Water Governance and Management Practices in the Republic of Ireland: Past, Present and the Future

Dissertation

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by

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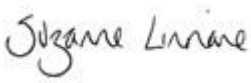
Supervisor Signature: 

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Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor of Philosophy is entirely my own work, and that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

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Dundalk, May, 2023

Sarpong Hammond Antwi

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Acronyms and Abbreviations

ASSAP	Agricultural Sustainability Support and Advisory Programme
CAP	Common Agricultural Policy
CRU	Commission for Regulation of Utilities
CSO	Central Statistical Office
DECLG	Department of Environment Community and Local Government
DHLGH	Department of Housing and Local Government
DHPLG	Department of Housing, Planning and Local Government
DCCAE	Department of Communications Climate Action and Environment
DCHG	Department of Culture Heritage and Gaeltacht
EPA	Environmental Protection Agency
EU	European Union
FILLM	Integrated Land and Landscape Management
GWS	Group Water Schemes
ICA	Irish Countrywomen Association
IFA	Irish Farmers Association
IPA	Institute of Public Administration
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resource Management
LAWPRO	Local Waters Authority Programme
NCMC	National Co-ordination and Management Committee
NFGWS	National Federation of Group Water Schemes
NGO	Non-Governmental Organization
NIDIS	National Integrated Drought Information System
NWRP	National Water Resources Plan
OECD	Organisation for Economic Co-operation and Development
PoMS	Programmes of Measures
PwC	Price Waterhouse Coopers
RBD	River Basin District
RBMP	River Basin Management Plan
RoI	Republic of Ireland
SDG	Sustainable Development Goals
SI	Statutory Instrument
SWAN	The Sustainable Water Network
UFW	Unaccounted for Water
WASH	Water, Sanitation and Hygiene
WEF	World Economic Forum
WFD	Water Framework Directive
WPAC	Water Policy Advisory Committee
WQMP	Water Quality Management Plan

Summary

Robust water governance and management practices are critical in safeguarding water resources against threats such as drought, water pollution, infrastructure deficits, population growth, and policy implementation challenges. Despite being susceptible to these challenges, the Republic of Ireland (RoI) has implemented reforms aimed at facilitating a more integrated national approach to water resource protection.

Research aim

Following a descriptive, concurrent mixed method approach and research lens, this study examines three key research questions, providing the first comprehensive evaluation of changes in water governance and practices in the water-rich RoI. The research highlights significant events and measures taken to prepare for future challenges.

Summary of research activities and their contribution to each research question

Research Questions	**RQ 1:** How have significant historical events led to key water policy changes in the RoI?	**RQ 2:** To what extent have recent changes in water policies affected the value placed on water?	**RQ 3:** How have policy responses to recurrent drought events impacted water conservation actions in the RoI?
Unit of analysis	Historical and Literature review	Legislative Policies. Case study	Drought strategies
Independent variables	Significant events	Perceptions and attitude to changes in GWS. Socio-economic value on drinking Water resources	Drought communication
Primarily addressed in	Chapter 2	Chapter 3 and 4	Chapter 5

The research provides a historical antecedent of how significant events in the last seven decades have influenced governance and management practices. It identifies the factors that have driven the policy reforms towards a more sustainable water future. The contribution is historical, but empirical examples from water policies and management

practices are retrieved through desk research and document analysis to support theoretical arguments. The findings indicate that in the early 1970s, water governance was characterized by reactive regulations aimed at pollution control and monitoring. The introduction and subsequent removal of domestic water charges have also been divisive since 1977. The impacts of climate change, land-use planning, demographic changes and international legislation, and the impact of the activities of agriculture on water quality are further discussed to ascertain their influence on water policy and management. This research also sheds light on how the state and non-state institutions and groups tend to deflect attention from their inadequacies regarding water quality issues and regulatory compliance with water quality and conservation measures. The impacts of climate change, land-use planning, demographic changes, and international legislation are further discussed to ascertain their influence on water policy and management in RoI.

With the advent of the Water Framework Directive (WFD) in 2003, the crux of policy and management practices has since changed. The River Basin Management Plan (RBMP) under WFD provides a structure to plan present policies and management practices. To this effect, the research evaluates the RBMP to identify its successes and challenges, document stakeholder expectations, and propose recommendations to improve the effectiveness of the third RBMP, scheduled to be effective from 2022–2027. Along with fourteen key stakeholder interviews and a desk review of water policies and literature, a broad spectrum of actors and a three-tier governance structure that has been implemented in the context of the first and second RBMP are discussed in this research. Towards the third RBMP, enhanced and well-resourced communications among actors in the water sector, optimised water sector finance, and improved stakeholder collaboration are needed to foster effective and efficient water service delivery and quality. There are also suggestions to maximise the benefits of public participation and recommendation for the consideration of the Sustainable Development Goals (SDG) in water management. This

includes multi-sector approaches to derive the triple benefits from biodiversity, climate change initiatives and water quality measures.

GWS as a case study and their Willingness To Pay (WTP) for water services

Using the Group Water Schemes (GWS) as a case study this research uses Willingness to Pay as a contingent valuation method and survey questionnaire to evaluate water demand trends and conservation and to test the willingness of consumers to pay for water services. With Unaccounted-For-Water (UFW) rates above 25%, overaged pipelines and leakages and increase water demand and usage, the majority of GWS members have an expressed desire to pay €50 per annum for improved water quality and services delivery, which can also be additional revenue to improve the activities of schemes. The study of the GWS sector also provides insights into water governance differences between rural and urban Ireland and indicates how practices from the sector could be scaled up to improve water service delivery nationally.

Research contribution

A critical review of relevant scientific literature also provides insight into the impact of climate change on water resources and the broader domain of drought impacts on water supply and availability. The research highlights the influence of communication in promoting water conservation and awareness amidst climate uncertainty, such as drought. Using an analysis of social media communication, newspaper articles published from 2018 to 2020, and stakeholder interviews, the study identifies lessons from the 2018 and 2020 droughts and offers recommendations to improve public communication on water resource availability. The findings suggest a comprehensive national information management system and a national drought plan to improve water conservation during and after drought events.

The research acknowledges that the challenges of effective governance and management of water resources are complex and multifaceted. While it does not present a comprehensive solution to these challenges, it emphasizes the importance of communication, bottom-up stakeholder engagement, including the inclusion of youth and gender perspectives, as well as an understanding of the socio-economic values that shape water

resource use and management. By prioritizing these elements, it is believed that effective governance and management practices can be developed and implemented to ensure the long-term sustainability of water resources. Generally, the findings from this research deepen understanding and contribute to the broader knowledge of water governance and management by highlighting and addressing identified gaps, with recommendations for governance and management changes. It further contributes to the design and implementation of water policies, especially under changing climatic conditions and a rise in demand and usage for the RoI.

Although the centrality of the research is on the RoI, its findings and means of implementation can be replicated. For countries aiming for a sustainable water future, the various methods and approaches used here can be adopted to evaluate water governance and management practices. Additionally, there is potential for further research into consumer behaviour, water conservation communication and policy implementation from legal, economic, educational, and public administration perspectives.

Future enquires

The research was carried out in a PhD-by-publication format, which involves publishing peer-reviewed papers or book chapters in reputable journals or other outlets (DkIT Academic Council, 2020). This format allowed the researcher to disseminate the findings to stakeholders for policy consideration in a timely manner and to receive external feedback through various review processes. In addition, undertaking this PhD research by publication is the first of its kind in the Centre for Freshwater and Environment Studies (CFES) in DkIT.

Research format

Achoimre

Tá rialachas uisce agus cleachtais bhainistíochta láidre ríthábhachtach chun acmhainní uisce a chosaint ar bhagairtí mar thriomach, truailliú uisce, easnaimh bhonneagair, fás daonra, agus dúshláin maidir le cur i bhfeidhm beartais. In ainneoin go bhfuil sí i mbaol na ndúshlán seo, tá leasuithe curtha i bhfeidhm ag Poblacht na hÉireann (RoI) atá dírithe ar chur chuige náisiúnta níos comhtháite a éascú do chosaint acmhainní uisce.

Tar éis cur chuige tuairisciúil comhthráthach modh measctha agus lionsa taighde, scrúdaíonn an staidéar seo trí phríomhcheist taighde, ag soláthar an chéad mheastóireacht chuimsitheach ar athruithe ar rialachas agus cleachtais uisce i bPoblacht na hÉireann saibhir in uisce. Aibhsíonn an taighde imeachtaí suntasacha agus bearta a glacadh chun ullmhú do dhúshláin amach anseo.

Aidhm taighde

Ceisteanna Taighde	**RQ 1:** Cén chaoi ar tháinig athruithe tábhachtacha ar bheartas uisce i bPoblacht na hÉireann mar thoradh ar imeachtaí suntasacha stairiúla?	**RQ 2:** Cé chomh mór agus a chuir athruithe le déanaí ar bheartais uisce isteach ar an luach a chuirtear ar uisce?	**RQ 3:** Cén tionchar a bhí ag freagairtí beartais ar thriomach athfhillteach ar ghníomhaíochtaí caomhnaithe uisce i bPoblacht na hÉireann?
Aonad anailíse	Léirmheas ar Stair agus Litríocht	Beartais Reachtaíochta. Cás-staidéar.	Straitéisí triomach.
Athróga neamhspleácha	Imeachtaí suntasacha	Dearcadh agus dearcadh ar athruithe i GWS. Luach socheacnamaíoch ar acmhainní uisce óil.	Cumarsáid triomach
Primarily addressed in	Caibidil 2	Caibidil 3 agus 4	Caibidil 5

Achoimre ar ghníomhaíochtaí taighde agus an méid a chuir siad le gach ceist taighde

Soláthraíonn an taighde réamhinsint stairiúil ar conas a chuaigh imeachtaí suntasacha le seacht mbliana anuas i bhfeidhm ar chleachtais

rialachais agus bhainistíochta. Aithníonn sé na fachtóirí a spreag na leasuithe beartais i dtreo todhchaí uisce níos inbhuanaithe. Is ranníocaíocht stairiúil é, ach faightear samplaí eimpíreacha ó bheartais uisce agus ó chleachtais bhainistíochta trí thaighde deisce agus anailís doiciméad chun tacú le hargóintí teoiriciúla. Tugann na torthaí le fios go raibh rialacháin imoibríocha dírithe ar rialú agus monatóireacht ar thruailliú mar shaintréith de rialachas uisce sna 1970idí luatha. Tá tabhairt isteach agus baint na dtáillí uisce tí ina dhiaidh sin deighilte ó 1977. Déantar tuilleadh plé ar thionchair an athraithe aeráide, ar phleanáil úsáid talún, ar athruithe déimeagrafacha agus ar reachtaíocht idirnáisiúnta, agus ar thionchar ghníomhaíochtaí na talmhaíochta ar cháilíocht an uisce chun a fháil amach cén fáth a bhfuiltear ag súil leo. tionchar ar bheartas agus bainistíocht uisce. Léiríonn an taighde seo freisin an chaoi a mbíonn claonadh ag institiúidí agus grúpaí stáit agus neamh-stáit aird a tharraingt ar a n-easpaí maidir le saincheisteanna cáilíochta uisce agus comhlíonadh rialála le cáilíocht uisce agus bearta caomhnaithe. Déantar tuilleadh plé ar thionchair an athraithe aeráide, pleanáil talamhúsáide, athruithe déimeagrafacha, agus reachtaíocht idirnáisiúnta chun a dtionchar ar bheartas agus ar bhainistiú uisce i bPoblacht na hÉireann a fháil amach.

Creat rialachais agus bainistíochta uisce

Le teacht na Creat-Treorach Uisce (WFD) in 2003, tá athrú tagtha ar bhunchloch na mbeartas agus na gcleachtas bainistíochta ó shin. Soláthraíonn an Plean Bainistíochta Abhantraí (RBMP) faoin WFD struchtúr chun polasaithe agus cleachtais bhainistíochta reatha a phleanáil. Chuige sin, déanann an taighde meastóireacht ar an RBMP chun a rath agus a dhúshláin a shainaithint, chun ionchais na ngeallsealbhóirí a dhoiciméadú, agus chun moltaí a mholadh chun éifeachtúlacht an tríú RBMP a fheabhsú, atá le bheith éifeachtach ó 2022-2027. Mar aon le ceithre agallamh déag le príomhpháirtithe leasmhara agus athbhreithniú deisce ar bheartais agus ar litríocht uisce, pléitear speictream leathan gníomhaithe agus struchtúr rialachais trí shraith a soláthraíodh (le leasú) tríd an gcéad agus an dara RBMP. I dtreo an tríú RBMP, tá gá le cumarsáid fheabhsaithe agus dea-acmhainní i measc gníomhaithe san earnáil uisce,

airgeadas earnála uisce barrfheabhsaithe, agus comhoibriú feabhsaithe le geallsealbhóirí chun seachadadh agus cáilíocht seirbhísí uisce atá éifeachtach agus éifeachtúil a chothú. Tá moltaí ann freisin chun na buntáistí a bhaineann le rannpháirtíocht an phobail a uasmhéadú agus moltaí maidir le breithniú na Spriocanna Forbartha Inbhuanaithe (SDG) i mbainistíocht uisce. Áirítear leis sin cineálacha cur chuige ilearnála chun na tairbhí triaracha a bhaint as bithéagsúlacht, tionscnaimh um athrú aeráide agus bearta cáilíochta uisce.

GWS mar chás-staidéar agus a dTonntanas Le híoc (WTP) as seirbhísí uisce

Ag baint úsáide as na Grúpscéimeanna Uisce (GWS) mar chás-staidéar úsáideann an taighde seo Toilteanas chun Íoc mar mhodh luachála teagmhasach agus ceistneoir suirbhéireachta chun treochtaí éileamh uisce agus caomhnú a mheas agus chun toilteanas tomhaltóirí íoc as seirbhísí uisce a thástáil. Agus rátaí Uisce Gan Cuntas os cionn 25%, píblínte ró-acmhainne agus sceitheanna agus méadú ar éileamh agus úsáid uisce, tá fonn léirithe ag formhór chomhaltaí an GWS €50 in aghaidh na bliana a íoc as cáilíocht feabhsaithe uisce agus seachadadh seirbhísí, rud is féidir. ioncam breise a bheith ann freisin chun gníomhaíochtaí scéimeanna a fheabhsú. Soláthraíonn an staidéar ar an earnáil GWS léargas freisin ar dhifríochtaí rialachais uisce idir an tuath agus Éire uirbeach agus léiríonn sé conas a d'fhéadfaí cleachtais ón earnáil a mhéadú chun feabhas a chur ar sheachadadh seirbhísí uisce go náisiúnta.

Athrú aeráide agus cumarsáid

Tugann athbhreithniú criticiúil ar litríocht eolaíoch ábhartha léargas freisin ar thionchar an athraithe aeráide ar acmhainní uisce agus ar an réimse níos leithne de thionchair triomach ar sholáthar agus infhaighteacht uisce. Leagann an taighde béim ar thionchar na cumarsáide maidir le caomhnú uisce agus feasacht a chur chun cinn i measc na héiginnteachta aeráide, cosúil le triomach. Ag baint úsáide as anailís ar chumarsáid ar na meáin shóisialta, ailt nuachtáin a foilsíodh ó 2018 go 2020, agus agallaimh le páirtithe leasmhara, aithníonn an staidéar ceachtanna ó thriomach 2018 agus 2020 agus cuireann sé moltaí ar fáil chun cumarsáid phoiblí a fheabhsú maidir le hinfhaighteacht acmhainní uisce. Tugann na torthaí le fios go bhfuil córas cuimsitheach náisiúnta

bainistíochta faisnéise agus plean náisiúnta triomach ann chun caomhnú uisce a fheabhsú le linn agus tar éis teagmhais triomach.

Aithnítear sa taighde go bhfuil na dúshláin a bhaineann le rialachas agus bainistiú éifeachtach acmhainní uisce casta agus ilghnéitheach. Cé nach dtugann sé réiteach cuimsitheach ar na dúshláin sin, leagann sé béim ar a thábhachtaí atá cumarsáid, rannpháirtíocht geallsealbhóirí ón mbun aníos, lena n-áirítear peirspictíochtaí óige agus inscne a chuimsiú, chomh maith le tuiscint ar na luachanna socheacnamaíocha a mhúnlaíonn úsáid acmhainní uisce. agus bainistíocht. Trí thosaíocht a thabhairt do na gnéithe seo, creidtear gur féidir cleachtais rialachais agus bainistíochta éifeachtacha a fhorbairt agus a chur i bhfeidhm chun inbhuanaitheacht fhadtéarmach acmhainní uisce a chinntiú. Go ginearálta, cuireann torthaí an taighde seo le tuiscint agus cuireann siad leis an eolas níos leithne ar rialachas agus bainistíocht uisce trí bhearnaí aitheanta a aibhsiú agus aghaidh a thabhairt orthu, le moltaí le haghaidh athruithe rialachais agus bainistíochta. Cuidíonn sé freisin le ceapadh agus le cur i bhfeidhm na mbeartas uisce, go háirithe faoi choinníollacha aeráide atá ag athrú agus méadú ar éileamh agus úsáid do RoI.

Ranníocaíocht taighde

Cé go bhfuil lárnacht an taighde ar Phoblacht na hÉireann, is féidir a thorthaí agus a mhodhanna cur chun feidhme a mhacasamhlú. Maidir le tíortha a bhfuil sé mar aidhm acu todhchaí uisce inbhuanaithe, is féidir na modhanna agus na cineálacha cur chuige éagsúla a úsáidtear anseo a ghlacadh chun rialachas uisce agus cleachtais bhainistíochta uisce a mheas. Ina theannta sin, d'fhéadfadh tuilleadh taighde a dhéanamh ar iompar tomhaltóirí, cumarsáid caomhnaithe uisce agus cur i bhfeidhm beartais ó dhearcadh dlí, eacnamaíoch, oideachais agus riaracháin phoiblí.

Fiosrúcháin sa todhchaí

Rinneadh an taighde i bhformáid PhD-ar-fhoilseachán, lena n-áirítear páipéir phiarmheasúnaithe nó caibidlí leabhar a fhoilsiú in irisí creidiúnacha nó in asraonta eile (Comhairle Acadúil DkIT, 2020). Cheadaigh an fhormáid seo don taighdeoir na torthaí a scaipeadh ar gheallsealbhóirí le haghaidh breithniú beartais ar bhealach tráthúil agus aiseolas seachtrach a fháil trí phróisis athbhreithnithe éagsúla. Ina

Formáid taighde

theannta sin, tá tabhairt faoin taighde PhD seo trí fhoilsiú ar an gcéad cheann dá leithéid san Ionad um Staidéar Fionnuisce agus Comhshaoil (CFES) in DkIT.

Chapter 1

INTRODUCTION

Water governance and management in the Republic of Ireland have been undergoing changes to facilitate a more integrated national approach to water resources protection. This introductory chapter provides a background to the underpinning issues in the water sector (section 1.1), and the state-of-the-art knowledge and gaps (section 1.1.2). The research approach and justification, methodologies and data collection techniques and the contributions to the field of water governance and management are presented in various sub-sections[1]*. Section 1.2.2, for instance, explains the research lens that guided the research. Section 1.5 also contains a complete synopsis of the six chapters that make up this dissertation and the reading guide for selective readers.*

[1] Where applicable, Digital Object Identifier (DOI) links to data and results are provided.

1.1 Background

The Republic of Ireland (RoI) has a complex network of over 4,842 identified water bodies that covers an expansive 84,800 km of mapped river channels, more than 12,000 lakes, and over 14,000 km2 of coastal waters and numerous estuaries (Trodd et al., 2021). The entire Irish River Basin District covers a total area of 70,273km2, with 46 catchment management units and 583 sub-catchments, which encompass a total of 4,842 water bodies that comprise 112 coastal water bodies, 196 transitional waters, 812 lakes, 3,192 rivers, 514 underground waters and 16 canals (DHLGH, 2022; DHPLG, 2018a; EPA, 2020a). These resources serve as critical natural assets, supporting recreational, agricultural, and industrial activities, and providing a healthy ecosystem for aquatic life. They also hold significant cultural, spiritual, archaeological and historical value, as evidenced by various myths and folklore, such as the salmon of knowledge and holy wells of Ireland, that are associated with them (Heritage Council, 1990; Ray & McCormick, 2023). The abundance of water resources also makes the Republic of Ireland (RoI) a water-rich country with its surface waters and groundwater among the most desirable in Europe (EPA, 2020b; O'Driscoll et al., 2018).

Despite the abundance of water resources, studies have shown potential adverse impacts of climate change on the availability and quality of these resources in RoI (DCHG, 2019; DHPLG, 2019; García et al., 2021; Hall et al., 2012; IPCC, 2021; Mateus & Coonan, 2022; O'Driscoll et al., 2018), yet, the predicted detrimental effects of climate change on water resources, responses and actions to combat the phenomena have not equated to the pieces of evidence from scientific attestations and climate reports (Allan et al., 2019; Cisneros, Jiménez et al., 2014; IPCC, 2021). Changes in the hydrological cycle, variations in the freshwater ecosystem, and a reduction in water quality; even under standard treatment, are some climate change severity on available water resources in RoI as in other countries and cities (DCCAE, 2018; He et al., 2021; Mockler et al., 2016; O'Hara et al., 2019; Romano & Akhmouch, 2019).

Beyond climate change, there is a long-standing failure in aligning the agricultural sector to environmental laws and legislation, making it a challenge for the sector to adhere to sustainable practices that guide and protect available water resources. Almost half of river bodies (43%), a quarter of groundwater (24%) and one-

fifth of estuarine and coastal water bodies (22.2%) have excessive nutrient (i.e. nitrogen and phosphorus) levels mainly from intense agricultural activities (Trodd et al., 2021). Excessive pesticide usage, physical demand and wetland drainage also remain a significant concern in the agricultural sector which poses a significant threat to public and private water supplies (DHPLG, 2018a). Currently, over 84% of the population in the Republic of Ireland (RoI) receive their drinking water from Uisce Éireann (Irish Water) as a national utility while the remainder depend on private wells and small private supplies or various Group Water Schemes (Cotterill & Melville-Shreeve, 2021). At the end of 2020, over a million people were dependent upon 46 vulnerable water supplies. Approximately 15,500 domestic water consumers were on boil water notices for more than a month within the same year (EPA, 2021d).

Amid this challenge, there is an increase in population growth, a rise in average domestic water consumption and perennial water supply leakages and Victorian-aged water infrastructures, which poses a significant threat to the efficient supply and delivery of clean drinking water. In addition, economic growth leading to infrastructural development across various sectors of the economy, production increment and water demand among industries and discharge of industrial waste in water bodies have also been threatening the water sector. The glaring impact of the interlinked relationship between water demand and usage and economic development and population growth has been driving policy discussions on land-use planning, rural water programmes, agricultural reforms and leakage reduction programmes to augment water supply (DHPLG, 2018a).

