bheartais, agus réitigh a sholáthar i réimsí na haeráide, an uisce agus na hinbhuanaitheachta.

Measúnacht Straitéiseach Timpeallachta
- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaol in Éirinn *(m.sh. mórphleananna forbartha)*.

Cosaint Raideolaíoch
- Monatóireacht a dhéanamh ar leibhéil radaíochta, measúnacht a dhéanamh ar nochtadh mhuintir na hÉireann don radaíocht ianúcháin.
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha.
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta.
- Sainseirbhísí cosanta ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Faisnéis Inrochtana agus Oideachas
- Comhairle agus treoir a chur ar fáil d'earnáil na tionsclaíochta agus don phobal maidir le hábhair a bhaineann le caomhnú an chomhshaoil agus leis an gcosaint raideolaíoch.
- Faisnéis thráthúil ar an gcomhshaol ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaol *(m.sh. Timpeall an Tí, léarscáileanna radóin)*.
- Comhairle a chur ar fáil don Rialtas maidir le hábhair a bhaineann leis an tsábháilteacht raideolaíoch agus le cúrsaí práinnfhreagartha.
- Plean Náisiúnta Bainistíochta Dramhaíola Guaisí a fhorbairt chun dramhaíl ghuaiseach a chosc agus a bhainistiú.

Múscailt Feasachta agus Athrú Iompraíochta
- Feasacht chomhshaoil níos fearr a ghiniúint agus dul i bhfeidhm ar athrú iompraíochta dearfach trí thacú le gnóthais, le pobail agus le teaghlaigh a bheith níos éifeachtúla ar acmhainní.
- Tástáil le haghaidh radóin a chur chun cinn i dtithe agus in ionaid oibre, agus gníomhartha leasúcháin a spreagadh nuair is gá.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil
Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí. Déantar an obair ar fud cúig cinn d'Oifigí:
- An Oifig um Inmharthanacht Comhshaoil
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Fianaise is Measúnú
- Oifig um Chosaint Radaíochta agus Monatóireachta Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag comhaltaí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

EPA Research Report 364

Learning from Group Water Schemes: Community Infrastructures for Sustainable Development

Authors: Patrick Bresnihan, Arielle Hesse and James Merricks White

Identifying Pressures

The quality of many of Ireland's freshwater sources is declining. The decline in water quality impacts in turn the quality and affordability of Ireland's drinking water services. Ireland's water infrastructure requires significant upgrades and extensions if it is to continue to provide safe, affordable drinking water to the population and avoid direct and indirect financial penalties from the European Commission. The recent reform of the public Irish water sector has sought to address this through the establishment of a single, national water utility and the introduction of domestic metering and charges. However, in the face of public opposition, water charges have been suspended, and the future challenges for Irish Water are significant.

Informing Policy

In the context of national and international debates around the future of water resources and provisioning, the experience and performance of Ireland's group water scheme sector provides valuable insights and lessons. Over the past 20 years, the group water scheme sector has transformed itself by successfully addressing problems with water quality and leakage, in many respects outperforming the public sector, as well as being active in the protection of freshwater sources. This project examines the history and development of the group water scheme sector, identifying how and why it has been successful in providing essential water services to rural Ireland.

Developing Solutions

This project has several key findings that have implications beyond the rural water sector. First, in an era of infrastructural failure, when innovation is usually taken to mean disruption, group water schemes demonstrate the value of often-overlooked but essential work required to sustain environments, infrastructure, and community. Second, group water schemes are adaptive, responsive and community-focused institutions, able to tailor standardised regulations and technologies to local needs, environments and social differences. Third, through its focus on three source water protection projects in Counties Mayo, Monaghan and Roscommon, the project demonstrates that local expertise is both extensive and valuable in understanding the connections betweenlocal environmental change, national and European policy, land use change, farming practice and economicpressures. This expertise needs to be better combined with established scientific methods to generate morerigorous and critical insights into water-related issues. Finally, the project shows that source water protection is acomplex and contentious area of water governance as the protection of common goods can come into conflictwith private interests relating to land use and farming.

EPA Research: McCumiskey House,
Richiew, Clonskeagh, Dublin 14.

Phone: 01 268 0100
Twitter: @EPAResearchNews
Email: research@epa.ie

www.epa.ie

EPA Research Webpages
www.epa.ie/researchandeducation/research/