Nonetheless, the sheer urgency to implement governance and management reforms such as nitrate directives, emission reduction, infrastructural re-development and adherence to various environmental protocols and legislations are influenced by policy fragmentations and fear of socio-economic and political repercussions, as evident in the formation of Uisce Éireann (Irish Water) as a state utility in 2013 and nationwide protests over domestic water charges and installation of water meters which enormously influenced the 1997, 2011 and 2016 elections in the RoI (Bresnihan, 2016; Clinch & Pender, 2019a; McGee, 2012). Thus, the collective implication of population growth, economic expansion, industrial and agricultural pollution, as well as political nuances and reactive legislations in the RoI, have been impacting water

quality, its availability and ecosystems in general (CSO, 2020c; DHPLG, 2018a). Consequently, several, internal and external legislative instruments, governance and management reforms and alternative approaches have been developed over the last seven decades to manage and control the impact of these factors. These include the formation of Group Water Schemes between 1950 and 1960 through the "Turn on the Tap Campaign" to promote water access and equity among rural households (NFGWS, 2019a; waterschemes.ie, n.d.). The Local Government (Water Pollution) Act (1977), is also regarded as one of the earliest pieces of water legislation on which the first water quality management plan (WQMP) was launched to monitor local authorities' plans and progress on water quality and services (NDP, 2007). The adoption of the European Union Water Framework Directive (WFD) and its accompanying River Basin Management Plans (RBMP) in 2003 has also been a turning point in water management practices in the RoI, coupled with the introduction and subsequent removal of water charges, as well as the establishment of new institutions such as Local Waters Authority Programme (LAWPRO), and An Fóram Uisce|The Water Forum. The enactments of various Water Services Acts, in addition to agricultural reforms and the formation of the National Federation of Group Water Schemes (NFGWS) and Uisce Éireann, have also been driving changes and reforms in water resource governance and management. All these have resulted in a gradual shift towards a decentralised water management practice with traces of multi-level governance visible across the board, which hitherto was heavily centralised.

Notwithstanding these reforms, decades of shortfalls in the formulation and implementation of water resources management policies and practices have been hampering efforts towards a transition to a sustainable water future for the RoI (Antwi et al., 2021; Boyle et al., 2021; Daly et al., 2016; DHPLG, 2018a). In light of this background an assessment of significant reforms in the water-rich Republic of Ireland (RoI), albeit challenges with access, equity and availability aided by varying factors, are investigated. But whereas this research does not seek to project an absolute solution to all identified challenges in the water sectors due to the diverse direction from which effective governance and management of water resources can be approached. A sustainable water resource management perspective that recognises the importance of co-benefit approaches, dialogical communication, and bottom-up

stakeholder engagement involving the youth with gender inclusivity and socio-economic values is the standpoint from which various suggestions and recommendations are put forward in this research. This perspective is utilised because water resources governance and management are enshrined in socio-political, institutional and economic complexities that are influenced by multiple stakeholders and factors. These factors include changes in societal values and climate change uncertainties on water resources and conflicts of interest, which impact decision-making and implementation processes. This further justifies why water governance and management reforms in this research is evaluated from a multi-objective context to meet both long, medium and short-term consequences over time in the Republic of Ireland (RoI).

1.1.2 The Research Gaps

To date, there has been limited assessment of water resources management policy and governance in the Republic of Ireland (RoI), despite the large-scale changes and reforms from local to national levels. Although these changes in water-related policy and governance have been made to adhere to international legislation, several knowledge gaps remain, which can be divided into four areas: 1) the history of water governance and management in the RoI is limited, which hinders a comprehensive understanding of past challenges and opportunities, 2) a scholarly assessment of the challenges with implementing the River Basin Management Plans (RBMPs) and stakeholder expectations for the third RBMP (2022-2017) has not been adequately explored, despite RBMPs representing a move towards more integrated water management 3) water demand trends and consumer attitudes to water and water conservation, particularly among Group Water Schemes (GWSs), including their willingness to pay for water services, have not been adequately measured and 4) the impact of droughts on water resources and their anticipated recurrent threat contrasts with the perception of water-rich Ireland. Yet, the role of communicating to promote water conservation remains limited.

This research, therefore, assesses past, present and future water governance and management practices in the RoI to facilitate a transition into a sustainable water

future. By addressing the above knowledge gaps, the research enables a more integrated national approach to managing water resources, ultimately contributing to sustainable development and the achievement of national and international targets.

1.2 Research Approach and Design

The research approach and design outline the methodology and procedures employed to achieve the research objectives and address the research questions. This encompasses various aspects of the research process, including data collection, analysis, and the theoretical lens used to interpret the findings. It also includes the justification for the approaches adopted in this research.

1.2.1 Research Objectives and Questions

Main Research Objective

The overarching goal of this research is to provide the first-known assessment of the changes in water governance and management practices in water-rich Republic of Ireland (RoI), highlighting significant events and preparedness for future challenges. It is achieved by three specific guiding research objectives and associated questions (Table 1).

Main Research Questions

To what extent have water policy and governance changed in the Republic of Ireland (RoI) in response to socio-economic, political and climate events?

Table 1. Specific Research Objectives and Research Questions

Specific Research Objectives	**Specific Research Questions**
RO 1: A description of historical and current water governance in the Republic of Ireland. *Understanding how water governance has changed over time in response to changes in policy and management practices provides the foundational knowledge for future adaptive and sustainable management practices. The focus lies on the past seven*	RQ 1: How have significant historical events led to key water policy changes in the Republic of Ireland

decades and particularly on the Integrated River Basin Management Planning (RBMP) cycle.	
RO 2: An assessment of the socio-economic value of water in the Republic of Ireland and how this has been influenced by recent water governance changes. *This assessment spotlights how the Group Water Schemes (GWS) sector as a case study has adjusted to the changes in water governance, highlighting access and equity issues and efforts toward sustainable water demand and consumption.*	RQ 2: To what extent have recent changes in water policies affected the value placed on water?
RO 3: An assessment of the impact of climate change on water resource availability in the Republic of Ireland. *This analysis focuses on how a climatic phenomenon such as drought is communicated and evaluates the extent to which stakeholder actions and preparedness lead to water resources protection actions amid uncertainties.*	RQ 3: How have policy responses to recurrent drought events impacted water conservation actions in the Republic of Ireland?

1.2.2 Research Lens

A Multi-level Approach and Governance Principles, Theory of Change, and the Rounds Model are the primary lenses through which this research was done. These lenses guarantee that the research is theoretically informed, offers an explanation and interpretation of the facts gathered, and validates the assumptions, biases, and viewpoints (Ojansivu et al., 2022). The composite lenses also improve the validity and credibility of this research while providing a comprehensive and nuanced understanding of significant events in the water sector, management transition periods, challenges and opportunities for a sustainable water future for RoI.

A Multi-level Approach and Governance Principles

Water governance and management is a broad area with diverse perceptions and approaches to understanding its tenets. A considerable body of literature exists on different methods and tools that can be used to assess and address the complications of water governance systems across various settings and among institutions, including stakeholders and actors who use and manage water in determining what

constitutes good water governance (Akhmouch, 2014; Olagunju et al., 2019; Serrat-Capdevila et al., 2013). The majority of these assessment tools such as the Asia Water Governance Index (AWGi), The Middle East and North Africa (MENA) Regional Water Governance Benchmarking Project, the African Development Bank Water Governance Study and the Organisation for Economic Co-operation and Development (OECD) water governance principles are however only applicable within a specific regional setting or country, which adds up to the assertion that there is no particular rule of thumb for water governance (Jacobson et al., 2013; Lautze et al., 2011; OECD, 2018a; Tortajada, 2010). Others, such as the Annotated Water Integrity Scan (AWis) and Capability, Accountability and Responsiveness Framework and Drivers of Change Approach, rely on interdisciplinary means to assess water governance capacity under specific situations at both national and regional levels. Some tools and methods also consider different disciplines to offer a dynamic approach to water governance assessment; nevertheless, most are either too theoretical or limited to only defined jurisdictions or lack socio-cultural considerations. To determine what constitutes good water governance and management practices in the RoI, the Organisation for Economic Co-operation and Development (OECD) Multi-level Approach to Water Governance and principles concept is the first lens on which evaluations in this research are based. The multi-level approach and water governance principles serve as a diagnostic tool that aids in pinpointing the main multi-level challenges in the water sector and in developing necessary policies and strategies to avert such challenges (Akhmouch, 2014; Jacobson et al., 2013; OECD, 2018a). It entails Effectiveness, Efficiency, Trust and Engagement as overarching principles of good water governance that are mutually reinforcing (OECD, 2018a). Effectiveness encompasses coherency in the implementation of water policies including goals and objectives and the resultant outcomes in meeting set targets. Efficiency also touches on the contribution of governance in maximising the benefits of sustainable water management to meet present and future needs at a minimal cost. Trust and engagement emphasise stakeholder confidence and inclusivity in water governance processes (Akhmouch & Correia, 2016; OECD, 2015a, 2018a). The application of these three principles is complementary to 12 specific principles as defined by the OECD as follows:

- Principle 1. Clear allocation and separation of roles and responsibilities for policymakers, policy implementation, management and regulation, and coordination across responsible authorities.
- Principle 2. Water management practises that reflects local conditions through integrated basin governance systems at different scales.
- Principle 3. Policy coherence through effective cross-sectoral co-ordination that involves spatial and land use planning, agriculture, water, energy and the environment as a whole.
- Principle 4. Capacity building for responsible authorities to meet water challenge complexities.
- Principle 5. Production and timely dissemination of water data and information relevant for improve water policy.
- Principle 6. Efficient, transparent and timely financial mobilization and allocation.
- Principle 7. Effective enforcement and implementation of water management regulatory framework in the interest of the public.
- Principle 8. Implementation of innovative water governance practices across all levels of stakeholder engagement and responsible authorities.
- Principle 9. Integrity and transparency across water institutions, policies and governance framework to ensure accountability and decision-making.
- Principle 10. Informed and outcome oriented stakeholder engagement and contributions towards water policy design and implementation.
- Principle 11. Effective water governance framework that can accommodate trade-off across rural-urban areas and among water users now and the future.
- Principle 12. Promotion, monitoring and evaluation of water policy and governance where appropriate, and sharing of results and feedback relevant for improvement where possible.

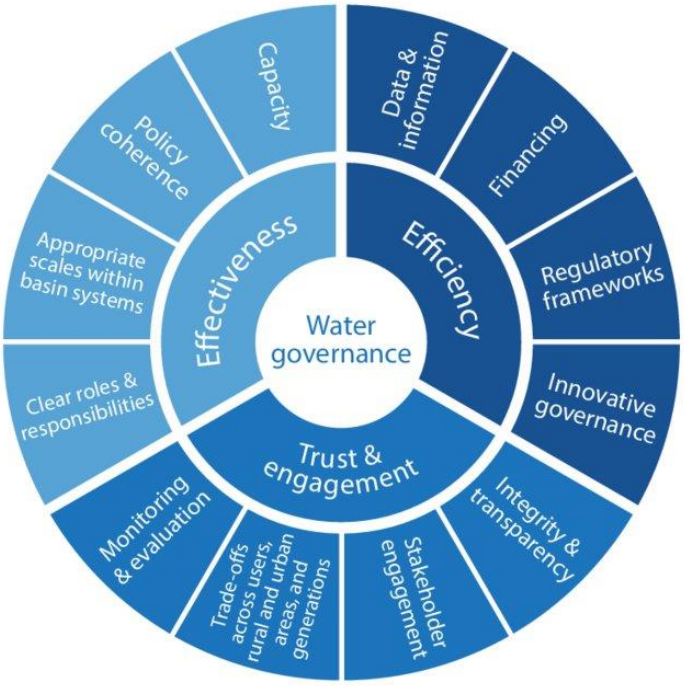

Figure 1. OECD Principles on water governance. Source: *(OECD, 2018a)*.

The governance principle (Figure 1) is used widely in assessing water governance status at different scales, with varying multi-stakeholder dialogues, and as guidance for internal and external processes and practices across OECD and non-OECD countries (OECD, 2018b). Although the principles do not serve as a one-stop solution to all water problems, in light of the circumstances of water governance and management in the RoI, it is assumed they can advance the improvement in water governance. The principles offer options for building robust water governance systems that can be adapted to meet present and future challenges via multi-level guidelines for integrated water policy and management practices through stakeholder integration (Akhmouch, 2014; OECD, 2018a). Stakeholders as described by the OECD are actors from the private and non-profit sectors with different motivations, needs and interests in the water sector. Stakeholder engagement in the water sector is a key principle of good water governance as these actors are either impacted by policy decisions or do take part in discussions to influence certain decisions within the water sector (Akhmouch & Clavreul, 2016; OECD, 2015b). This governance principle is relevant because RoI has a range of stakeholders (i.e. citizens, private actors, consumers, financial institutions, service providers, research,

agricultural and industry players, policy makers etc.) with a keen interest in outcomes in the water sector.

Whereas the multi-level approach to water governance is tailored to the spatial scale of a river basin and to exploring the gaps in water policy (Akhmouch, 2014; OECD, 2018a), it does not take the passage of time into account as required in understanding water governance and management reforms. A Theory of change approach was therefore deployed in the policy context of the Republic of Ireland (RoI) to identify the changes that have occurred over time and their implications for water governance and management practices.

Theory of Change

The historical roots of theory of change have been recognized since the 1990s from the field of theory-driven evaluations (Reinholz & Andrews, 2020). The theory spells out measures that can be used to achieve long-term outcomes by offering a description of how changes occurred in the past, the present and their impacts in the future. The theory has proved useful in drawing the threads together on why, how and when significant changes occurred in the water sector and in understanding their impacts on future policies and implementation actions in the RoI (Maru et al., 2018). To depict this visually, a pathway of change is created as a representation of the connections between significant events that have influenced water governance and management from the 1950s (Figure 2).

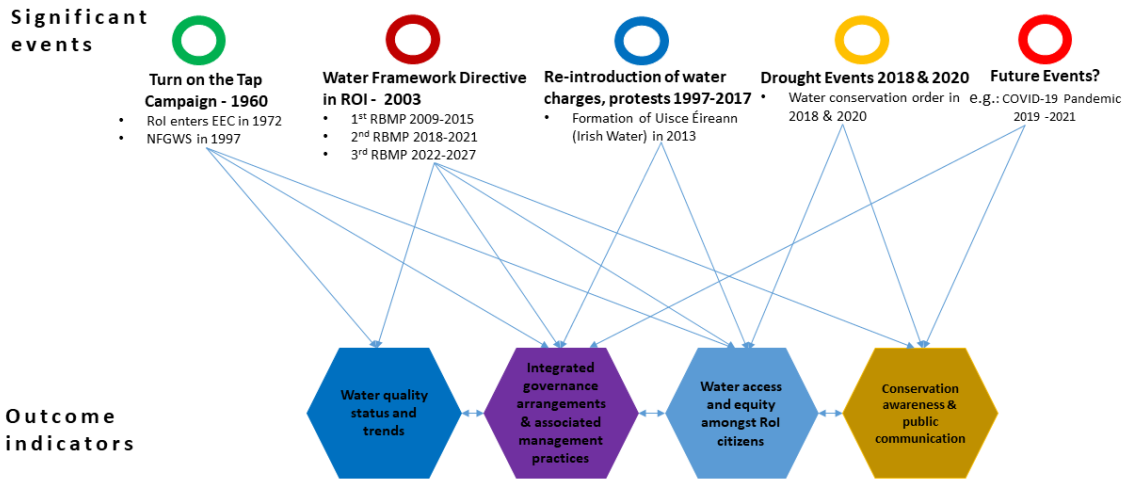

Figure 2. Theory of change in water governance and management in the Republic of Ireland.

The theory of change envisages the present outcomes and potential future impacts as configured by significant events in water management in RoI in the past. In the figure above, the significant events since the 1950s are depicted as open circles (upper row), while the outcome indicators are depicted as hexagons (lower row). Potential future events are indicated, as are the anticipated impacts of (i) the third RBMP on conservation awareness and (ii) the droughts of 2018 and 2020 on water access and equity.

Rounds Model

The water policy reforms in RoI present a complex and intricate landscape that requires in-depth understanding of the changes that have occurred over time. To address this need for clarity and meaningful insights, the Rounds model was adopted to sift the policy context, decision-making actors, and the evolving management systems at various points in time (Teisman, 2000). The rounds model guided the division of the policy process of RoI into three phases: past, present and future, to facilitate a comprehensive analysis of the water governance reforms in RoI. Notably, the European Water Framework Directive (WFD) marked a change from the past (1950 to 2003) to the present form of water governance and associated management practices (2003 to 2021). These rounds delivered a description of the terms of the policy context, the actors involved in the decision making and the management system operative at the time (Bontje, 2017). The Rounds model policy approach was thus, adopted in categorising the changes in water policies into three rounds, to help describe the relationships between various components of policy reforms and interventions and provides a roadmap for their impact on water governance and management

All these lenses facilitated the translation of the research into practice by providing step-by-step guidance in identifying the key elements that influence the policy context, significant events at different points in time, the management practices in place, and the outcomes.

1.2.3 Methodology

The methodological approach adopted in this research was descriptive and shaped by a pragmatic worldview. A pragmatic worldview emphasises the "what" and "how" of problems under investigation based on socio-political, and historical context (Creswell, 2014). Pragmatic worldview is also problem-centred and oriented towards real-world practices (Creswell, 2014). It also allows the usage of mixed methods to generate deeper insights into a research problem and addresses relevant societal problems such as water governance and management practice with consideration of all stakeholders in the sector (Kaushik & Walsh, 2019). The use of mixed methods offers a bridge between the traditional qualitative and quantitative data collection processes either through concurrent or sequential research procedures (Creswell, 2014).

The *qualitative* aspects in this research were used to explore and gain a deeper understanding of the complex water governance and management practices and legislations and to generate enquiries that are difficult to quantify. This consisted of case study analysis, literature reviews, interviews, and secondary written sources to validate the accuracy of data and interpretation of findings.

- *Literature review*

The literature review synthesised and analysed the existing knowledge on water governance and management. It provided an overview of the current state of knowledge, including gaps and limitations. It also helped in identifying areas for further investigation. The literature review also provided a historical and theoretical context for the research, informing the research designs and enhancing the relevance of the study. The patterns and themes generated from the literature review were thematically analysed to provide rich and in-depth insights into the history of water governance since 1960 and reforms management and other nuanced issues related to management reforms, communication and stakeholder engagements in the water sector.

- *Interviews*

Interviews were used to gather information and insights from individuals and institutions with specialised knowledge, experiences and vested interest in water

governance and management. Individuals (key informants) interviewed in this research had direct access to relevant information and provided valuable perspectives and insights. The interviews were semi-structured and used to complement other data sources gleaned from surveys and literature reviews. Other stakeholders from state and non-state organizations with a vested interest in water resources also provided valuable insights into the views, experiences and opinions. The interviews were used to gather information about stakeholders' needs, motivations, and behaviours and identify potential opportunities and challenges. Including stakeholders' perspectives ensured that the research was well-informed, relevant, and responsive to the stakeholders' needs.

- *Case Study*

A case study was employed to provide insights into water management differences between rural and urban RoI through an in-depth investigation of the Group Water Schemes (GWS). The case study was also used to gain an in-depth understanding of what influences policy learning and transfer, using the GWS sector as a single unit of a wide-ranging occurrence of water governance and management practices in RoI (Lieu, 2012). The GWS sector has, since the 1960s, contributed immensely to the promotion of water access, equity and equality in RoI. The sector undertakes several initiatives to improve water quality, promote water conservation, mitigate climate impact on water resources and reduce water leakages through enhanced metering and service delivery (Brady & Gray, 2010; EPA, 2022a; NFGWS, 2019a).

The *quantitative* aspects of this research also primarily comprised surveys with close and open-ended questions to measure data numerically and undertake statistical analysis to describe trends, attitudes and opinions of various interviewed participants using charts, tables and illustrated graphs (Creswell, 2014). The COVID-19 pandemic, which had an influence on in-person meetings, potential site visits, and group interactions, inspired the development of surveys as a useful tool for gathering data online effectively and affordably.

These qualitative and quantitative methods were used concurrently in this research. The concurrent approach was adopted because it combined the strengths of both qualitative and quantitative research methods and allowed for the examination of water governance and management phenomenon from multiple

perspectives. In the concurrent approach, the results from both methods informed and enhanced each other, providing a more comprehensive understanding of the phenomenon being studied. The concurrent integration of qualitative and quantitative data also offered a seamless transfer of multivariate analyses and descriptions of evidence. The concurrent mixed method further offered the advantage of achieving a detailed perspective and understanding of results and their implication for future policy discussions and practical implementation, as well as achieving validity and reliability of findings for replicability (Castro et al., 2010).

1.2.4 Data Collection

The data in this research were collected concurrently from 2019 to 2022 from both primary and secondary sources. The primary data were mainly from open and closed-ended survey questionnaires and interviews with various stakeholders. Following the stakeholder identification processes of Gregory et al. (2020), stakeholders in this research were selected based on their direct and indirect involvement and expertise in water governance and management practices and River Basin Management Planning in RoI. These stakeholders (see Appendix F) were drawn from state and non-state institutions with the inclusion of The Sustainable Water Network (SWAN), River Trust, Department of Housing, Planning and Local Government (DHPLG), the National Federation of Group Water Schemes (NFGWS) and some media agencies for instance, showing a bottom (the impact of governance at catchment scale) to the top (national) analysis. To initiate the data collection process, research descriptions and consent forms outlining the purposes of the study (what it involves, what participants will be asked to do, confidentiality, use of data and right to withdraw) were sent to them. Following this initial contact, stakeholders who responded and expressed interest in participating were further contacted to schedule interviews.

Secondary sources of data were also sourced from scientific journals, books and reports from relevant state agencies and other grey sources such as websites, newspaper articles and social media content. The initial exploratory phases of data collection included a historical review of water governance and management from

1950 as a period where governance and management practices gained recognition in the RoI.

With graphs created using Microsoft Excel and R software, the data acquired from online interviews were transcribed, coded and analysed thematically using Nvivo-12 qualitative analytical software following the coding process by Wainwright & Russell (2010). The study of secondary data from newspapers and the opinions of water consumers on social media was also analysed using Azure machine learning. In general, all of the research interviews (see Appendices) were analysed following a five-step process (Fig 3).

Figure 3. Process of conducting interviews.

Limitations, especially with interviews and surveys such as interviewees' social desirability bias, low responses rate and limitation of fixed response options are acknowledged. To reduce these limitations, the interviews conducted with stakeholders ensured anonymity and confidentiality. The interview questions (see, Appendix A and E) were carefully formulated in a neutral manner, taking into account the specific context of each study. Open and close response questions were also to minimize social desirability bias and encourage more accurate and reliable responses while testing the interview protocols. Different sources of data and information were also used to buttress and check validity of responses to avoid erroneous interpretations. To further mitigate the risk of low response rates, the case study survey questions on were tested with members of NFGWS prior to the actual data collection to determine the average response rate and clarity of questions and to ensure that the questions' direction, layout and structure aligned with the research aims and objectives. This was done to enhance clarity and reduce respondent fatigue while ensuring flexibility in answering the survey questions (Creswell, 2014). Figure 4 depicts the overall research approach in terms of the composite lenses adopted, the

elements forming the focus and the research methods employed, including specific tools and techniques (inspired by (McEvoy, 2019). The use of these lenses and methods are further discussed across the chapters.

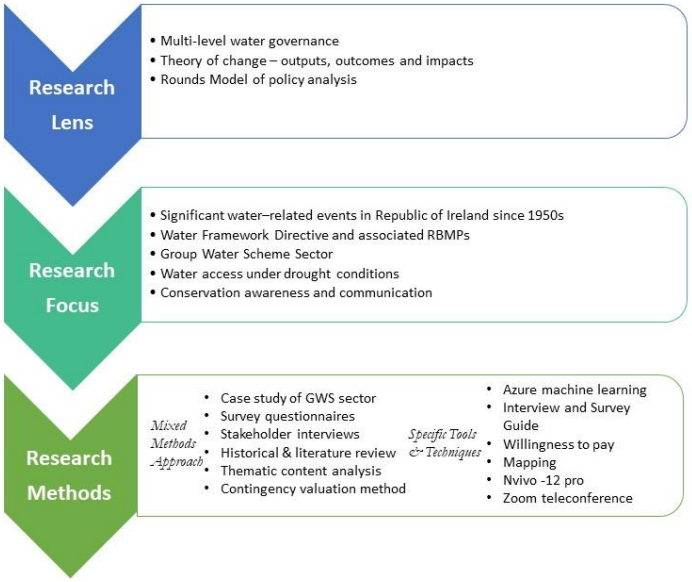

Figure 4. Schematic synthesis of the research approach (after McEvoy, 2019).

1.3 Contribution and originality of the research

This research contributes to the field of water governance and management practices by assessing past, present and future water policies while also contributing to the broader debate on the relevance of stakeholder engagement to sustainable water governance and management. It further highlights the reactive nature of responses, creates awareness of future threats and calls for a structured anticipatory response that will enable the water- rich RoI to cope with future uncertainties while contributing to various Sustainable Development Goals such as Goal 12 (Responsible Consumption and Production), Goal 13 (Climate Action), Goal 14 (Life Below Water), and Goal 17 (Partnerships for the Goals). The historical analysis of water governance and management was essential in identifying the significant factors that have been influencing water governance and management practices and resultant outcomes in the past seven decades. Overall, the research also seeks to inform both the theory and practice of water governance in the RoI, with four key groups considered as audiences. First, policymakers who develop and implement not only water but also environmental policies; second, water management practitioners from local to

national level (e.g., Uisce Éireann, NFGWS); third, the public and public representatives (e.g., GWS members, An Fóram Uisce|The Water Forum) who either use water for both domestic and non-domestic activities or advocate for constructive stakeholder engagement; and finally, researchers who analyse water governance and management practices to improve the quality of water resources, the sustainable management and equitable access to water services.

1.4 Dissertation outline and reading guide

This research is conducted in a publication format wherein each chapter represents a published or submitted paper for peer-reviewed publication. This format enables the undertaking of multiple semi-independent research projects, resulting in peer-reviewed research output and a more comprehensive understanding of the field of water governance and management. The process of writing and submitting papers for publication, presenting at conferences, and responding to peer reviews also facilitates the development of valuable skills for an academic or research career. Additionally, this format offered the advantage of disseminating the research findings to stakeholders for policy consideration in a timely manner, while obtaining external feedback through rigorous review processes. The entire dissertation structure is illustrated in Figure 5. Chapter 1 is an introductory chapter that establishes the current state of the art or research gap, research objectives, methodological approach and contribution and originality of the research. Chapter 2 provides a historical perspective on water governance and management from the 1950s. Relying on historical and literature reviews and key informant validation interviews, the chapter addresses Research Objective 1 and contributes to Objective 2. In Chapter 3,

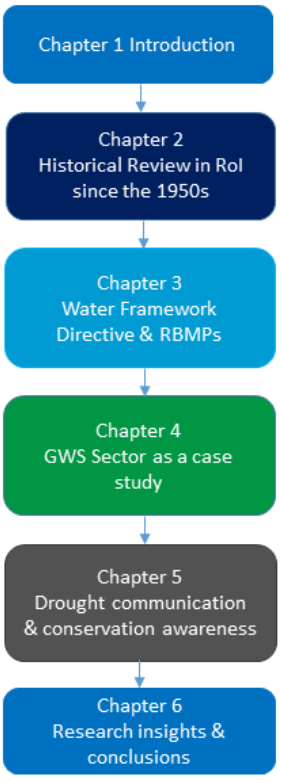

Figure 5. Structure of dissertation

the Water Framework Directive (WFD) and the River Basin Management Plans (RBMP) are assessed. The assessment considers stakeholders' perspectives on the second RBMP through a desk-based review and interviews with fourteen stakeholders from nine institutions. The chapter primarily addresses Research Objective 1. In Chapter 4, the empirical results of Group Water Schemes (GWS) as a case study is presented in two parts. The first aspect of the case study explores water demand trends and consumer attitudes to water and water conservation among GWS in the RoI. By using Willingness to Pay as a contingency valuation method, the second part of the case study attempts to quantify the socio-economic values placed on water among GWS. The choice to study the GWS sector case provides insights into water management differences between rural and urban Ireland and indicates how practices from the sector may be scaled up to improve water service delivery nationally. The findings from the case study address research objectives 2 and 3. Chapter 5 emphasises the impact of climate change on water resources and how climate phenomena such as drought can be communicated to improve water conservation awareness. The chapter primarily addresses Research Objective 3 and offers suggestions on how to influence decision-making and awareness among stakeholders on drought communication, water conservation and resource availability. Chapter 6 presents the concluding discussion and summaries those insights that have implications for implementation. It also presents future research suggestions relevant to the subject area.

To accommodate the interest and styles of different readers, Table 2 can serve as a reading guide, as some chapters have preludes that offer broader perspectives on different subsections. Chapter sections 2.4 and 2.3, for example, summarise aspects of factors influencing water governance and management that are described in detail in Chapters 3 and 5.

Table 2. Reading guide for readers

Interested in…	Recommended chapters and sections
Historical narrative and policy change processes of water governance and	Chapter 2 (Significant historical events) 2.4 (Factors influencing governance and management). 2.6 (Concluding remarks)

management practices in the Republic of Ireland (RoI)	
Literature overview and conceptualisation of water governance	Chapter 1.3 (A Multi-level Approach and governance principles) Chapter 2.1.2
Water Framework Directive (WFD) and River Basin Management Plans (RBMP)	Chapter 2.3 (The Integration era of water governance in RoI Chapter 3 (1st and 2nd RBMP) 3.5 (Stakeholder expectations towards 3rd RBMP)
Research Approach and methodologies	Chapter 1.3, 1.3.1, 1.3.2
Group Water Schemes (GWS) as a Case Study	Chapter 2.2 (The Rural era of water governance in ROI Chapter 4 Prelude (Background of GWS and National Federation of Group Water Schemes)
Climate change impact on water resources	Chapter 2.5 Chapter 5 Prelude (Impact of climate change on water resources)
Role of communication and water conservation efforts	Chapter 4.1 and 4.4 (Water conservation) Chapter 5.1.1 (Comparative overview of drought management between the RoI and United Kingdom (UK) Chapter 5.3 and 5.4 (Media framing of communication on drought and recommendations for policy considerations)
Socio-economic values	Chapter 4 Prelude B (Overview and valuation methodologies) Chapter 4 Section C (Willingness of consumers to pay for water services)
Answers to research questions	Chapter 6.1 (Research questions and answers) 6.3 (Reflections) and 6.4 (Implication for practice)
A quick scan of the entire dissertation	Summary

Chapter 2

A HISTORICAL PERSPECTIVE ON WATER GOVERNANCE IN THE REPUBLIC OF IRELAND

The aim of this chapter is to present a historical perspective on water governance and management from the 1950s. A theory of change is used to identify the evolution of water governance and management practices in the Republic of Ireland (RoI) in terms of past and present outcomes and future impacts. Significant events and policy decisions are connected using the Rounds Model of policy analysis and linked to past and present outcomes and future challenges. Water governance and management is also conceptualised in section 2.1.2. From the historical perspectives and insights; water governance is broadly defined in this dissertation as an economic and socio-political pathway that induces access, equity and quality of water resources over time through active stakeholder engagement in management processes. This chapter specifically addresses Research Objective 1 and also contributes to Objective 2.

The content of this chapter was published in:

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2.1 Introduction

The governance of water resources has attracted global concern because of the pervasive risk that water crises pose to humanity (WEF, 2018; Woodhouse & Muller, 2017). The prospects of water crises have already led to governance reforms at the national, regional, and organisational levels focusing on the environment and socio-economic development (Romano & Akhmouch, 2019; WPG, 2021). Water crisis is however not just a lack of freshwater resources to meet demand and the associated urgency in ensuring that mechanisms are implemented to accommodate the impact of stress on water resources (WEF, 2016). It also involves how the resource is governed and managed to avert scarcity and potential conflicts, particularly in water-stressed areas (Vieira, 2020; WEF, 2018).

There is a broad literature base examining water governance reflecting the different schools of thought influencing its conceptualisation. These schools of thought are based on the diversity of interests and objectives of the authors regarding the development and management of water resources and services (Jiménez et al., 2020; Woodhouse & Muller, 2017). The Organisation for Economic Co-operation and Development (OECD), for example, defines water governance as "a range of political, institutional and administrative rules, practices and processes through which decisions are taken and implemented, stakeholders can articulate their interests and have their concerns considered, and decision-makers are held accountable for water management" (OECD, 2018a). Water governance is further regarded as both a process and an outcome, defined by diverse areas of influence, that may be political, institutional and economical in context (Özerol et al., 2018). Other influencing factors may also include public participation (Jiménez et al., 2020; Wen et al., 2015), performance (Akhmouch et al., 2018; Nicholson-Sanz, 2020), and laws and policies (Bruch et al., 2020; Green et al., 2013). For Heinrichs & Rojas (2022), cultural and social values are also key factors in water governance and management decision-making processes. There has also been a growing interest in the water-energy-food nexus (Albrecht et al., 2018; Simpson & Jewitt, 2019) and inter-sectoral cooperation (Wen et

al., 2015) as examples of factors influencing the definition of water governance. Water governance thus considers culture, functions, attributes, and outcomes to achieve one or more desired results shaped by the interest and aspirations of different organisations and individuals (Heinrichs & Rojas, 2022; Jiménez et al., 2020).

2.1.1 Conceptualising water governance and management

Water governance differs from the more functional exercise of water management, and it is necessary to distinguish between the two as both terms are used in this paper (Özerol et al., 2018; Pahl-Wostl, 2009). According to Keping (2018), management involves activities that ensure the effective implementation of measures to monitor and develop resources, while governance considers the interaction among stakeholders through regulatory processes to protect these resources. Good governance considers the public management processes and also the public interest (Keping, 2018). From the perspective of resource management, Pahl-Wostl et al.(2010) refer to water governance as the activities of a diverse set of stakeholders who formulate policies and ensure their implementation to protect the water resources, whilst water management focuses on the technical aspects involving analyses and the development and monitoring of the formulated policies to ensure that water resources are in a good state. Keping (2018) adds that good governance involves joint management between stakeholders and policymakers to ensure that resources are well protected. Thus, the management of resources cannot be effective except where there is adaptive and integrated resource governance (Pahl-Wostl, 2009). Considering this it is conceivable that it takes effective governance systems to enable management practices to deliver desired outcomes for water resources. A considerable body of evidence from across Africa, Asia, Australia, Europe, Latin America, and the USA points to water governance failure as a significant challenge to effective water policy design and implementation in management practices (Jiménez et al., 2020; Vieira, 2020). The RoI is no exception as the country has experienced various socio-economic growth and development challenges in the last decades.

In this paper, we adopt a historical perspective on water governance in relation to the promulgation of various laws and policies to understand how water resources have been managed over the past seven decades. The enactment of the Water

Services Acts, the rural water scheme sector and the present responsibilities of various agencies and institutions in the water sector, such as Uisce Éireann, are discussed. Bottom-up strategies like community engagement, agricultural reforms, and regional catchment assessments performed by institutions such as the Local Authority Waters Programme (LAWPRO) are examined. Additionally, the controversial introduction and subsequent removal of drinking water supply charges are also considered as are the implications of climate change. The overarching aim of this paper is two-fold: 1) to provide a historical overview of significant occurrences in water governance and management practices in the Republic of Ireland over the last seven decades; 2) to identify the factors that have driven the policy reforms toward a more sustainable water future. A sustainable water future is predicated on the ability of the water sector to withstand climate change impacts, population growth, rise in water demand, water quality and services delivery through effective governance and management practices. Adopting a historical perspective of water governance in the Republic of Ireland also helps in defining the concept as an economic and socio-political pathway towards inducing water resources access, equity and quality over time through active stakeholder engagement in the management processes.

The entire chapter is structured into the following sections: following the introduction, Section 2.1.2 describes the temporary framing and research approach deepening the conceptualisation of water governance and associated management practices. An overview of water resources in the Republic of Ireland is provided in the case study description in Section 2.1.3. Section 2.2 explores the history of water governance in Ireland from the 1950s to the present day. Section 2.4 discusses the factors that have influenced water governance and management practices in the past and may do so in future. The concluding remarks follow in Section 2.6.

2.1.2 Research Approach

In recognition of the need for effective water governance and management practices for a sustainable water future (Antwi et al., 2021), this study traces the history of water governance reforms to understand how water policy and governance have developed and changed through time. The Rounds model policy approach was adopted in

categorising the changes in water policies into three rounds (see (Teisman, 2000). These rounds are:

- Rural era (1950 – 2003)
- Integration era (2003 – 2021)
- Future challenges (2022 – onwards).

The rural era considers water governance and management prior to integrating Water Framework Directive (WFD) into Irish laws, with rural Ireland and Group Water Schemes (GWS) in focus. The integration era emphasises post-WFD, covering rural and urban Ireland with outcomes that include water access and equity, supply services, tariffs, and legislation. The future challenges look at potential threats and impacts on water resources. Within each of these rounds, supporting policy and management practices are reported and major influencing factors are highlighted. For instance, the analysis commences from the early 1950s when pressures on available water resources, awareness of environmental issues and concerns over water demand and quality started receiving attention (Bresnihan et al., 2021; NFGWS, 2019a). Notably, the European Water Framework Directive (WFD) marked a change from the past (1950 to 2000) to the present form of water governance and associated management practices (2003 to 2021).

2.1.3 Case study description

The Republic of Ireland (RoI) shares a land border with Northern Ireland (a part of the United Kingdom) and lies between latitude 51°N and 56°N and longitude 5°W and 11°W in western Europe (Mateus & Coonan, 2022). It is surrounded by the Atlantic Ocean, with the Celtic Sea to the south, the Saint George's Channel to the south-east and the Irish Sea to the east. The country has ample water resources, considered an essential natural asset, with an annual mean rainfall of approximately 1225mm (Mateus & Coonan, 2022). For the implementation of the Water Framework Directive (WFD), the second River Basin Management Plan (RBMP) defined one national River Basin District (RBD) and two international RBDs (Fig 6). The national RBD covers an area of 70, 273 km^2 with 46 catchment management units and 583 sub-catchments. These encompass a total of 4,842 water bodies that comprise 112 coastal water

bodies, 196 transitional waters, 812 lakes, 3,192 rivers, 514 underground waters and 16 canals that support agricultural, industrial and recreational needs as well as a healthy ecosystem for aquatic life (DHLGH, 2022).

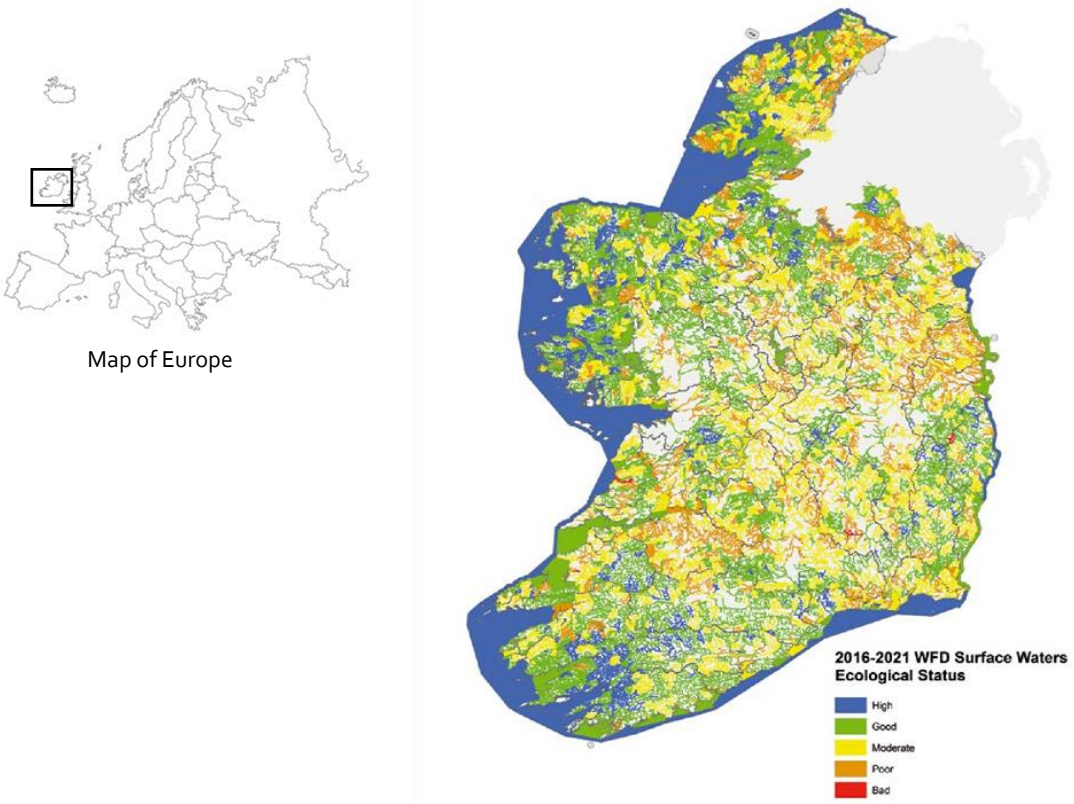

Figure 5. Map of Ireland showing surface water bodies and their ecological status. Source: (Trodd et al., 2021).

Although the percentage of groundwater bodies and coastal water bodies with satisfactory ecological water quality in RoI is above the European average (EPA, 2021c), there are categories of water resources at some risk of not meeting the objectives of WFD which is to ensure that there is a sound ecological status for surface and groundwater in Europe (Fig 7). An assessment of over 4,000 surface water and 514 groundwater bodies over 2016-2021 shows that 46% of surface water bodies are not ecologically healthy (EPA, 2020b; O'Boyle et al., 2019; Trodd et al., 2021).

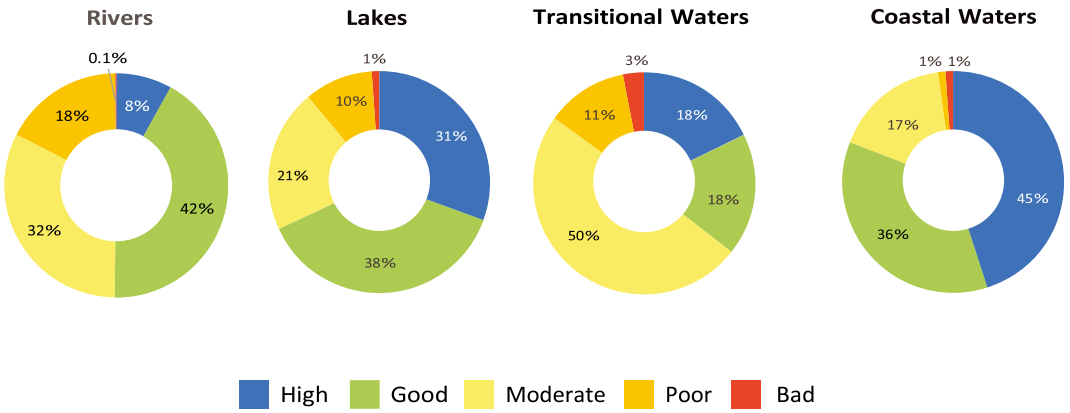

Figure 6. Distribution of risk across categories in the water sectors. Source: (Trodd et al., 2021)

At present, only 50% of rivers, 69% of lakes and 36% of transitional waters and 92% of groundwater bodies exhibit satisfactory (high or good) ecological health. The coastal waters category has the highest percentage of good or better ecological status (81%), followed by rivers (50%), lakes (69%) and transitional and coastal waters (36%), which have the worst water quality (Trodd et al., 2021). Overall, surface water quality has been declining since 2015 (EPA, 2020b; O'Boyle et al., 2019; Trodd et al., 2021). Most of the decline can be attributed to the deterioration in the inflowing river water quality owing to pollution and human disturbances. Agriculture, which is the most prevalent land use (67.6%), is responsible for about 30% of the total pollution of water resources. Other significant stressors and pressures on available resources are changes to the physical habitat conditions (hydromorphology), peat extraction and drainage. There are also industry, urban runoff, domestic and urban wastewater, poor waste water treatment and farmyard effluents that enter watercourses (Trodd et al., 2021; Trodd & O'Boyle., 2020).

Despite these stressors, water resources in RoI are very important to the people due to the range of ecosystems and the socio-economic and cultural benefits they provide. Historically, Irish people followed river paths to build their settlements with numerous myths and folklore that show great regard for water resources spanning from the salmon of knowledge to the holy wells of Ireland (Heritage Council, 1990). Public water services reforms have also contributed to a growing trend of active bottom-up engagement in decision-making about water resources management, water quality and service delivery in the country.

2.2 The Rural era of water governance in the Republic of Ireland

2.2.1 Group Water Schemes

In the early 1900s, most of the Irish population lived in the countryside however, by the 1950s, living standards had started improving with electric and water networks established to meet the populace's needs (ESB, n.d.; Ó Gráda & O'Rourke, 2022). This reflects the water-rich nature of the Irish countryside in which farmers were responsible for managing their own water resources and city populations were supplied with free water. Given the intricate connection between access to water and development, this led to fundamental changes in the quality of life of the people leading to pressures on available water resources, awareness of environmental issues and concerns over water demand and quality (EPA, 2022b). The absence of piped water supplies and inadequate sanitation in rural areas would, however, remain until a nationwide polio outbreak in 1957, which claimed 20 lives from about 499 recorded cases brought the issue of rural water into focus (Bance, 2013). The aftermath of the outbreak was among the key factors that triggered public discourse on water supply. From 1960 to 1971, numerous Group Water Schemes (GWS) sprung up across the country connecting over 58% of rural households (ESB, n.d.). The provision of a safe and reliable water supply resulted in major socio-economic development in rural Ireland and under the Industrial and Provident Societies Act, the wider community-owned rural water sector adopted a cooperative mode in 1973. However, without structured state support, financial resources and active supervision, water treatment challenges and inadequate coordination and management practices affected the activities of over 200 schemes that existed by this time, serving approximately 69,000 rural households (Deane & MacDomhnaill, 2021; NFGWS, 2019b). The general intention for forming GWS was to improve water access and equity by ensuring that many households in rural Ireland had clean drinking water. GWS were regarded as private and responsible for monitoring themselves; hence in 1996, GWS serving over 150,000 homes and rural businesses were exempted from abolishing service charges on domestic water supplies operated by local authorities. The National Federation of Group Water Schemes (NFGWS) was formed as a representative organisation for

GWS in 1997 in response to the abolition of the charges and to build a sustainable and resilient rural water sector through source protection, conservation and safe drinking water supplies (NFGWS, 2019a). The NFGWS influences water policy by appearing before the Joint Parliamentary Committee on Water Services alongside other bodies like the EPA, Uisce Éireann and the Department of Housing, Local Government and Heritage (a government department responsible for administering water services at the national level) to address key changes to the European Union proposed revisions to the Drinking Water Directive of 2016 (NFGWS, 2019a).

2.2.2 Water policy and legislation from the 1970s to 2003

The advent of GWS and growing access to water, along with water equity issues amid water and environmental pollution, raised concerns about the need for strict water legislation between the 1950s and 70s. The Local Government (Water Pollution) Act (1977) is one of the earliest pieces of water legislation on which the first water quality management plan (WQMP) rests, aimed at monitoring local authorities plans and progress on water quality and services (NDP, 2007). This was introduced in response to water pollution issues and the decline in drinking water quality (EPA, 2022b; NDP, 2007). Water quality monitoring was undertaken once every three years following a method based on macroinvertebrates (through the development of a Q-value method) as a quality rating system (EPA, 2022b). This system was first developed in 1971 by An Foras Forbartha (reformed as Environmental Protection Agency in 1993) and implemented across 121 rivers at 765 monitoring stations. The Q-value method provided clear evidence about the health of freshwater ecosystems in the country and declining water quality (EPA, 2022b). The first WQMP offered no precise details on the functions to be performed by local authorities until the Quality of Bathing Water Regulations (1988) came into force with detailed guidelines on monitoring bathing water (Hartnett et al., 2011). Under the Environmental Protection Agency Act (1992), local authorities had the power to monitor the water quality of estuaries, oversee discharges of urban wastewater plants and publish biannual discharge reports. Further water-related legislation followed, including the Waste Management Act (1996), aimed at scrutinising the influx of hazardous waste into the environment, including water bodies, and proposed waste collection, disposal and recovery

approaches (NDP, 2007). In 1997, the Fisheries Act (1997) also came into force to enable the checking of licenses and ensure the regulation of water quality, biological activities and the aquaculture industry (NDP, 2007). In the interim, there were also amendments and statutes aimed at monitoring environmental resources, including the Industrial Pollution Control (Act 7 of 1992), Environmental Protection Agency Act, 1992 Statutory Instrument No. 79 (1996), Environmental Protection Agency (Licensing) (Amendment) (No. 2) Regulations Statutory Instrument No. 59 of 1995 (1996), Urban Waste Water Treatment Directive (UWWTD), Waste Management (Amendment) Act Statutory Instrument No. 165 of 1998 (2001), Waste Management (Permit) Regulations Statutory Instrument No. 185 (2000), Sewage Sludge Statutory Instrument No. 148 (1998) and Sea Pollution (Amendment) Act (1999) (DHPLG, 2018a; Hartnett et al., 2011; NDP, 2007).

These acts and amendments demonstrate reactive attempts to protect the environment as a collective good without much emphasis on water governance and management practice as a distinct endeavour. Hartnett et al., (2011) affirm this assertion and further disclose that until 1999, when the Environmental Protection Agency (EPA) undertook a review of water quality management planning, the 1977 Local Government Water Pollution Act was the only legislation with an improved consideration for water management. The amended Act recommended national water quality management planning within a framework to facilitate information flow and consider all aspects of the environment as a coherent component of policy and development (EPA, 1999). The Act also recommended that efficient management and monitoring systems be made available. Although the recommendations addressed the significant challenges experienced with water quality management planning at the time, there was no proposition for an improved governance and management framework or structure. This may have been due to the ready availability of water resources in the Republic of Ireland, the limited awareness of water quality and the rural-urban divide regarding water and sewerage infrastructure and services. These regulations can be regarded as appropriate for the time as they contributed to reducing domestic and industrial pollution, including discharges from wastewater plants. The responsibilities for managing water were divided between the EPA and local authorities. The EPA focused on assessing pressures on water and the aquatic

environment through an individual and self-contained programme of actions, while local authorities were tasked with the implementation of legislation.

2.3 The Integration era of water governance in the Republic of Ireland

2.3.1 Water Framework Directive from 2003 to 2021

The European Union Parliament and Council adopted the Water Framework Directive (WFD) on 23rd October 2000 under EC Directive 2000/EC, and its implementation took full effect in 2003 (European Union, 2000). The framework aims to achieve good ecological status for surface and groundwater in Europe (European Union, 2000). The WFD imposes upon EU member states, such as the Republic of Ireland, the obligation to reach good ecological status for its water bodies by 2015 or, at the latest, 2027 (EEA, 2018). The obligation encompasses a multi-layered appraisal of the quality of water bodies in terms of their ecological and chemical status and their ability to meet agricultural, industrial and recreational needs and maintain the overall health of the ecosystems that support aquatic life (EEA, 2018; European Union, 2000). The framework is regarded as a revolutionary policy response to water management challenges because it regulates all water quality concerns and ensures that European Union (EU) member countries comply with laid down standards and measures to protect water resources (Giakoumis & Voulvoulis, 2018). In December 2003, under the European Communities (Water Policy) Regulation 2003 (S.I 722 / 2003), the WFD was officially integrated into the laws of the Republic of Ireland as a benchmark for water resource governance and management practices (Hartnett et al., 2011; NDP, 2007). By 2006, the WFD monitoring programme following the European Communities (Water Policy) Regulations, 2003, had taken full effect in the county (EPA, 2021c). Despite criticisms of the WFD regarding its technical language, reliance on compliance-driven approaches, lack of meaningful stakeholder engagement, cost of implementation, and ambitious timelines and targets (Giakoumis & Voulvoulis, 2018). Bresnihan (2016) argues that the WFD has highlighted the ecological features of the

water cycle in Europe through an integrated river basin approach. The WFD is also considered to have helped establish many functional water governance structures for member states through which over 110,000 water bodies are presently being managed to reduce pollution and prevent worsening water quality levels in the EU (European Union, 2019).

2.3.2 River Basin Management Planning

A key component of the WFD is for EU states to prepare, revise and update River Basin Management Plans (RBMP) within three planning cycles (2009, 2016 and 2022). However, RoI only produced its first RBMP in 2018 after falling behind schedule in monitoring, evaluating and categorising surface and groundwater on time as expected. The third RBMP (2022) aligns with the WFD timeframe of six years per planning cycle (Antwi et al., 2021; DHPLG, 2018a). Under the first RBMP, water resources in the Republic of Ireland were grouped into eight River Basin Districts (RBD), of which three were international river basins shared with Northern Ireland (DHPLG, 2018a). Key measures under the plan included licensing urban wastewater discharges and the implementation of the Nitrates Action Programme (Good Agricultural Practice Regulations) Amendment Regulations 2018. Although the measures resulted in progress in terms of compliance levels and reducing the impact of urban wastewater on water quality, there was insufficient progress in developing and implementing supporting measures. Taking the difficulties and failures of the first RBMP into consideration, the second plan defined a single national river basin district and two international RBDs, North Western and Neagh Bann, jointly managed with officials in Northern Ireland (DHPLG, 2018a). The second RBM planning process effectively involved a broad spectrum of actors in water governance and management under a three-tier governance structure. The Department of Housing, Planning, Community and Local Government was placed at the top of the tier overseeing water policy and implementation. The EPA was positioned in the second tier, holding responsibility for drafting environmental objectives, managing catchment characterisation and producing RMBP templates. The Local Authority Water Programme (LAWPRO), newly formed for the second RBMP, occupied the bottom tier, focusing on encouraging public participation, implementation, and legislation

enforcement (DHPLG, 2018a). LAWPRO coordinates public engagement, consultation and participation with communities and stakeholders at the local level across all 31 local authorities, with a team of 43 local authority investigative assessment personnel who carry out scientific assessments of water bodies and drive the implementation of measures at a local level.

LAWPRO also has a community Water Development Fund with a commitment of over €360,000 per annum to support community-led water initiatives. The activities of LAWPRO are focused on close collaboration with communities in promoting water quality and management practices. Through various bottom-up approaches, LAWPRO supports River Trusts. Its Blue Dot Catchments Programme and the *catchments.ie* and *watersandcommunities.ie* websites detail stories of the roles being played by community groups in promoting water quality (DHLGH, 2022; DHPLG, 2018a). The national WFD monitoring programme for 2019-2021 also provides a coherent and comprehensive national overview of the quantitative and chemical status of groundwater and the ecological and chemical status of surface waters (EPA, 2021c). The EPA carries out a surveillance monitoring and operational network to provide a comprehensive picture of the physico-chemical parameters of 259 out of 392 groundwater bodies three times per year (EPA, 2021c). There are also over thirty public institutions and bodies, including NGOs (e.g. Sustainable Water Network and Irish Environmental Network) and groups whose work and activities are towards achieving good ecological status as enshrined in the objectives of the WFD. However, the contemporary water governance structure is not without some identified challenges. Recent work by Antwi et al., (2021) suggests that a) lack of finance to broaden priority areas and ensure implementation of action plans, b) limited access to data and information, c) lack of appreciation of the diversity in behavioural and social values attached to water resources d) inadequate innovation to improve water management and service delivery and d) gaps in the coordination and collaboration among various institutions and even within units, are key gaps in the existing water governance and management structure.

Despite these challenges, trust is building up among actors in the water sector with organisations such as the An Fóram Uisce, the EPA, LAWPRO, and the Agricultural Sustainability Support and Advisory Programme (ASSAP) working to

improve water quality, promote integrated catchment management, and undertaking community engagement and awareness-raising (Antwi et al., 2021). Aside from the WFD, other European and international legislation and agreements are relevant for the Republic of Ireland. Indeed, the Aarhus Convention, the Urban Waste Water Treatment Directive, the Drinking Water Directive, and the EU 7th Environmental Action Programme serve as legal guidelines in the management and governance of water resources, while the Sustainable Development Goals serve as overriding long-term objectives. The growing emphasis on catchment management, stakeholder engagement and multi-disciplinary approaches to solving the challenges in the water sector is linked to the Integrated Water Resources Management (IWRM) principles of efficiency, ecological integrity and equity (Daly et al., 2016; Fenemor et al., 2011; Mitchell & Hollick, 1993). The Planning and Development Act (2000), the Water Service Act (2013), the Water Services Act No. 29 of 2017 (2017), the Water Services Act (2018 -2025) (2025) and The Water Conservation Regulations Statutory Instrument No. 527 (2008) are also examples of national legislative provisions pertaining to water governance and management (DHPLG, 2018b). While the plethora of policy and legal provisions since 2003 have clarified the overall ambitions of water governance as a route to sound ecological status for water bodies and the sustained provision of services, it has not simplified water management on the ground in the Republic of Ireland.

2.4 Major factors influencing water governance and management in the Republic of Ireland

2.4.1 Water charges, access and equity issues

Charges for drinking water supply have had a significantly divisive effect across the populous since their initial introduction in 1977 (Quinn et al., 2016). Prior to that, Irish local authorities financed water services, among others, through charges (referred to as rates) paid according to home value. Rural dwellers were also supported with grants to improve the quality of the water supply, with the locals paying flat rates to offset the cost of maintenance for wells and underwater schemes (Clinch & Pender, 2019a). However, the entire approach to water services and charges for both rural and urban

dwellers changed in 1977 when the Fianna Fail party came to power with the plan to substitute these rates and charges with government support through indirect taxes and grants. This policy was reversed in 1982 under a Fine Gael-Labour Party coalition (Quinn et al., 2016). Commentary on Fianna Fáil's electoral losses included the inability of the government to recoup its investment in water services, which affected other sectors of the economy (Caroll, 2014).

Nonetheless, the re-introduction of flat-rate water charges by the Fine Gael party was viewed as double taxation by many consumers who failed to pay the charges (Clinch & Pender, 2019a). In the run-up to the 1997 national elections, amidst public outcry, a decision was made to abolish charges under the Local Government Financial Provision Act 1997 (Clinch & Pender, 2019a). The issue of charging for water had a major influence in the 1997, 2011 and 2016 elections, with over half of Teachta Dala (TDs, elected members of the lower house of the oireachtas) elected to the Dáil (the lower house of the Irish parliament) in the 2016 elections being critics of water charges (McGee, 2012). For instance, the People Before Profit Alliance won two seats in the 2011 elections because of their staunch criticism of water charges (Caroll, 2014; Hearne, 2015; McGee, 2012). The abolition of domestic charges in 1997 was in effect until 2013 when direct charges for water services were re-introduced under the Water Services Act (2) (Caroll, 2014; Oireachtas, 2013). A timeline of the significant events and activities leading to the decision to end direct charges on domestic water consumption and progress made to date are presented in Table 3.

Table 3. Timeline of significant events related to water charges in the Republic of Ireland

Year	Significant events related to water charges
1977	• Fianna Fail government in power replaced direct charges with indirect taxes and grants.
1982	• Fine Gael-Labour Party coalition reversed indirect taxes and grants in the form of direct charges.
2010	• The conceptualisation of Uisce Éireann and the introduction of water charges are required as part of the Troika Memorandum with Ireland for financial assistance.
2011	• The process to set up Uisce Éireann as a state water utility commenced.
2012	• Bord Gais Eireann awarded Uisce Éireann the contract to roll out water charges and meter installations from 2014.

2013	• Direct charges were re-introduced under Water Services Act 2013. • Uisce Éireann established and accorded a semi-state company status under the Water Services Act 2013. • Uisce Éireann mandate to charge for water rushed through the Dáil in four hours.
2014	• Uisce Éireann spends €85 million of its €180 million set-up fund on consultancy services while protests on water meter installations occur across major cities. • Water charges are capped at €278 for a family of four, as announced by Commission for Energy Regulations. • In October, 35,000 signed 'Right2Water' online petition. In Cork city, anti-water charge protestors occupied Cork City Council offices. Over 100,000 protestors attended the 'Right2Water'-organised protest in Dublin. • By the end of October, 2/3 of households (circa 1 million) failed to register with Uisce Éireann as required to implement the water charges. • In November, demonstrations swept across Ireland; approximately 150,000 took to the streets to protest against water charges and the overall economic situation in the country.
2015	• In January, 760,500 households (approximately 50%) registered to pay water charges out of a potential 1.5 million households. • In February, 36 candidates who supported the 'Right2Water' campaign won elections. • Over 650,000 (43%) households failed to register to pay water charges, resulting in a deadline extension to June 2015. • Over 50,000 people demonstrated in Dublin over water charges in September. • Public Water Forum is constituted as an independent consumer consultative body in developing and directly feeding into the activities of Uisce Éireann and the interest of water consumers in relationship with the Commission for Regulation of Utilities.
2016	• 61% of households paid their bills at the end of the third water charge cycle in March, although this was less than the 2015 expectation of 80% of households from Uisce Éireann (Irish Water). • In April, Minister for Health Leo Varadkar, publicly stated that suspension of water charges was not in the public interest in reaction to allegations that Uisce Éireann cancelled water bills as the 2016 election drew closer. • Fianna Fail and Fine Gael parties agreed on a new government based on the common ground of suspending water charges in May. • The suspension of water charges in May led to a 50% revenue downturn for Uisce Éireann in July. • In November, an expert commission on Domestic Public Water Services recommended general taxation to fund water services in Ireland.
2017	• An estimated 20,000 people took to the streets in protest in April. A final rescindment of water charges by the lower house of the Irish Parliament came to bear with a 96 to 48 vote margin. • A refund of water charges was announced in July, leading to the issuing of 180,000 cheques issued to customers who had made payments earlier.

2018	• Plans to open charges on 'excess water usage' with effect from January 2019 announced by Uisce Éireann in February. • In June, An Foram Uisce was instituted as a statutory body to promote public engagement and debate on water quality, water charges and issues affecting Irish Water customers in addition to the implementation of WFD and other roles, including the number of representatives on the forum that are consumers.
2019	• In December, the Commission for Regulations of Utilities released a report on the Uisce Éireann plan for water charges on 'excess water usage' for January-April 2020.
2021	• Charges for excessive water usage (€1.85 per cubic meter/1,000 litres) and Wastewater (€250 per year) above allowed thresholds for domestic and non-domestic customers approved by the Commission for Regulations of Utilities and announced in October by Uisce Éireann.

Before the first re-introduction of water charges in 1982, the government was the sole financier of water services. The Water Services Act (2013) recommended the imposition of water charges, the transfer of powers held by local authorities on water charges, as previously mandated under the Local Government Act 1995, and the revision of the Water Services Act 2007 to ease the financial burden on government (Oireachtas, 2013). Further reforms under Water Services Act (2013) and amendments under Act (2014) brought about a reduction in water charges and a cap on water bills. The cap charges, however, culminated into citizens' anger which led to the 'Right2Water' campaign group in 2014 (Clinch & Pender, 2019a; Quinn et al., 2016). The group comprised political parties like Sinn Fein, the Workers Party and the Anti-Austerity Alliance, People Before Profit, as well as unionists, community groups and other activists with a key demand to eliminate all water charges and recognise water as a human right (Clinch & Pender, 2019a; Hearne, 2015).

At the peak of such demands for water charges to be eliminated, the Irish economy was still grappling with the aftermath of the 2008-2009 economic recession with a series of austerity measures and fiscal consolidation programmes to reform and recapitalise the banking sector, and the entire economy in full force (Dunphy, 2017; Hearne et al., 2018). Part of the economic bailout conditions agreed upon with the "Troika",[2] was the need to introduce water charges and establish a utility company to take control of water services from the local authorities (Lenihan, 2009; Quinn et al.,

[2] Troika is a colloquial term referring to the International Monetary Fund (IMF), European Union (EU) and European Central Bank (ECB)

2016). However, continuous protests by the Right2Water group and public outcry frustrated such plans, with water charges fully suspended until further review by a joint committee of the House of Oireachtas (The National Parliament). Prior to this suspension of water charges, an estimated 50% of households with installed water meters had started paying bills; and Uisce Éireann reported it had saved over 3 billion litres of water within the first six months of meter installations in addition to the repair of over 50,000 leakages (Joh, 2015; Quinn et al., 2016). Investment in water services also increased, with about €166 million spent on water alone between 2014 and 2015 (Ervia, 2015). Despite such progress, ineffective revenue collection, lack of accountability, metering installation challenges, billing disparities, and boil water notices were bottlenecks that influenced the final recommendation made by the Joint Committee of the house of Oireachtas to discontinue water charges under the Water Services Act 2014 (Quinn et al., 2016).

The Oireachtas further recommended a reversal to general taxation to cater for water expenses and further transparency on the exact amount from taxes that goes into funding water services in compliance with WFD standards (Oireachtas, 2017). After revoking the water charges, the RoI became the only EU member state where water charges for domestic consumption were not in place, except for Group Water Schemes and households that use more water than the specified threshold as covered under Water Services Act 2007-2017 (Irish Water, 2021a). The issue of water charges has significantly influenced the governance and management of water resources.

2.4.2 The formation of Uisce Éireann

The motivation for a single national entity to manage all water-related issues in the RoI was borne out of the financial crisis, which forced the Irish government to seek a bailout from the Troika. Fiscal discipline and structural reforms were conditions included in the bailout package. The Irish government was mandated to cut its annual spending by €10 billion and increase yearly taxes by €5 billion to help reconfigure its financial balances (Bresnihan, 2016; Laffan, 2017). Despite being under financial surveillance from the EU, Ireland secured a "carve-out" exemption under the WFD Article 9(1). This article indicates that member states are to "take account of the

principle of recovery of water services which comprises environmental and resources cost with regards to economic analysis carried out according to Annex III following polluters pay principles" (European Union, 2000). Previous governments had held on to this article as a reason for not implementing water charges (Bresnihan, 2016); however, there were other EU-backed reform measures that Ireland could not overlook. Such measures included introducing new policy options, nationwide water metering, and developing RBMP and future-proof governance strategies. Prior to the establishment of Uisce Éireann (Irish Water), clear definitions of roles and responsibilities, which are fundamental in water management, were inadequate. The water sector's operational system permitted interference and was fraught with undefined obligations, unsatisfactory quality standards, and constrained fiscal resources. Also, poor water services delivery and lack of return on investments were contributing reasons to the demands by the TRoIka for reformation in the water sector to improve the financial wellbeing of the country (PwC, 2011).

Price Waterhouse Coopers (PwC), the professional services firm offering a range of services across tax, advisory, and audit, was hired to advise on the best model for managing the water sector in Ireland. They published their report in 2011, recommending the establishment of Uisce Éireann as a self-financing water utility company, similar to practices in South Africa, Scotland, the Netherlands, Germany and France (Bresnihan, 2016). Uisce Éireann took over the responsibility for managing water services from 34 local authorities as a single public utility company. On July 27 2013, Uisce Éireann was formally established under the Water Services Act 2013 as a semi-state-owned utility subject to the planning, regulation and financial scrutiny within Irish laws and that of European legislation (Irish Water, 2018a). Upon its creation, Uisce Éireann was attached to Ervia- another state-owned multi-utility that delivers gas and fibre services to learn from its financial robustness and experiences in management and services delivery (Ervia, 2015). It is anticipated that Uisce Éireann will achieve full autonomy from both Ervia and the central government, and attain the status of a fully-fledged national utility company by 2023. This transition is expected to result in cost savings of approximately €70 million per year (Bardon, 2018).

Currently, Uisce Éireann manages 790 water treatment plants across 1,173 abstraction points made up of 70% of groundwater and 30% of surface water, serving

about 83% of the population through public water supply schemes. The utility further manages over 88,000 km of water and wastewater pipes, about 7,000 individual assets, and supplies over 1.7 billion litres of water daily (Gallen & O'donoghue, 2018; Irish Water, 2021b). Nevertheless, the utility's average age of water infrastructure is also about 65 to 85 years, which is above the EU average of 36 years, with over 43% of treated drinking water lost through leakages (Irish Water, 2020a). Although much is still to be done, the formation of Uisce Éireann and its current role in water services have shaped water governance and management practices by improving transparency in operations, adherence to quality standards, and resolving water supply fragmentation among local authorities. The utility is also considering the introduction of water charges (Irish Water, 2021a). Although attempts to introduce water charges is still complex and sensitive because of its socio-political ramifications, different surveys have shown consumers' willingness to pay water charges (Collins, 2015; Dwyer, 2019; Leahy, 2016). Such evidence, together with effective and efficient public engagement and the political will to implement charges, may lead to the introduction of domestic water charges in the future by Uisce Éireann (Irish Water, 2021a). Also, mechanisms to encourage and facilitate domestic water conservation measures that focus on technology, water efficiency labelling, water conservation incentives, education, and awareness campaigns remain to be explored fully. Additionally, the high inflation rate due to the ongoing war in Ukraine and the slow COVID-19 pandemic recovery will affect the political will to introduce water charges as the general cost of living keeps rising.

2.4.3 Agricultural activities

The historical and economic importance of agriculture in relation to other industries is associated with this sector being the largest contributor to declining water quality over time (DHPLG, 2018a) (Fig 8). About 4.93 million of the total 7.04 million hectares of land in the RoI is used for agriculture, with the sector currently employing about 163,600 people, with over 137,500 farms that produce more than €8.2 billion in output (CSO, 2021b; DAFM, 2021). According to the Department of Agriculture, Food and the Marine, in 2020, the RoI's food and agrifood products were exported to over 180 markets worldwide and were valued at €14.2 billion, a 60% increase from €8.9 billion

in 2010 due to increase in the dairy sector (DAFM, 2021). Recent water quality reports show that almost half of river bodies (43%) in RoI, a quarter of groundwater (24%) and one-fifth of estuarine and coastal water bodies (22.2%) have excessive nitrogen levels coming from intense agricultural activities (Trodd et al., 2021). Nearly half of the lakes (33%) and river sites (30%) also have unsatisfactory nitrate and phosphorus concentrations from agricultural activities, mainly in the northeast and southeast of the country (Trodd et al., 2021). Previous studies from 2013 - 2019 revealed that about 34% of river sites and 54% of lakes had unsatisfactory phosphate concentrations, while over a fifth (22%) of groundwater, sites had high (>25mg/l No3) nitrate concentrations, with three sites exceeding the drinking water standard (50 mg/l No3) (Trodd & O'Boyle., 2020). Total dissolved inorganic nitrogen (DIN) concentrations within the same period were found to be unsatisfactorily high in 22% of estuarine and coastal water bodies (Trodd & O'Boyle., 2020).

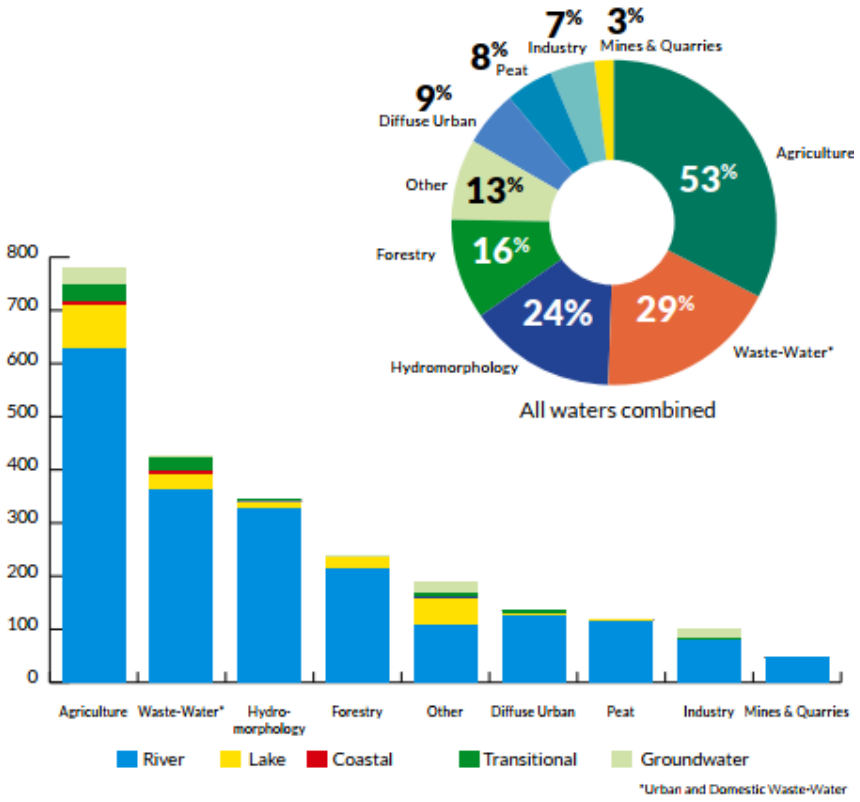

Figure 7. Significant pressures on the aquatic environment. Source: (DHPLG, 2018a).

While drinking water quality in public water supplies is relatively high following treatment, the continuous presence of nutrients and issues with pesticide and microbial contamination in some supplies remain. This counteracts efforts to improve

water quality and the overall attainment of the required WFD standards, thereby necessitating further policy changes and actions in the country towards protecting water bodies (EPA, 2020a). As a result, there is a consideration for a new ten-year strategy to address the adverse effects that agriculture poses on water quality and biodiversity (EPA, 2020b). There is also consideration under the national climate action plan to reduce emissions between 22% and 30% by 2030 through the intensification of organic farming and improvement in carbon footprint and the genetics of herds (DECC, 2021a). The Agriculture and Food Development Authority (Teagasc) Climate Action Strategy (2022 - 2030) also aims to accelerate the adoption of new technologies and production systems for farmers to increase profitability and reduce greenhouse gas emissions from the agricultural sector in 2030 by 25% (Teagasc, 2022). An Agricultural Sustainability Support and Advice Programme (ASSAP) has also been instituted with 30 farm sustainability advisors who work with farmers to identify problems and implement appropriate measures to avert agricultural pollution (ASSAP, 2019). As a system of subsidies and support programmes for agriculture, the EU Common Agricultural Policy (CAP) has been undergoing reforms to set new requirements for farmers to encourage responsible pesticide usage and probable non-chemical weed control methods in farming (EPA, 2020b). The RoI has also signed up for the EU Biodiversity Strategy for 2030, which aims to protect and restore ecosystems through organic farming, reduce pesticide usage by 50%, and plant three billion trees by 2030. The strategy also includes halting the decline in pollinators and aligning with the developments in CAP (EPA, 2020b). The Nitrates Directive (91/676/EEC) also focuses on protecting water quality by reducing pollution from agricultural sources. This Directive forms part of efforts by the RoI towards improving water quality, with the entire country regarded as a vulnerable nitrate zone (EPA, 2020b). In order to implement this Directive and other environmental policies, a series of Good Agricultural Practice for Protection of Waters Regulations have been implemented since 2008 (e.g. Statutory Instrument No. 605 of 2017). These include the inspection of farms and the imposition of penalties for non-compliance with phosphorus and nitrate. Although the enforcement of these regulations has not been effective, the significant impact of the agricultural sector on water quality has been receiving further attention under the National Biodiversity

Action Plan 2017-2021, which seeks, among other goals, to promote best agricultural practices to the benefit of the environment (DECC, 2021a). More so, not all farmers are polluting their waters and while work is still required to tackle non-compliance on phosphorus and nitrate, it is expected that under the European Green Deal, a range of actions to tackle climate, biodiversity, water resources and natural heritage and environmental emissions challenges will be prescribed to compel farmers to take actions that can turn the challenges into opportunities.

2.5 Future challenges

2.5.1 The effect of climate change

Climate change is altering weather patterns with severe implications for food production, water availability and biodiversity globally, and RoI is no exception. Prior studies have suggested that the crux of climate change in the RoI will be observed through water resources availability and quality, with extreme meteorological and agricultural drought and increased variability in the freshwater ecosystem being some of the direct effects of climate change on water resources (DHPLG, 2019; García et al., 2021; IPCC, 2021; O'Driscoll et al., 2018). Projections of temperature and rainfall by Met Éireann (the national weather agency for the Republic of Ireland) suggest that RoI will witness an increase of between 1°C and 2.4°C in mean annual temperatures by mid-century with the largest increases in the east of the country (EPA, 2020b). There will also be about a 20% decrease in summer rainfall by 2050 and 35% increase in dry periods, and 25 - 44cm sea level rise levels by 2080 (DCHG, 2019). Other climatological features such as precipitation and wind and variability in river flows, groundwater recharge, wetlands inundation, aquatic habitats, and biodiversity are also projected to change (DCHG, 2019; Mateus & Coonan, 2022). These impacts, mainly around the midlands regions and the East and South East of the country where the largest of the population lives and where the best agricultural lands are, will consequently lead to competing demands for water resources for domestic usage and agricultural and industrial purposes (DECC, 2021a; Mateus & Coonan, 2022). A rise in sea water levels will also have a severe environmental and socio-economic impact on the population located along the coastal lines of major cities like Cork, Waterford and Galway.

Nonetheless, the aftermath of many discussions on climate change has not yet manifested in intended implementation or mitigation programmes. Until the Water Quality and Water Services Infrastructure, Climate Change Sectoral Adaptation Plan was published in 2019; no policy document had fully conceptualised climate change and water resources as a specific sector. Climate change and water resources were discussed sporadically as subsets of other plans and actions (DCCAE, 2018; DECC, 2021a; DHPLG, 2018b; Irish Water, 2021b). The Adaptation Plan currently outlines adaptive measures to build resilience in response to climate change impacts on water resources and related socio-economic effects (DHPLG, 2019). Procedural guidance on assessments required by WFD on how plans and programmes may be integrated into Strategic Environmental Assessment is also under consideration through Strategic Environmental Assessment Guidelines for Regional Assemblies and Planning Authorities. The National Climate Change Risk Assessment has also adopted a tiered assessment approach to capture the range of climate-driven risks on water resources (DHPLG, 2019). Since 2019, Climate action is being strengthened through a new governance structure and Climate Action and Low Carbon Development (Amendment) Act 2021, which aims at supporting climate neutrality by 2050 and a 51% reduction in emissions by 2030 (DECC, 2021a). Indeed, the anticipated impact of climate change on water resources is a driving force in policy and water governance reform, as evident in the new National Water Resources Plan by Uisce Éireann, the Biodiversity Climate Change Sectoral Adaptation Plan and Climate Action Plan and efforts to conserve water during periods such as drought (Antwi et al., 2022; DCHG, 2019; DECC, 2021a; Irish Water, 2020a). The efficacy of such efforts in achieving real change in water management practices and building resilience in the water sector in the RoI remains to be seen in the coming years.

2.5.2 Demographic and land use changes as emerging threats

The RoI currently joins Sweden, Malta, Denmark, Luxembourg, and Cyprus as an EU country set to experience higher population growth by 2070 (European Union, 2020). The Irish population has grown from 4.9 million in 2019 to 5 million in 2021 - the highest growth rate since 1851. By 2051, the population is projected to reach over 6.5 million (CSO, 2020c). The majority of the population (84%) receive their drinking

water from Uisce Éireann, the remaining from private wells and small private supplies or various group water schemes (Cotterill & Melville-Shreeve, 2021). The high population growth amid rising average domestic water consumption, water supply leakages and ageing water infrastructures has impacted efficient water supply and delivery. At the end of 2020, over 1 million people were dependent upon 46 vulnerable water supplies, while approximately 15,500 consumers were on boil water notices for over a month within the same year (EPA, 2021d).

Largely across catchments in midlands and the West part of Ireland García et al (2021) reveal that land use changes have significantly affected water quality and the biological status of lakes and other water bodies. The challenges that land use and demographic changes pose to the water sector, coupled with intense agricultural activities, and climate change threats on water quantity and reliability, have triggered recommendations for water conservation to be included in various water policy principles. Indeed, this led An Foram Uisce to launch a framework to improve domestic water conservation, discourage wastage and improve conservation amidst climate uncertainty, especially as witnessed in the hydrological and meteorological droughts of 2018 and 2020, which resulted in limited rainfall, higher temperatures, rise in water demand and a water conservation order to conserve water control water usage (Antwi et al., 2022; Cotterill & Melville-Shreeve, 2021). Infrastructural development, rural water programmes, and leakage reduction programmes have also received massive investments to augment supply, while management reforms to address the pressures that water demand poses to supply are also occurring (DHPLG, 2018a). Water table management is also required as part of optimal land use strategy for the future due to sequestration on agricultural land, afforestation levels and emissions from drained peat grasslands (Teagasc, 2022).

Demographic growth also has an impact on land use planning, for example, increasing housing development and driving policy reforms both now and into the future. Hence, an alignment and integration of planning systems for effective and efficient water management and increased compatibility between planned growth and environmental sustainability will require keen consideration to ensure that development planning does not cause deterioration of water quality. Public consultation for the third RBMP has recognised such needs and is drafting planning

guidelines that will provide planning authorities with tools to determine development plans and their impact on water bodies (DHLGH, 2022). This is set to ensure that there are best practices for sustainable water quality management for all development and that relevant development plans are consistent with the RBMP and the requirements of the WFD to avert deterioration in surface and groundwater status.

2.6 Concluding remarks

A seventy-year history of the rich availability of water in RoI contrasts with the future challenges to supply occasioned by climate change impacts and anticipated long-term shifts in demographic characteristics. A review of the historical context of water governance highlights how central government funding and reliance on prescriptive regulations to control pollution were the basis of Ireland's environmental and water policies in the 1970s (Table 3). The various regulations mandated local authorities to act but offered no specific guidance on how water quality management plans were to be carried out. However, these regulations were appropriate for the time and contributed to a reduction in domestic and industrial pollution, including discharges from wastewater plants. In 1997, the National Federation of Group Water Schemes (NFGWS) was formed as an umbrella body for all group water schemes to build a sustainable and resilient rural water sector through source protection, conservation and safe drinking water supplies (NFGWS, 2019a). GWSs are responsible for supplying water to about 6% of the Irish population. The controversy over water charges, from 1977 onwards, has been a significant factor in policy reforms and management strategies regarding water, with ongoing efforts to realign focus on implementing water charges and ensure equitable access to water by all now led by Uisce Éireann.

This paper further highlights that the adoption of the WFD and related statutory laws and regulations has brought a remarkable shift in water governance and management practice in the Republic of Ireland since 2003 by introducing a comprehensive framework for drinking water source protection using a catchment-centred approach. The shift is intensifying presently because of the continuous decline in water quality from intense agricultural activities and demographic changes coupled with land use planning as a latent enabler (Table 4). The implementation of

the RBMPs, the Common Agricultural Policy, the Nitrates Directive (91/676/EEC), Climate Action Plan, and the Biodiversity Action Plan 2017-2021 aim to improve water quality through a reduction in various pollutants.

Table 4. Water policy and governance evolution

Rounds	Policy context	Institutions & management practices	Major influencing factors
Rural era (1950-2003)	Group Water Schemes Water Quality Management Plan (WQMP)	NFGWS formed as an umbrella body for Group water schemes for rural Ireland. Local authorities with primary responsibility for the provision of urban public water and wastewater services through coordination with EPA.	• Water charges, access and equity. • Pollution and declining water quality.
Integration era (2003-2021)	WFD and (numerous supportive water sector policies such as the Aarhus Convention, The Nitrate Directive, The Water Conservation Regulations)	Catchment-centred approach under River Basin Management Plan (RBMP). Uisce Éireann as state utility mandated with water and wastewater services operations. Catchment assessment roles by the Local Water Authorities Programme. Stakeholder engagement by Water Forum.	• Intense agricultural activities and reforms.
Future challenges (2022 -)	Water Framework Directive, Climate Action Plans and increased integration of Integrated Water Resources Management (IWRM)	Uisce Éireann in charge of water and wastewater services. Strong alignment with the principles of Integrated Water Resource Management (IWRM), applied at river basin scale.	• Climate change effect such as drought. • Demographic changes and land use changes.

The various reforms in water governance and management practices show attempts towards meeting the objectives of various environmental sustainability initiatives to maximise the socio-economic benefits of water resources in RoI. The Central Statistical Office affirms this observation and further reveals that the degree

of integrated management in various water policies in the RoI stood at 81% in 2020, with most management instruments and decision-making tools relying on Integrated Water Resources Management (IWRM) principles of efficiency, ecological integrity and equity (CSO, 2021a). The alignment towards IWRM is helping the transformation from the old top-down water management approaches to an evolving and coherent strategy that embraces stakeholders' participation in water management. The RoI has also declared the entire national territory a vulnerable nitrate zone under the Nitrates Directive (2000/60/EC). The Nitrate Directive is a key instrument under the WFD to protect water resources against pollution from agricultural practices. Institutions such as LAWPRO have also been carrying out public engagement sessions on a phased basis to promote the implementation of mitigation measures aimed at improving water quality, including the Common Agricultural Policy (CAP). Nonetheless, CAP as a policy alone is insufficient to prevent the growing pressures from agricultural activities. A holistic approach that involves the establishment of effective and accountable initiatives that will deliver not only environmental targets but also on-farm efficiencies and market access through collaborative engagement across the agricultural sector with respect to source protection and climate change adaptation plans are also indispensable (DECC, 2021a; EPA, 2020b).

In drawing the threads together from the rural to the integrated era, including the future challenges (Table 4), the complexity of factors driving water governance and management practice in the RoI becomes evident. Improved efforts are required from all actors in the water sector to build resilience and accelerate actions towards achieving good ecological status for all water resources in the Republic of Ireland. To achieve this, improved information flow among various institutions in the water sector, funding availability, and water policy coherence, are needed to enhance data sharing, promote trust, and increase efficiency and the timely implementation of various action plans (Antwi et al., 2021).

Overall, the historical insights from this paper contribute to a deeper understanding of water governance and management in the RoI and provide a context for future policy formulation and implementation. Looking into the future, it is evident that the impact of climate change will constrain available water resources for domestic and agricultural use. Demographic and land use changes and planning

would also severely impact water resources usage and distribution while demand increases due to population growth. More so, policy reform and implementation challenges and their effect on policy interventions such as water conservation measures, water quality and services delivery and charges could strain public support for effective water governance and management practices.

Given the multi-faceted and interdependent relationship between water, climate change, agriculture, biodiversity, and the perceptions and values the public place on water resources, future policy formulation and implementation should be cross-sectoral in nature. The policy formulation and implementation processes should strive for a balance between socio-economic and environmental factors that impact water resources and active public engagement to improve water quality, availability and service delivery. This should include community representatives, business interests; local authorities; property owners; farmers and young people as stakeholders in water governance with the idea of increasing equity of access to water and improvement in water quality. This should ensure that most stakeholders will have a voice in decision-making on water-related policies and will help towards developing a sustainable and equitable water future. Effective agricultural reforms and pursuance to reduce the sectors impact on water resources will be required to improve water quality and reduce emissions. Water governance and management practices also need to be calibrated continuously to the IWRM approach to improve catchment engagements, public awareness on water management and meet present and future water needs.

Chapter 3

RIVER BASIN MANAGEMENT PLANNING IN THE REPUBLIC OF IRELAND: PAST, PRESENT AND THE FUTURE.

Integrating the Water Framework Directive (WFD) and associated River Basin Management Plans (RBMP) have significantly changed how the Republic of Ireland (RoI) manages and governs its water resources. The WFD currently serves as a wheel on which many water legislations and actions run. Moving away from the broad brush historical review in Chapter one. This chapter focuses on an assessment of the 2nd RBMP and catalogue stakeholders' perspectives towards the 3rd RBMP, expected to be in effect from 2022-2027. As a novel scholarly assessment of the RBMP, the research design and data collection approaches are explained in Section 3.3. The successes and challenges with RBMPs are detailed in subsequent sections. The expectation of stakeholders with an interest in the water sector and their perspectives towards the 3rd RBMP are also discussed in section 3.5, and finally, conclusions drawn in section 3.6.

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Supplementary material for this chapter is provided in Appendix A

3.1 Introduction

The European Union (EU), in response to the prevalent threats on water resources, developed and adopted the Water Framework Directive (WFD) in 2003 (European Union, 2000). The WFD attempts to integrate a number of environmental policies and former directives (such as Nitrate Directives, Drinking Water Directives, Urban Waste Water Treatment Directives, etc.) and aims to pursue ecological goals for all water resources and investments in water protection measures and water ecology in the EU. It further provides direction toward integrated water resource management and cross-cutting links to other EU legalisations that are relevant to the prevention, restoration and protection of fresh, coastal and transitional waters (European Union, 2000; Wiering et al., 2020). Currently, in excess of 110,000 water bodies across the EU are being managed under the WFD to reduce pollution and to improve water quality through functional water governance and management practices (European Union, 2019). Despite its attempted holistic approach to improving water management, the WFD has been subjected to broad criticism. From a legal perspective, Santbergen (2013) described the WFD as environmental legislation whose interpretation is very complicated because its ambivalent wording contradicts its very principles and objectives. The WFD also places a financial strain and intensely demanding timelines with some misunderstanding on key tenants of the technical and scientific aspects of the directive (Kanakoudisa & Tsitsiflib, 2010; Kelly-Quinn et al., 2014; NDP, 2007). EU member states are further obliged to quantify the cost of the socio-economic and environmental effects of using water services under the WFD; however, article 9 (4) of the directive diffuses the same responsibility. The Article requires that "member states may not be in contravention of any principle if they choose in line with implementation not to comply with the cost recovery as far as it does not undermine the overall purpose and objective of the directive" (Kanakoudisa & Tsitsiflib, 2010; Kelly-Quinn et al., 2014). Coordinating the WFD with policies such as the Common Agricultural Policy (CAP) and achieving compliance with Nitrate Directive are other problems identified to be thwarting efforts at reaching a good ecological status for water bodies (Wiering et al., 2020). These problems, according to Giakoumis & Voulvoulis, (2018), stem from the heavy influences from the European Parliament and

environmental-based non-governmental organisations with different interests during the framework preparation. Nevertheless, a 2019 fitness check sanctioned under Article 19.2 of the WFD revealed that the framework was still flexible enough to deal with such threats, including emerging micro-plastics and pharmaceutical pollution and climate change, impacting water quality (European Union, 2019). Thus, the WFD is still considered one of the most significant piece of legislation for water policy in Europe (EPA, 2020b; Giakoumis & Voulvoulis, 2018). Under Article 14 of the WFD, EU member States are required to produce a River Basin Management Plan (RBMP) that sets out actions to regulate all member States' water quality concerns and also ensure the attainment of good ecological status for water bodies (rivers, lakes, estuaries and coastal waters) by 2027 through three RBMP cycles from 2009–2015, 2016–2021 and 2022–2027 (EPA, 2020c; European Union, 2000).

3.2 RBMP in the Republic of Ireland

The WFD was written into law in the Republic of Ireland (RoI), through the European Communities (Water Policy) Regulation 2003 (SI 722/2003) (NDP, 2007). The Water Policy Regulations replaced a number of previous and existing legislative instruments aimed at improving water quality, including the European Communities Act 1972 Local Government (Water Pollution) Act 1977, the Quality of Bathing Water Regulations 1988, Local Government (Water Pollution) Act 1990, EPA Act (1992), Local Government Act 1994 and Waste Management Act 1996, the implementation of which had been fraught with management and governance challenges (Hartnett et al., 2011). The WFD, since its legal adoption, has attempted to correct these by setting a benchmark for water management and governance by ensuring that water resources are grouped into catchments to enhance monitoring and attainment of good ecological status (EPA, 2015; Hartnett et al., 2011). To achieve the required good ecological status means that all 4829 water bodies, comprising 111 coastal water bodies, 195 transitional waters, 818 lakes, 3192 rivers, 513 groundwater bodies and 15 artificial water bodies in the Republic of Ireland must reach a specific level that meets not only drinking and bathing needs but also agricultural, industrial and recreational needs as well as a healthy ecosystem that can support aquatic life (DHPLG, 2018a;

EPA, 2015). In 2010, the RoI produced its first RBMP, two years later than intended, to monitor, evaluate, and categorise surface and ground waters.

The delays affected the planning and implementation of the second plan, which consequently had a delivery period of four years instead of the required six-year duration. Although it is expected that the third RBMP will realign with the WFD timeframe of six years in 2021 (MECLG, 2019), the delayed adoption and implementation of RBMPs has been common in other EU countries for example Germany, Greece, Lithuania and Norway (EEA, 2018; Reese, 2021). Dukelow (2016), however, relates the delays in the RoI to the Irish 2008 financial and economic meltdown and reforms in the water sector.

3.2.1 First RBMP in the Republic of Ireland (2010–2015)

The Environmental Protection Agency (EPA) first published its River Basin monitoring programme in 2006 and followed it up in 2007 with a report on significant water-management issues, after which a six-month public consultation was launched (White et al., 2014). The outcome of the public consultation and Programmes of Measures (PoMS) was then published in December 2008, leading to the first RBMP formally adopted in 2009 (Daly et al., 2016). The cost of the consultation and final production of the first RBMP was estimated at €50 million (Daly et al., 2014); even so, difficulties in differentiating the types of water resources, a single implementation approach and over-generalisation were some gaps that characterised the first RBMP (Daly et al., 2016). Other major gaps identified in the first plan included poor development of assessment methods on the classification of ecological status, unclear methodology on cost recovery of water to domestic consumers and the absence of some quality elements (QEs) in the monitoring programme for lakes and coastal waters (European Commission, 2012). According to Earle & Blacklocke (2008), the goals of the first plans themselves were unfeasible because the idea of RBMP was new in Europe. The plans' implementation also happened during the Irish economic crisis, which strained the needed fiscal resource for its implementation (MECLG, 2019). The absence of a single authority to oversee the plan with clearly defined responsibilities also restricted the opportunity for consultation and understanding between stakeholders, consulting

authorities and various advisory councils, which was required to foster a culture of responsiveness (Irvine & O'brien, 2009; White et al., 2014). In effect, the scientific basis of the plan became highly reliant on expert judgement (Irvine & O'brien, 2009). A 2019 report by the EPA revealed that despite some improvement in water quality during the period that the first RBMP was in place, about 47.2% of water resources kept worsening. The report further disclosed that 44 out of 904 public water in 2016 could not meet the EU Drinking Water Regulation 2014 standards on pesticide and nitrate pollution (O'Boyle et al., 2019). (Figure 9)

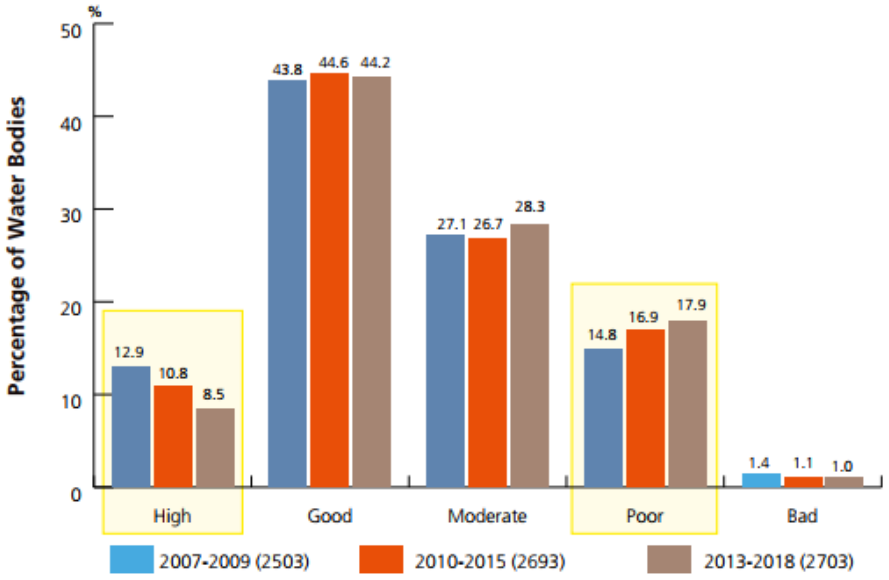


Figure 8. Percentage changes in water quality levels from 2007 to 2018. Source: (O'Boyle et al., 2019).

Overall, ecological assessment from 2013 to 2018 on 2703 surface water bodies and 514 groundwater showed 52.8% "satisfactory level" for surface water bodies while 47.2% remained "moderately poor" (O'Boyle et al., 2019). Although the first RBMP failed to reach its 13% national improvement in water quality status for the six-year period, it was a significant development in national water policy, leading to the establishment of eight River Basin District (RBD) (EPA, 2020c). Licensing for urban-waste water discharges and agricultural regulations to protect water bodies were also introduced under the plan. The plan also enhanced water quality monitoring and implementation processes through established legal frameworks under European Communities Environmental Objectives (Groundwater) regulations 2010 (SI 9 of 2010)

and European Communities Environmental Objectives (Surface Water) Regulations 2009 (SI 272 of 2009) (MECLG, 2019).

3.2.2 Second RBMP in the Republic of Ireland (2018–2021)

The second RBMP was initiated in 2018, following a two-year delay, and is expected to run until the end of 2021. The second RBMP built upon lessons learned through the development, implementation and review of the first RBMP which identified gaps in public participation and governance processes required to meet objectives under the WFD. As a result, and to streamline national reporting requirements, the second RBMP combined separate river basins (i.e., Shannon, Western, South Western, Eastern and South-Eastern RBDs) into a single national river basin district. Two international RBDs—North Western and Neagh Bann—remained jointly managed with Northern Ireland (UK) to consolidate planning, monitoring and management (EPA, 2020c). A water quality indicator report for 2017–2019 under the period of the second RBMP revealed that 57% (1329) of river bodies attained a good biological quality while 43% (1002) remained in moderate quality (Trodd & O'Boyle., 2020). While the report further indicated improvements in 2019, declines in high water bodies have not significantly halted through the first two RBMPs due to excess nutrients such as phosphorus and nitrogen, mainly from agriculture and wastewater (Trodd & O'Boyle., 2020). This has further affected the number of pristine rivers across the country from 500 in the 1980s to 20 in 2020, indicating a 90% loss (EPA, 2020b).

Aside the attempts to reverse the decrease in good water quality, the implementation of the second RBMP has introduced some reforms into the water sector. These include the formation of the Local Authority Waters Programme (LAWPRO) in 2018 to promote community engagement and raise awareness of water quality issues (LAWPRO, 2017). Other programmes introduced include the Agricultural Sustainability Support and Advisory Programme (ASSAP) to promote sustainable agricultural practices in 190 targeted areas (ASSAP, 2019) and the 'Blue Dot Catchments Programme' to maintain and restore good water quality status (DHPLG, 2018a). An Fóram Uisce|The Water Forum was established as a statutory body under Water Services Act 2017 to also enhance democratic input into decision making in the

water sector as part of RBMP implementation in the RoI (The Water Forum, 2018). An investment of €1.7 billion to deliver approximately 250 wastewater treatment projects and achieve 37% leakage reduction by 2021 are included within the second RBMP (DHPLG, 2018a). To further address governance issues, the three-tiered governance structure of the first RBMP was greatly enhanced (see Section 3) to provide clarity on the processes and actors involved in managing water river basins in RoI (EPA, 2020c). The governance structure aims at solving the cross-cutting challenges in the water sector coherently with a detailed consideration to agriculture, peat extraction and other identified water services issues (EPA Catchments Unit, 2018).

Water governance and management under the second RBMP, nonetheless, have shown signs of susceptibility to external influences on water resources affairs due to the high tendency for a government through its state agencies and bodies to influence environmental affairs to suit its interest (SWAN, 2015). In addition, ineffective communication among relevant stakeholders, duplication of managerial roles and responsibilities and the ability of the RBMP to deal with the impact of drought on water resources and other recurring water resources challenges at catchment levels have all hampered the effectiveness of the second RBMP. Sustainable Water Network (SWAN), an umbrella NGO of Ireland's leading environmental organisations, concludes that the second RBMP lacks the ambitions needed to ensure water resources in Ireland stay clean and in good quality because of the reductions in water quality targets under the plan (SWAN, 2015).

Although seminal contributions have been made on the implementation of WFD and the first RBMP in RoI (Daly et al., 2014; DHPLG, 2018a; Giakoumis & Voulvoulis, 2018), there has been limited scholarly outputs on the second RBMP and its impact on governance and management of water resources except for two recent reports published by the Environmental Protection Agency in 2021 (Boyle et al., 2021; O'riordan et al., 2021). The reports were conducted using Experimental Governance Lens (Boyle et al., 2021) and the Organisation for Economic Co-operation and Development (OECD) Water Governance Indicator Framework (O'riordan et al., 2021), with the findings from both reports emphasizing close policy and practical linkages between water, climate and biodiversity agendas and overall improvements in existing arrangements in the water sector. Considering the challenges with the

implementation of RBMP and in view of limited assessment of the water governance and management implementation actions thus far, this paper assesses the second RBMP from a stakeholders' perspective. It does this by (i) identifying the successes and challenges with the second RBMP; (ii) cataloguing the expectations of stakeholders for the third RBMP, which can potentially improve the quality and effectiveness of policy measures required for the success of RBMP in the Republic of Ireland and then (iii) propose suggestions that can positively contribute to achieving the objectives of the third RBMP for 2022–2027. Although the analysis presented in this paper focused on the RoI, it is assumed that the findings are relevant to other European countries and regions where water sector planning, management and implementation challenges affects the overall achievement of good ecological status (EEA, 2018).

3.3 Materials and methods

The findings in this study were derived from a mixed qualitative method using a desk-based review of the RBMP and key stakeholder interviews. The process involved: A review of water governance and management in the RoI with a focus on the first and second RBMP to provide a baseline information and understanding of the governance processes and to validate emerging findings and evidence to inform policy and practice for the third RBMP. The review considered journal articles, annual reports and government policy papers in addition to submissions made by state and non-state institutions such as the Sustainable Water Network (SWAN); public consultation report on Significant Water Management Issues for Ireland published by the Department of Housing, Planning and Local Government (DHPLG) and various EPA reports in relation to water quality and the RBMP. Based on the approach of Gregory et al.,(2020), for selecting stakeholders for an interview, we identified and interviewed fourteen key stakeholders from nine institutions based on context and time, with multiple roles or positions related to the governance and management of water resources (Table 5). All the stakeholders interviewed had different degrees of expertise related to the management and governance of water resources in the

Republic of Ireland, but due to difference in roles and responsibilities, some institutions had more than two stakeholders interviewed from within.

Table 5. Representative Key stakeholders interviewed.

Key Stakeholders Institutions	Total Number of Interviewees
Department of Housing and Local Government (DHLGH)	1
Environmental Protection Agency	3
Irish Farmers Association	1
Institute of Public Administration (IPA)	1
Local Authority Waters Programme (LAWPRO)	3
Maigue Rivers Trust	1
National Federation of Group Water Schemes (NFGWS)	1
Sustainable Water Network (SWAN)	1
Water Forum	2

The open-ended qualitative interviews with the identified stakeholders aimed to gain insight into the implementation of RBMP (Supplementary Materials). Due to COVID-19 restrictions, the interviews were conducted remotely using Zoom. Nvivo 12 was used to qualitatively analyse all interview responses which were coded into six themes (i.e., positive progress made under the second RBMP; significant challenges; Sustainable Development Goals; attaining the WFD objectives under the second RBMP; stakeholders' expectations; a general overview on water governance and management in the RoI) and twenty-nine child nodes. The child nodes were derived from the themes to identify patterns and understanding from stakeholders' responses and to establish connections with their expectations for the third RBMP. The number of stakeholders from state institutions and non-state institutions reflects the structure of the stakeholder community in the water sector. Moreover, the inclusion of Maigue River Trust, NFGWS and DHLGH shows a bottom (the impact of governance at catchment scale) to the top (national) analysis.

3.4 Results

Results from the desk-base review and stakeholder interviews were analysed to identify broad themes and understanding from the data gathered. These themes

relate to the positive progress made under the second RBMP, significant challenges, Sustainable Development Goals, attaining the WFD objectives under the second RBMP, stakeholders' expectations and overview of water governance and management leading to recommendations for the third RBMP.

3.4.1 Positive progress made under the second RBMP

The second RBMP, according to stakeholders, has contributed to efforts to improve local water quality and initiatives and imposed itself as the gateway to participatory governance and management of water resources under a three-tier governance structure (Figure 10). Although improved water quality takes time to manifest, the key institutions and actors involved in river basin management in the Republic of Ireland now work under a defined governance and management structure (EPA, 2020c).

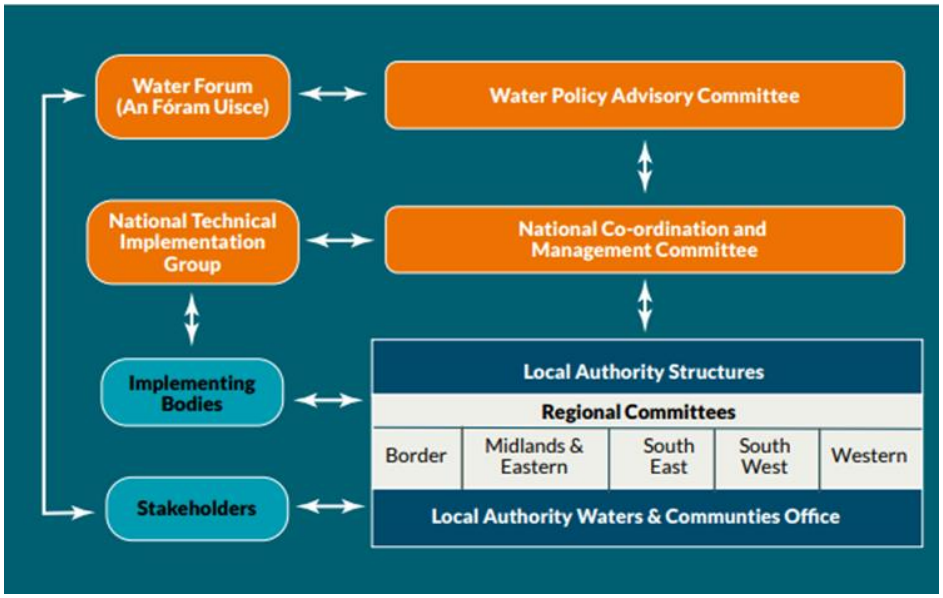


Figure 9. The three-tier governance structure for RBMP implementation Source. (DHLGH, 2018).

The first tier of the governance structure exists under the auspices of The Water Policy Advisory Committee (WPAC), which is chaired by the Department of Housing, Planning, Community and Local Government. The WPAC monitors the implementation of the RBMP and offers policy advice and befitting recommendations to the Department of Housing, Planning, Community and Local Government, who provide the needed resources for implementing the plan (DHLGH, 2018; EPA, 2015). With four meetings every year, WPAC also brings on board key policy-setting

organisations together towards the preparation of RBMPs and to map up strategies and approaches towards achieving various objectives under the plan. An Fórum Uisce|The Water Forum is a member of WPAC and represents its constituent stakeholders at this level. The National Co-ordination and Management Committee (NCMC) under tier two also ensures that the measures outlined in the RBMP are strengthened through partnerships with various stakeholders and implementing bodies within the water sector. The EPA plays a significant role here as the responsible body that drafts the environmental objectives, manages catchment characterisation and produces the RMBP templates with input from local authorities (EPA, 2015). In addition, the EPA has a history of being in tune with science-driven environmental management and does monitoring and reporting on the quality of environment, funding and coordination of environmentally related research under this tier (Wemaere et al., 2009).

Local authorities are also responsible for leading the implementation and enforcement of legislation on the ground and in encouraging public participation in decision making on RMBP under tier three (EPA, 2015). The Local Waters and Communities Office, now the Local Authority Water Programme (LAWPRO), coordinates this with technical advice from the EPA. The establishment of LAWPRO and its emphasis on public participation and engagement stems from the failure of the first RBMP on decision-making processes and public participation. Commenting on the governance structure, former Minister for Housing, Planning and Local Government Eoghan Murphy TD stated that "It is to solve the cross-cutting challenges in the water sector coherently because of the detailed consideration it has given to other areas like agriculture, peat extraction and other identified water services issues" (EPA Catchments Unit, 2018). An analysis of the structure affirms this statement due to its consistent Catchment Management (ICM) features which further demonstrate attempts by the RoI towards ICM adoption in managing catchments as implemented in Australia, South Africa, New Zealand and the USA, for instance (EPA, 2015; Mitchell & Hollick, 1993). ICM is regarded as a way of organising catchments as units for better understanding and management of ecosystem processes in a socio-economic and political context that offers communities an opportunity to turn input into sustainable natural resource management in their catchment. Local governments, communities

and states have used the approach since 1988 for effective decision-making on catchments (Fenemor et al., 2011).

Institutional Set-Up

In contrast to the first RBMP, the second RBMP has resulted in structural changes with the implementation of new programmes and institutions. As agreed by all interviewees, a major success under the second plan is the introduction of active community engagement spearheaded by LAWPRO, which was not in the first plan. Within LAWPRO, the community and catchment scientist team engage communities to initiate actions to promote water quality. This has increased Tidy Town groups and community groups' focus on cleanliness and assisting with invasive species issues (LAWPRO, 2017). By the end of 2019, LAWPRO had reported a 62% completion of all its desk studies and held 111 community meetings and over 90 fieldwork assessments (LAWPRO, 2019). Another indicator of progress was the establishment of An Fórum Uisce|The Water Forum in 2018, which has since grown in stature, competence and capacity through continuous stakeholder engagement and contributions to the discussion on water policy at the national level (The Water Forum, 2018). There has also been significant catchment characterisation by the EPA catchment unit. The Agricultural Sustainability, Support and Advisory Programme (ASSAP) under the plan supports the implementation of best practice at the farm level in 190 Priority Areas for Action aimed at addressing agricultural pressures on water (ASSAP, 2019).

Participation and Collaboration

According to the interviewees, collaboration and participation among stakeholders in the water sector have also seen an improvement under the second plan, resulting in a gradual build-up of trust among agencies and working units in the water sector. The agricultural sector, which has been a significant source of pressure on water quality, has seen improved level of interaction and discussion with other groups such as the Department of Agriculture, industries, individual farming bodies and the Dairy Sustainability Council. Thus, having local authorities liaise with farmers with input from the agricultural, processing and dairy industry, catchment scientists and ASSAP

farm advisors have been a positive step. The Water Policy Advisory Committee, local authorities, Uisce Éireann, EPA, Department of Agriculture and the Office of Public Works also meet four times a year to discuss emerging challenges, progress and measures to improve the water sector, which interviewees deemed as remarkable. Interviewees further identified LAWPRO's engagement with communities as a success, with an extra 120 to 130 new community groups that did not exist pre-2017 now involved in delivering action on the ground thanks to the Community Water Development Fund. As an interviewee said, "*The huge kind of network and stakeholder engagement status built up and the relationships that have been developed across all the public agencies and stakeholders have been absolutely unbelievable" (RI 4).*

Enhanced Governance and Management Processes

The first RBMP divided the RoI into eight river basin districts, which resulted in disjointed and ineffective management (DHPLG, 2018a). The eight river basin districts have under the second RBMP been consolidated into one large river basin to monitor and implement actions effectively (EPA, 2020c). When asked about the pace of governance processes, the interviewees were unanimous in their view of improved coordination in the governance and management of water under the second plan due to structural changes under the second RBMP. The development of strategic tools and mechanisms to improve water quality and management through the Internet of Things (IoT) was also realised. For instance, the EPA Catchments Unit has a WFD app, enabling the local authorities to determine significant pressures. Catchment.ie webpage has also been established to disseminate science and stories about Ireland's water catchments and people's connections to their water. In addition, a host of other pollution potential and risk maps have been developed to identify critical sources. These web-based interfaces show where the most risks are likely to come from in terms of nitrogen and phosphorus on the landscape. One interviewee further revealed the on-going development of a risk assessment tool for hydro-morphology to enhance efficiency in the identification of physical characteristics and water content of water bodies across different catchments. These information dissemination portals and applications help foster water data management, providing decision-makers with

feedback and indicators that are essential in planning and implementing policy decisions to improve water governance and management.

Awareness among Stakeholders and the Public

All interviewees echoed improved awareness among stakeholders in the water sector and the public. They alleged that the catchment works being carried out by LAWPRO, the stakeholder engagement by An Fórum Uisce|The Water Forum and publications by EPA and ASSAP in association with farmers had culminated in raising public awareness on water governance and management, hitherto was limited. Evidence from case studies on local catchment groups in the Republic of Ireland from 2018 to 2020 revealed that catchment engagement and community events organized by LAWPRO enhanced the skill and capacity of river trust and catchments groups and improved their level of awareness on catchment management (Micheál et al., 2021). Interviewees alleged that the various institutions across the water sector were now more aware of their roles and responsibilities, previously not well defined. Thus, the steady working relationship and defining roles and responsibilities contributed to awareness among stakeholders and the general public.

3.4.2 Significant challenges under the second RBMP

Time and Financial Constraints

The implementation of the second RBMP, on the one hand, was hampered by a mixture of short timeframes and financial constraints. Stakeholder concerns in relation to finance affirmed earlier findings by Boyle et al., (2021), in which the Water Development Fund of €225,000 opened to various community and voluntary groups involved in protecting and restoring water at the catchment level in 2020 was deemed insufficient. The limited annual funding impacted catchment actions required to protect and improve local water quality and in delivering local benefits. Moreover, criticism of the plan as not being ambitious enough is traced to limited financial resources. The limited funding also transcends into urban wastewater treatment and constraints local authorities face in driving water quality improvements and protection functions, all of which have also been highlighted as a key challenge in the

water sector (Trodd & O'Boyle 2020). A national funding strategy that spells out the funding of RBMP also remains unclear under the second RBMP. Some interviewees argued that financing of the RBMP is tied to a political will. At the same time, new units under the governance framework were set up with a limited connection to other units and tiers due to time constraints. Interviewees thus contended that all agencies and bodies had to learn how to work with each other under a limited period. COVID-19 also reportedly hindered the work done by community water officers in the summer of 2020, as most of their work is seasonal.

Governance Structure and Institutional Overlaps

The overall interviewees' response to the governance structure points to complications triggered by structural inefficiencies and overlaps in roles and responsibilities at both local and regional levels and among agencies despite the changes from the first RBMP. Getting all bodies to contribute to the plan of action, according to interviewees, has been difficult because the plan and institutions within were not integrated enough. It was further alleged by an interviewee that the national coordination and management committee, for example, was dominated by engineers than environmental scientists who were either overburdened with responsibilities or lacked interest in water quality issues. The lack of clarity regarding the second RBMP's performance management, for instance, between various departments, the EPA and the agricultural sector, was also mentioned. Additionally, the proliferation of different agencies further hampered monitoring processes and the implementation of common actions and the identification of value for money. Taken together, these overlaps suggested that organizational structures and governance processes had not been efficiently coordinated.

Policy Coherence

A recurrent theme in the interviews was a sense among interviewees that policy coherence on what is important (i.e., water quality, flood relief, or agriculture) was not well distinguished. As a result, contradictions on who does what and to what extent remained a challenge under the second RBMP. Cited examples include LAWPRO's

efforts at water quality management and improvement while, on the other hand, dairy expansion and agricultural activities continuously impact such efforts. While this may not be intentional, all interviewees agreed that it impedes efforts to reach the expected quality levels because the various institutions managing water appear to have no significant influence or direct power over those making decisions about agriculture. There are also a number of gaps in terms of implementation and supplementary measures needed, especially on urban and domestic wastewater, hydro-morphology, forestry and other pressures on water resources. The second RBMP was also identified as not being sufficiently integrated into other environmental laws and regulations. O'riordan et al. (2021) posit that the absence of primary legislation to support the implementation the WFD also represents a challenge for the RBMP due to devolved responsibility on the enforcement of water abstraction, wastewater treatment directive and nitrates directives for instance which has also influenced EU infringement actions against the Republic of Ireland for non-compliance to WFD. The absence of primary legislation makes the court moderate on environmental breaches. In addition to the absence of a primary legislation, LAWPRO for instance has no enforcement powers while a framework on accountability and code of conduct in the water governance arrangements remain unseen (O'riordan et al., 2021).

Communication

Although Section 3.4.1 highlights the positive progress made regarding public engagement and awareness-raising under the second RBMP, communication concerns were more widespread, particularly in identifying progress, areas of difficulties and in sharing learning among implementing bodies. Overall, interviewed stakeholders acknowledged that the General Data Protection Regulation (GDPR) on data access impacted the sharing of data openly even among various bodies in the governance structure. WPAC, for instance, meets frequently, yet records of their meetings are not detailed enough for other agencies to rely upon. Interviewees indicated that clear and early communication from the national coordinating committee, for instance, needed to feed into the action of local-level agencies,

communities, and the general public, were not forthcoming. Thus, the lack of real-time data and the willingness to share information among institution and between implementation bodies served as a challenge under the plan. An interviewee stated that *"within the agricultural sector, the absence of preliminary figures regarding how much nitrogen needs to be removed from the agricultural system and targets on how much needs to be taken out by 2027 has not been communicated" (R13)*. These communication concerns further impacts the identification of data gaps, in monitoring and reviewing progress.

3.4.3 Sustainable Development Goals under the Second RBMP

Most of the measures and underlying objectives that constituted the design and implementation of the WFD were framed to address clean water and sanitation which fits into Goal 6 of the Sustainable Development Goals (SDG). The goal is about ensuring availability and sustainable management of water and sanitation for all (DECC, 2021b). Other related goals such as Goal 12: (Responsible Consumption and Production), Goal 13: (Climate Action) and Goal 14: (Life Below Water) also fit into the objectives and principles of the WFD. The RoI and Kenya were the countries that facilitated the final phase of the intergovernmental negotiations for the acceptance of the goals; even so, the most striking results to emerge from the literature review and interview on the SDG showed limited public awareness of the goals in the Republic of Ireland (Carragher & O'reilly, 2021; DECC, 2021b). Two recent assessments of the RBMP by the EPA did not consider the SDGs, which further affirms the limited recognition of them (Boyle et al., 2021; O'riordan et al., 2021). Although the SDGs were not explicitly stated in the second RBMP, some interviewees argued that they were linked to clean water objectives under the second plan. However, evident in the number of times the SDGs are referred to and the limited attention given in literature, it could be concluded that the RBMP did not try to achieve the SDGs the ROI.

Moreover, considering all of the comments by interviewees, it appeared that the different units, bodies and departments deal with different issues and do not have a concerted approach to achieving the SDGs. As explained by an interviewee: *"RBMP ideally is to be a vehicle for the delivery of the SDG, but that is not clear. People have the*

perception of the goals as global issues and not local issues, but it is about local action for global action but that is not the perception in Ireland. There should be the linkage of what local communities are doing on water quality and how it is linked to environment locally and nationally, but that is not happening currently" (RI 05). None of the interviewees could clearly identify with the success of the SDG under their organisation, although they recognize the need for the RBMP to help achieve the SDGs. The limited consideration and attention to the SDG, consequently, have implications on attaining not only the goals but, to a greater extent, the WFD by 2027 because the SDG and WFD objectives are parallel, and achieving either contributes to the other.

3.4.4 Attaining the WFD Objectives under the 2nd RBMP

Interviewed stakeholders expressed a high degree of uncertainty in achieving WFD by 2027. A lack of political will, underinvestment in the sector public participation and delays in implementing the RBMP were some factors attributed to the uncertainty by interviewees. Other factors included eutrophication (excess phosphorus and nitrogen in freshwater and estuarine), hydro-morphology (physical alterations and modifications of water bodies), agricultural activities, urban discharge and forestry activities. While these factors are prevalent not only in the RoI but also many EU states and in England and Scotland, they require improved governance arrangements, approaches and active engagement with farmers who are pivotal in reducing these pressures and in the successful implementation of the WFD (Vito et al., 2020). Commenting on Ireland's ability to attain the objectives of WFD, one of the interviewees said, *"At our current pace of progress? No way, it would be very difficult. I think it could be possible in some catchments. If there was a focus on the individual catchments, but given the way the management, governance is structured, and the continuation of the priority action areas, which are kind of piecemeal, I think it would be very difficult to achieve those targets across the board across the whole country" (RI 03).*

3.5 Stakeholder Expectations Towards the 3rd RBMP (2022-2027)

The governance and management process under the second RBMP is considered experimental, with the expectation for some additions going into the third plan. Table 6 presents an overview of some key areas interviewees believe need improvement. Much of the expectation lies in implementing, monitoring and evaluating actions in agriculture and stakeholder engagements. Hydro-morphological pressures that affect over 329 rivers, 10 lakes, and six transitional water bodies require extra attention. In addition, poorly managed forest operations, peat extraction and activities which affect water quality would also require improved attention in the next plan coupled with investment in wastewater and leakage programs. There is also an expectation for the third plan to consider larger water bodies and not be limited to only 190 priority areas of action with greater emphasises on source protection. Primary legislation to support the implementation of the WFD in the Republic of Ireland is amiss, but to deal with significant pressures and activities that impact water bodies, the third plan is expected to produce clearly defined compliance approach to deal with polluters. A robust form of local and national environmental education that target farmers, the general public and schools in collaboration with state and non-state agencies is also expected under the third RBMP.

Table 6. Stakeholders expectations for areas of improvement in the third RBMP.

Areas of Improvement	Suggested Measures
Communication and coordination	• Improve communication with the public, landowners, communities, farmers and implementing agencies. • Enhance communication between committees in the governance structure. For instance, sharing of minutes among committees could help avoid duplications and inefficiency in implementation. • Expansion of programmes in the agriculture sector such as ASSAP. ASSAP's working relationships with other agencies and bodies could help improve the focus from the productivity of farms and environmental biodiversity across the agricultural sector.

Governance structure	• Greater collaboration between agencies and institutions is expected, particularly between the national coordinating management committee and the local authorities. • Distinguished guidelines on the roles of traditional local authorities and their environmental team and that of LAWPRO and ASSAP. • Distinction and coordination among local authorities and other institutions towards promoting implementation efficiency. • Policy coherence and robustness to improve and protect water resources. • Primary legislation to support the implementation of the WFD in the RoI.
Uisce Éireann (Irish Water)	• Make Irish Water an integral part of RBMP implementation plans. • Improve action on wastewater, urban discharges and capital investment.
Monitoring and implementation	• Greater emphasis on water protection activities by LAWPRO and ASSAP advisors and all 38 catchment scientists. • Review of CAP and Nitrate Action Plan to ensure accountability and reward farmers upon delivering water quality, biodiversity and other climate benefits. • Deepen attention on pressures that affect water quality such as hydro morphology, forestry, invasive species and wastewater. • Synergies on actions required to promote forestry to derive the benefits of carbon capture. • Collaborative approach in implementing actions that has biodiversity, water and climate change benefits. • Mid-term progress monitoring and assessment of plan to track progress. • Current progress is regarded as slow, hence, focus on the 190 priority actions should be broaden and also focused on source protection.
Resource availability	• Establish stream of funding to ensure that farmers can provide and ensure ecosystem services for the benefit of the environments. • Funding to ensure more priority areas are covered. • Catchment scientists should be available across all local authorities for efficient and effective monitoring and assessment across catchments. • The third plan should be released on time to avoid delays in implementation.
Stakeholder engagement	• The third plan should see LAWPRO expand in areas like community engagement with wider stakeholders and broaden its scope on biodiversity and water in relation to wider communication and engagement. • Public participation and inputs from stakeholder should be key in the next plan. • Plan of action for all 46 attachment should be made available to the public and to all stakeholders.

Although the community engagement by LAWPRO is generally perceived as good, stakeholders expect an expansion in community and stakeholder engagement. There are also expectations for mid-term progress monitoring and assessment of progress and collaborative approaches in implementing actions that have biodiversity, water and climate change benefits. As generally acknowledged by all interviewees; the three-tier governance structure is new and needs continuation; nevertheless, specific guidelines on the roles of traditional local authorities and their environmental team and that of LAWPRO and ASSAP, as well as greater collaboration between the national coordinating management committee and the local authorities, are among the expectations of stakeholders in the third RBMP.

3.5.1 The Way Forward

The RBMP challenges highlighted in Section 3.4.2 and expectations summarized in Table 6 are cumulative and reflect the impact of water governance and management under the second RBMP. Although this study identifies the current governance processes as being supported by a broad spectrum of stakeholders, the late implementation of the plan has affected the realization of its full impact especially on water quality, because it takes considerable time for quality standards and action to manifest. From the stakeholders' perspective and identified shortfalls, the study identifies and summarises the challenges with the second RBMP as being the following: finance to broaden priority areas and implementation of action plans, limited access to data and information on targets and progress, and inadequate coordination and collaboration between institutions and units as part of the governance process towards ensuring the planning and water quality protection as well as the SDG's becoming everyone's concern. Another challenge deduced from both desk review and interviews is related to innovation. Innovation through nature-based solutions, smart practices and state-of-the-art technologies that could improve water management and service delivery and protect, improve, and sustainably manage the environment were not sufficiently conceptualised in the RBMP processes. For instance, consensus towards smart metering for domestic water consumption, a national drought monitoring and early warning system, simplified administrative

procedures through digitisation and extended public participation, as well as new tools and approaches to respond to sector needs, are either in their primary stages of development, implementation or not in existence. Another missing link is the multidisciplinary approach to addressing behavioural and societal values attached to water as a priority.

These shortfalls nevertheless offer a guideline for making adjustments in the upcoming third RBMP. The study complements stakeholders' expectations from interviews and a review of literatures by offering the following suggestion: Firstly, to enhance effective and efficient communication, there could be the adaptation of digitisation and an online platform with a unified database that also allows internal and external communication to be fostered among all bodies at each level of the governance structure. Without sufficient access to data, information and communication among institutions and the public could impact decision-making and scientific-based approaches to improving water quality and reducing pressures. It could also impact shared learning and feedback of relevant information flow among stakeholders in the water sector.

Secondly, a co-benefits approach which is a strategy that conceptualizes both environmental benefits and social development in a single plan or policy framework could also be adopted to ensure that resources made available to implement the third RBMP yield the needed results at the catchment level. A co-benefits approach is essential given the interconnected nature of water to other sectors of the economy and the potential in triggering sustained socio-economic and infrastructural outcomes due to the strong relationship between co-benefits approaches and water resources (Raymond et al., 2017; Ürge-Vorsatz et al., 2014). Ürge-Vorsatz et al., (2014) further argue that co-benefits could help resolve barriers faced by policymakers in implementing climate and environmental ambitions of which the water sector is an integral part. The Water Forum has already laid the foundation for co-benefits approach through a proposed Framework for Integrated Land and Landscape Management (FILLM), which, if implemented, could improve environmental outcomes in areas of water and ecosystem management towards meeting the country's environmental goals for climate adaptation and mitigation, biodiversity protection and water quality (Water Forum, 2021).

The governance structure is relatively new, from which ineffective coordination of the different agencies in the governance structure has resulted in fragmentation of actions and duplications of some roles and responsibilities (Boyle et al., 2021). Improved coordination, particularly around monitoring, implementation and engagement, are therefore needed for robust governance and management of water resources. A study on how to tackle diffuse pollution from agriculture in England and Scotland, for example, showed that institutional fragmentation hindered efforts among stakeholder in building trust and cooperation and in implementing stringent measures to tackle agricultural pollution in England. This was in contrast to Scotland where meaningful engagements of all stakeholders helped in tackling agricultural pollution (Vito et al., 2020). Similarly, improved institutional coordination, monitoring and stakeholder engagements could also help solve agricultural pollution, which has a significant impact on water quality in the RoI. When the institutions and units coordinate, collaborate and share resources including meeting minutes instead of working in silos, it could help complement the management and governance of water resources and avoid duplications and inefficiencies in implementation.

Additionally, to maximise the benefits of public participation and minimise the tendency of a "decide-announce-defend" posture, which mars the spirit of involvement, transparency and public participation, the next plan could outline strategic approaches towards public participation. Whereas there is no "one-size-fits-all" solution to public participation, lessons from France and Denmark and from other European countries on RBMP implementation through active participation are worth considering in the next plan because despite institutional legacies, active participation of decision- makers in the learning processes and knowledge production towards policy formulation and the clear top-down and bottom-up approach to river basin institutions decision can influence high stakeholder participation and information flow (Pellegrini et al., 2019). To this effect, modern communication options, both virtual and physical, could be activated to simplify public engagement and participation processes under the third plan.

As stated earlier, the SDG's have not been significantly considered in environmental legislations and discourse over time in the RoI. This has implications on developing coherent and relevant socio-ecological strategies and in building synergies

towards tackling wastewater, water supply, sanitation and hygiene problems, which are tied to the goals (Marcinko et al., 2021). It may also transcend into difficulties with managing the environment under the context of good health, responsive consumption and food production. Thus, given the cross-cutting impact of the SDG on water resources and the interconnected relations and trade-offs among the goals (Carragher & O'reilly, 2021; DECC, 2021b; Tortajada, 2020), we argue that it could be embedded into various actions of the third RBMP and also made explicit in various intended actions through coordinated implementation and improved awareness among stakeholders. This would improve the chances of attaining the SDG by 2030 and, to a more considerable extent, the WFD in 2027 through public awareness of the goals, multi-stakeholder partnerships and knowledge sharing towards the ultimate-water quality standards required under law.

Various comprehensive studies published by the EPA on water quality (Trodd & O'Boyle., 2020), bathing water quality (EPA, 2021a) and the environment in general (EPA, 2020b) have shown that water resources in RoI are not biologically healthy as they should be. Plans to improve and reduce pressures such as urban wastewater, diffuse pollution from agriculture and septic tank leakages which impact not only the biological quality of ground waters, rivers and lakes, and the quality of coastal water, bathing water and that of transitional (estuarine) are worth considering in the third plan. The plan could also consider key aspects of the environment, such as climate change and biodiversity and their interplay in water resource management and governance. This could be framed along with a gap analysis that espouses the progress, challenges and integrated approaches required to meet the 2027 water quality benchmark across all water resources in the RoI. Lastly, the provision of sufficient funds is a requisite in delivering RBMP actions. In this regard, private funding options and external funding from the EU Green Deal and the European Agricultural Fund for Rural Development, for instance, could be explored to help meet the fiscal requirement for infrastructural revamp, deployment of state-of-the-art techniques and equipment in water supply, including research, and the cost of fixing leakages. Moreover, in broadening priority areas, emphasis should be placed on rural development, and deployment of more catchment scientists under LAWPRO to serve community needs and help in the building of resilience in the water sector.

3.6 Conclusions

This paper contributes to the governance and management of water resources by highlighting stakeholders' perspectives of the second River Basin Management Plan (RBMP) in the RoI. It identifies the water governance and management processes under RBMP as being supported by a broad spectrum of stakeholders through a three-tier governance structure that clarifies the processes and actors involved in the water sector. Institutions such as An Fóram Uisce|The Water Forum, Agricultural Sustainability Support and Advisory Programme (ASSAP) and the Local Authority Waters Programme (LAWPRO) have been effective under the plan. However, stakeholders argue that it is unrealistic to assert that RoI could meet the 2027 water quality benchmark based on progress under the RBMP. The reasons for this include the late implementation of the plan, communication lapses and ineffective collaboration and coordination among stakeholders. Agriculture and forestry activities, peat extraction, eutrophication and hydro-morphology were also significant pressures on water resources. Stakeholders' expectations for the upcoming RBMP suggest the need for a centralised information system to implement effective and efficient communication among stakeholders. There is also a need for increased financial investment to broaden priority areas and the integration of the Sustainable Development Goals in catchments actions towards water quality improvement. The paper further recommends the need for co-benefits approaches to derive the triple benefit from biodiversity, climate change initiative and water quality measures in the third RBMP. Although the context of this paper is limited to RoI, its findings could be replicated to suit the local context in other European countries and regions who aim at implementing integrated river basin management policies.

Chapter 4

GROUP WATER SCHEMES AS A CASE STUDY

To begin this chapter, a detailed historical overview of Group Water Schemes (GWS) and the National Federation of Group Water Schemes (NFGWS) based on the earlier description in Chapter 2 section 2.2.1 is provided for context as a case study. The role of GWS has been instrumental in promoting water access and equity since the 1960's. The GWS sector has undertaken a number of initiatives to improve water quality, promote water conservation, mitigate climate impact on water resources and reduce water leakages through enhanced metering and service delivery. The rationale to explore the case of the GWS sector in this chapter is to provide insights in water governance differences between rural and urban RoI and indicates how practices from the sector may be scaled up to improve water services delivery nationally. Divided into three parts, Section A of this chapter presents Water demand and usage trends among GWS consumers and their implication on conservation efforts. Section B provides context through a literature review of socio-economic values placed on water resources. Section C also details consumers' willingness to pay for water services through a Contingency valuation methodology. The combination of these sections helps to address research objective 2.

The content of this chapter is based on two publication:

1. Water Demand and Usage trends among Group Water Schemes: Implication for Water Conservation. *Submitted to IWA AQUA Journal on 6th April 2023*
2. Consumers Willingess to pay for water services: A case study of Group Water Schemes in the Republic of Ireland. *Submitted to Elsevier Journal of Technology in Society on 21st December 2022*

Supplementary material for this chapter is provided in Appendix B and C

Background of Group Water Schemes in the Republic of Ireland

By the early 1950's, living standards in the Republic of Ireland (RoI) had witnessed a significant improvement with the advent of rural electrification pursued rigorously by the government through the Electricity Supply Board. The same could, however not be said about water supply and services which was unevenly distributed between urban and rural Ireland (ESB, n.d.). The aftermath of a national polio outbreak, regarded as the worst in Irish history in 1956, gave rise to a nationwide discourse for improved sanitation and overall health care services (Bance, 2013; Cawley, 2020). Even so, at the beginning of the early 1960s, only one in eight rural homes had access to a water supply. Contrarily, over 97% of urban homes had pipe water. The water supply for rural areas were mainly from nearby lakes, private wells or rivers using buckets and barrels and other rainwater collection systems prone to contamination. These disparities prevailed even after the Planning and Development Acts of 1963, 1976 and 1982, which factored water and sanitation had been introduced (NFGWS, 2019a).

Turn On the Tap Campaign

Under the auspices of the Irish Countrywomen's Association (ICA), in 1960, the "*Turn on the Tap Campaign"* was launched to promote the provision of water supply and services to rural Ireland as a means of enhancing the quality of life, especially for women who hitherto carried the pain in fetching and drawing water for household use (waterschemes.ie, n.d.). The Irish Countrywomen's Association (ICA), took inspiration from a similar campaign that resulted in the extension of electricity to rural Ireland to organise a series of events (i.e. community meetings, conferences, lecturers and advertisements). With support from the Department of Local Government, the ICA distributed educational materials and pamphlets to raise awareness of the need for improved water access and services as well as the importance of water to the quality of life and standard of living (NFGWS, 2019a).

There were severe socio-political resistance towards the turn on the tap campaign but the benefits of water for rural Ireland and the fierce arguments put

forward by ICA on flipping the gender narrative on women's role at home influenced the Department of Agriculture to consider investment in rural water supply (waterschemes.ie, n.d.). Following continuous campaigns and debates, a strategy was subsequently developed by the Sanitary Authorities for the provision of regional schemes and by 1960/1970s, with grants provided by the government, the formation of Group Water Schemes across rural Ireland took shape with Father Joe Collins regarded as one of the pioneers in the formation of GWS at Oldcourt, and across many parts in County Wicklow (Brady & Gray, 2010; NFGWS, 2019a). Group Water Schemes have since become an integral part of water access and supply to rural Ireland courtesy of the "Turn on the Tap Campaign" which is regarded as one of the monumental women's advocacy in this history of the RoI in the 20th century (Deane & MacDomhnaill, 2021; waterschemes.ie, n.d.). The Electricity Supply Board (ESB), the Irish Department of Agriculture and farmers also remained influential in the life-changing potential of water schemes in rural Ireland. Farmers for instance donated water to various schemes for onward supply to rural consumers (Deane & MacDomhnaill, 2021). Moving forward, schemes were supported through government grants, local cooperatives and voluntary labour, until the Irish government provided extra funding after it joined the European Union community in 1973 (Bresnihan et al., 2021). Joining the European Union meant an expansion of water infrastructure and other essential social services to meet growing economic growth and industrial production, of which the rural sector was key.

At present, over 200,000 people (approximately 6% of the total population) in the RoI rely on about 400 schemes for their water needs which are mainly sourced from wells, groundwater and springs, while the rest of the population relies on Uisce Éireann connection for their water needs (DHLGH, 2020; EPA, 2022a). GWS's currently gets grant assistance based on priorities from the Department of Housing, Local Government and Heritage through local authorities under the Multi-Annual Rural Water Programme based on seven key measures. These measures are to be towards source protection to ensure compliance with water quality parameters and to facilitate the continuous expansion of the coverage of piped water supply and wastewater collection by schemes (DHLGH, 2020). Another measure for funding is to enable existing GWS to transition into the public water sector where possible and to

support rural communities' socio-economic development by creating new schemes to serve such communities. Another funding measure is towards improving water quality in existing schemes by upgrading their treatment facilities to meet compliance standards regarding Drinking Water Regulations on a consistent long-term basis (DHLGH, 2020).

The GWS sector is unique for its role in using water meters across consumers' points of connection. These meters are used to monitor water demand and supply and to check excess usage which is charged at a rate per cubic metre. While this charge varies from county to county as set by local schemes, consumers pay for excess domestic allowances based on the connection type. In Roscommon GWS, for instance, Water charges were set at €0.75 per m^3 with a dwelling house allowance of 160m^3. All domestic water connections above this allowed were charged[3].

National Federation of Group Water Schemes (NFGWS)

The GWS governance structure focuses on community members' inclusive and participatory engagement in managing schemes. Each scheme is managed by either employed or voluntary managers and committee members who are usual known and trusted within their communities. The GWS model is unique in the RoI and has been exemplary for other countries (Deane & MacDomhnaill, 2021). The activities of the schemes are regulated by the National Federation of Group Water Schemes (NFGWS).

The NFGWS was founded in February 1997 and expeditiously gained recognition as the representative organization for privately-owned and part-privately-owned group water schemes. This recognition led to the incorporation of the Federation as a co-operative society in 1998. The NFGWS has been the umbrella organisation for the GWS sector since 1998. The establishment of the NFGWS provided a unified platform for advocating the interests and needs of rural areas in Ireland that are dependent on GWS for their water supply. The NFGWS represents and liaises with individual GWS

[3] Mid-Roscommon Co-Operative Society Limited is one of the large GWS formed in 2007 through the amalgamation of 10 smaller GWS. The Scheme has about 900 members and over 1,800 connections. Accessed online: https://www.midroscommongws.com/water-charges

to identify and address water quality issues and risks and also aims to improve water conservation, leakage reduction and promotions of best practices for schemes (EPA, 2022a; NFGWS, 2019a). Since its inception, the federation has been working with local authorities, government agencies and stakeholders to achieve water quality standards. The NFGWS also negotiates for the upgrade in water supply, operational subsidies, and research on source protection and strategies to improve water quality and access. As of 2020, 406 GWS were affiliated with the NFGWS, increasing from 405 in 2018 *(NFGWS, pers comm.).* There is an anticipated decline in the total number of affiliates as Uisce Éireann prepares to take charge of some GWS, whereas others will merge or be defunct (NFGWS, 2019b).

A. Water demand and usage trends among Group Water Schemes: Implications for Water Conservation

4.1 Introduction

Group Water Schemes (GWS) are privately or publicly owned and operated groups that manage water distribution, usually in areas outside the scope of public water supply. Group Water Schemes (GWS), abstract, treat and distribute their water supply from sources such as wells, rivers or lakes or from the public supply for local distribution to rural areas (Brady & Gray, 2010). The water from GWS are primarily supplied to both domestic (households) and domestic consumers (mainly agricultural and commercial users), as part of an effort to improve water access and equitable distribution of water and water services to rural areas that are usually cut out from major supply networks. The role of GWS in the Republic of Ireland (RoI) has gained global recognition not for only its efforts in bridging water equity gaps and the provision of water services to mainly rural Irish population but also in providing key learning for other countries (Brady & Gray, 2010; Deane & MacDomhnaill, 2021; Hendry & Akoumianaki, 2016). The GWS sector within the Irish context is the only sector with meters and subsidies to meet the cost in domestic water connections as

part of efforts to promote equity and fairness in water supply to consumers (CRU, 2022; NFGWS, n.d.-a).

The benefits of GWS among water users, regulators, communities and policymakers are also widespread (Hendry & Akoumianaki, 2016). In Austria, over 3,400 community-owned water schemes serve approximately 11% of inhabitants, while in rural Denmark, 20,000 households rely on water supplied by various GWS in addition to over 13% of Finland's rural population being served by about 1,500 schemes; in the same vein, Scotland has over 22,000 water schemes also serving nearly 197,000 inhabitants (Deane & MacDomhnaill, 2021; Teedon et al., 2020). Across Canada and the USA, over 43 million people rely on schemes for their water supply, with 6% of the present Irish population relying on about 400 schemes for their water needs (EPA, 2022a; Munene & Hall, 2019). In developing countries such as Mali, Zimbabwe, Mozambique and Vietnam, for instance, water schemes also plays a significant role in water supply for rural areas and a number of urban zones (Andres et al., 2018). Beyond helping to improve the equitable distribution of water and water services to primarily rural areas the services of GWS also enhance the socio-economic sustainability of local economies that rely on water to survive while encouraging citizen participation in source protection and management of water resources (Andres et al., 2018; Teedon et al., 2020). Nonetheless, water schemes have challenges in delivering efficient services to consumers. In Sub-Saharan countries, many water schemes have failed in their core duty of providing water service delivery (Liddle & Fenner, 2017). The non-functionality of these schemes accounts for the failure of approximately 39% of schemes in Ethiopia, 21% in Ghana, and 46% in Nigeria (Andres et al., 2018). Project politics, priorities, corruption and underutilisation also impede the impact of GWS in many other countries (Van Koppen et al., 2012). The lack of system and technical knowledge and associated skills also affects the adaptive capacity of communities in managing their water schemes, as found in some rural areas in Scotland (Teedon et al., 2020). A comparative study by Hendry & Akoumianaki (2016), further points to three lows - low revenue, low quality of service, and low investment as fundamental challenges facing schemes all over. A number of studies have also indicated that smaller GWS are likely to deliver services that do not meet drinking water standards due to contamination, in addition to poor construction

and maintenance of facilities, including data on water quality to support treatment options (Hendry & Akoumianaki, 2016; Munene & Hall, 2019; Vandergeest et al., 2020). This is supported by a recent study that provides evidence on nitrate contamination and its impact on large immigrant Latino communities who rely on water from private wells (Vandergeest et al., 2020). Non-compliances with microbiological and chemical quality standards, unclear legal responsibilities for both operators and regulators in the case of a disease outbreak as well as water schemes age are other phenomena that have also widely been observed as a challenge to GWS around the world (Andres et al., 2018; Munene & Hall, 2019).

In the RoI, some Group Water Schemes (GWS) struggle with water quality issues despite growing efforts toward compliance. A 2020 Environmental Protection Agency (EPA) report on Drinking Water Quality in Private Group Schemes and Small Private Supplies reveals that one in every twenty private schemes has *E.coli* contamination, which is a significant health risk to consumers (EPA, 2022a).This has further been confirmed from a 2011 to 2020 study across groundwater supply networks in the RoI where *E.coli* was detected in 66.7% of monitoring wells at least once every ten years (Andrade et al., 2022). Earlier, Brady & Gray (2010) also reported on faecal coliform contamination among 485 GWS in 2001, which resulted in Ireland's breach of Water quality standards under the European Union Drinking Water Directive (98/83/EC). Conversely, excess nutrient concentration, mainly nitrogen and phosphorus, from agricultural activities also impact efforts at improving overall water quality in the RoI. It further impacts surface water, potentially impacting human and animal health and, subsequently, the water quality supplied by schemes. Poor compliance with regulatory standards, leakage on distribution mains and on the consumer side of connections, particularly among GWS in Ireland have also been documented (Bresnihan et al., 2021). Other identified GWS challenges in the RoI includes limited funding for infrastructure and treatment facilities in addition to inadequate training and up-to-date information on efficient and effective ways of source protection and water treatment for supply coupled with the uneconomical returns in implementing advanced water treatment facilities for especially smaller water schemes (Brady & Gray, 2010; Bresnihan et al., 2021).

Despite these challenges, the water scheme sector in the RoI has significantly enhanced water availability and equity, particularly among rural consumers, in the last seven decades. Various strategies and policies such as expanding the water supply network, repairing ageing pipes, introducing universal water meters, and water conservation measures have been introduced. Although the impact of some of these initiatives have brought an improved reduction in water demand, especially across the sector in the last two decade, the full scale of this reduction has not yet been adequately assessed due to the variation in the successes recorded among the schemes. Until recently, only a few studies (see e.g., (Brady & Gray, 2010; Bresnihan et al., 2021; Deane & MacDomhnaill, 2021; DHLGH, 2020; Rolston & Linnane, 2020) had attempted to evaluate the significant contribution of GWS and their role in informing water policy and management changes in RoI. Perhaps this should not be a surprise as the entire water sector, its governance and management practices in the RoI have been shrouded with controversies from efforts to remove charges on water, to the transfer of responsibility of public water delivery to Uisce Éireann, water metering, late implementation of River Basin Management Plan and other policies and regulatory measures (Antwi et al., 2021; Bresnihan & Hesse, 2020). An opportunity, therefore, exist to assess the GWS sector to inform legislative, policy and management practices as part of a broader mixed-method study on the assessment of GWS, their water consumption and quality trends and the willingness of consumers to pay for water services. This part of the broader study aims to provide a deeper contribution to existing knowledge on GWS by evaluating water demand trends over the past 20 years and identifying the factors that drive the implementation of water conservation measures within the GWS sector. Given the limited empirical assessment of the GWS sector, findings from this study may be used to inform relevant stakeholders, policy-makers, and regulatory frameworks in developing active long-term water conservation measures and monitoring networks among schemes.

4.2 Materials and methods

This study used a survey questionnaire to solicit data from representatives of Group Water Schemes (GWS) in RoI. The questionnaire was developed using QuestionPro

survey software (See Supplemental Material). QuestionPro aids the design of the survey questions and enables sharing and analysis of data in real time. It also allows for data transfer and analyses on third-party applications such as Microsoft Excel and R studio (https://www.questionpro.com/). The survey response gathered was the primary source of data for this study. Meter records on water demand and usage from schemes were also gathered and analysed to draw inferences on water supply and consumption trends from 2008 to 2020 - a period when most schemes started collecting data on their schemes under the directive of the National Federation of Group Water Schemes (NFGWS). Unaccounted for Water (UFW) rates were also calculated from the water demand and usage records provided by schemes. Key secondary sources of documents also consulted in this study were NFGWS legislation and policies, newsletters and reports from GWS on innovations, challenges and plans for the future, scientific publications, and key governmental reports accessible online.

4.2.1 Survey setup and administration

A combination of closed-ended and open-ended questions were adopted to enable respondents to easily make choices and give additional input on questions as required. A test of the survey questions was carried out with some members of the NFWGS with respect to the structure and potential bias. A key consideration in the testing process was ensuring clarity of questions and reducing the time required to complete each survey. Some of the questions were quantitative to improve data comparability and maximise the volume of data collected (Hynds et al., 2013). After some changes were made to enhance clarity and reduction in respondent fatigue while ensuring flexibility in answering the survey questions, a final set of 45 questions divided into four sections was deem fit for this study (Creswell, 2014).

The survey questionnaire began with general background information following the Human Research Ethics Committee of Dundalk Institute of Technology guidelines. The general background informed respondents that their participation was entirely voluntary and if they felt unable or unwilling to answer particular questions they could skip these or the entire survey. The respondents were also notified that their responses were treated with strict confidentiality. The first section of the survey asked for information on the Group Water Scheme (i.e. respondent roles,

and water source for GWS). The second section was on water demand management (i.e. average water demand, factors accounting for water demand). The third section of the survey also asked respondents to evaluate the tools/mechanisms used in informing daily water demand strategy (i.e. monitoring of flow, metering, network mapping, Unaccounted for Water). The final part aimed at ascertaining efforts at addressing excessive demand on individual connections (i.e. water audit, water conservation efforts, stakeholder engagement and communication).

The survey was accessible online from 7th July 2020 to 21st October 2020. An article on this study and the survey link was also published in the 2020 summer edition of the NFGWS newsletter, followed by periodic reminders via email to schemes representatives to complete the questions. A total of 109 completed responses were recorded at the close of the survey online, with an average survey response rate of 11 minutes.

4.2.2 Data analysis

The survey responses were descriptively analysed using percentages with figures for Unaccounted for Water (UFW) generated using R studio software. Unaccounted for Water (UFW) in this study represents the difference between the volume of water supplied into a network over a fixed period, usually daily, and the total volume of water recorded on consumer connections during the same period metered or not (NFGWS, n.d.-b). That is, if the total records of all individual meters over 24 hours is 5,000 litres, but the bulk meter at the treatment facility of 6,000 is recorded as being fed into the main supply, then the amount of UFW is 1,000 litres, which is usually lost through leakages or illegal connections. The Unaccounted for Water (UFW) and rates were generated from the reading and usage data collected by schemes as follows:

$$\text{UFW} = (SUM(MR - MU)$$

$$\text{UFW Rate } \frac{=(SUM(MR-MU)}{MR} \times 100$$

Where MR = Meter Reading and MU = Meter Usage

4.3 Results and discussions

4.3.1 Demographic characteristics of respondents

A total of 109 responses from GWS representatives (referred to as respondents), was recorded, representing 27% of GWS nationally affiliated with the NFGWS. Of this number, 82 were males, 20 females, while 7 respondents opted not to disclose their gender. The male bias in the sex of the respondents is historically linked to the limited representation of females in GWS and the water sector as a whole, although women are mostly the main actors in deciding water usage and availability at home, particularly in rural areas and in developing countries (NFGWS, 2021; Seelen et al., 2019). There have however been growing concerns in recent times to improve gender balance, particularly female representation on GWS boards and committees, to improve gender parity in the management of schemes and the water sector in the RoI. To do away with the misconception about the role of scheme representatives in terms of expected manual labour which deter females, there are calls for concerted effort through awareness creation in local communities on the roles of GWS representative and why women should be active members (NFGWS, 2021).

Demographic and socio-economic characteristics such as age, gender, education and income of respondents also play a role in drawing statistical inferences on water quality perceptions, and in understanding factors that influence, for instance, risk perception of water quality among well owners (Schuitema et al., 2020). Nevertheless, ethical implication meant that questions on some of these variables could not be asked in the survey.

Overall, the majority of the survey respondents (35%) were committee members assigned with managing schemes, while employed managers constituted 33%, with voluntary managers representing 22% of respondents. Voluntary caretakers and employed managers also constituted 5% and 6% of survey respondents, respectively. Except for the duly employed scheme managers, the rest perform their roles and responsibilities voluntarily, and do not receive any financial remuneration. Each of these respondents indicated that their schemes try to fulfil an essential function in delivering safe drinking water to its members through three primary sources, with groundwater (i.e. spring, dug-well, and bore-well) as the

predominant (67%) source of water for schemes. Surface water (i.e. rivers, lakes) makes up 27% of water sources for schemes, while a mix of groundwater and surface water sources also contributes to 6% of water sources for schemes. Contrary to the above findings on water sources for schemes, the EPA has widely indicated that a quarter of all GWS have their water supply from surface water and nearly three-quarters from wells or springs ((EPA, 2021b). The EPA's finding is also in line with the overall national drinking water supply source, which reveals that approximately 82% of all drinking water supplies in the RoI are sourced from surface water, with about 10.5% and 7.6% coming from groundwater and springs, respectively (DHLGH, 2020).

4.3.2 Water demand and usage trend

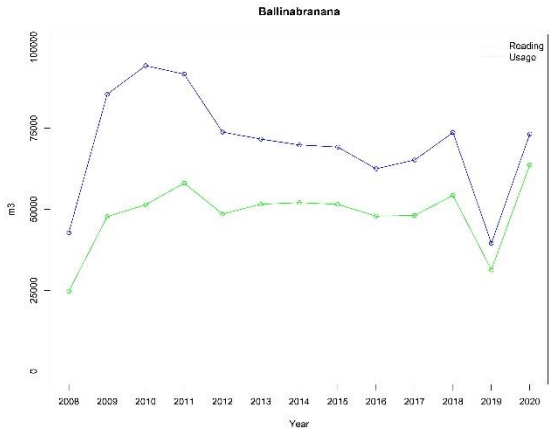
In order to have a better overview of the performance of a scheme, the amount of water supplied and consumed as well as average water demand is paramount due to its implication on conservation strategies and implementation measures. Nonetheless, our findings showed inconsistent data collected over time by schemes. This can be attributed to either the absence of scheme representatives, the voluntary nature of duties, the late introduction of meters or limited knowledge in data collection or a combination of these factors. As a result, the scope of data availability and coverage from 2008 to 2020 among some schemes is inadequate and could not to be considered for analysis (see supplementary material). However, a total of 102 respondents indicated that there had been some improvement in their daily water demand. Comparing daily average water demand from 2018 to 2019, 30% of respondents admitted that their scheme recorded lower daily water demand, whilst 53% indicated that their daily demand for 2019 was approximately the same as that of 2018. However, 17% of respondents pointed out that their 2019 daily water demand was much higher compared to 2018. For example, the average daily water demand for schemes in 2019 ranged from 5.1m^3 to 1000m^3, with just 7 schemes consuming more than 1000m^3 on a daily basis (Table 7). An earlier study by Rolston & Linnane (2020), found that the majority of GWS supply less than 1500 m^3 of water per day which is relatively consistent with our result as presented in Table 7 on average daily water demand by schemes.

Table 7. Average daily water demand in 2019

Average daily water demand in 2019	Frequency	Percentage %
5m^3	5	5%
5.1 - 25m^3	10	10%
25.1 - 50m^3	16	16%
50.1 - 100m^3	11	11%
100.1 - 250m^3	20	20%
250.1 - 500m^3	21	21%
500.1 - 1000m^3	12	12%
>1000m^3	7	7%
Total	102	100%

Although the identified variation in daily water demand among GWS is broadly in line with the national average per person on domestic meters, which ranges from about 148 to 368 litres per consumer; some schemes have managed to reduce their daily water demand (also referred to as reading), and water usage while others are on the rise (CSO, 2020a). These variations are further attributed to the introduction of conservation measures, consumer meter installation and the detection of leakages from 2008 to 2020. Late monitoring and recording of consumer's demand and usage, the type of connections, and the population around the scheme were also identified as factors that affected the schemes' ability to keep proper and adequate water demand and usage records.

Those variations among some schemes, as presented in Figure 11 shows that in Walterstown Water Scheme *(Co. Cork),* for instance, no data was collected from 2008 until 2013, and by 2015, major leaks had been detected, resulting in over 20% water losses. Some hand units under the scheme also became defunct in 2016, all of which affected the water reading and usage trends. Striking gaps in data collection were further observed among those schemes that started data collection on demand and usage either late or stopped along the line. For example, in the Ballingate Water Scheme *(Co. Wicklow)* (Fig. 1a), water reading was collected in 2018, and usage only recorded in 2016. In Tydavent Water Scheme *(Co. Clare)*, data collection began only in 2016, except for Ballinabranana *(Co. Carlow),* which had up-to-date records from 2018 to 2020 (see other schemes in Fig. 11 and supplementary materials).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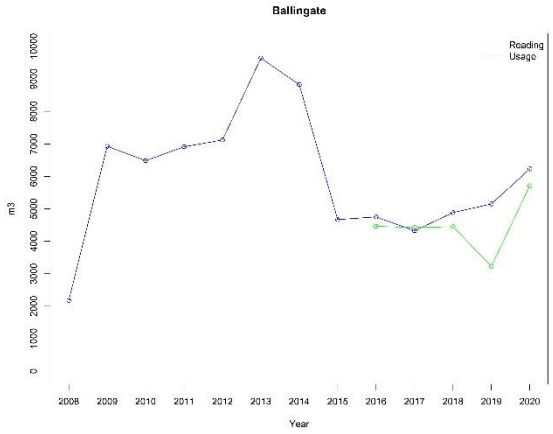
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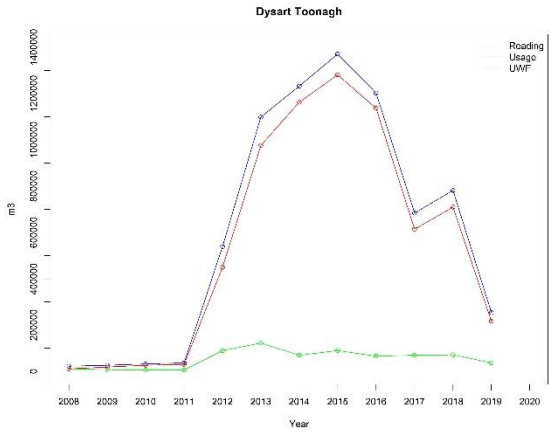
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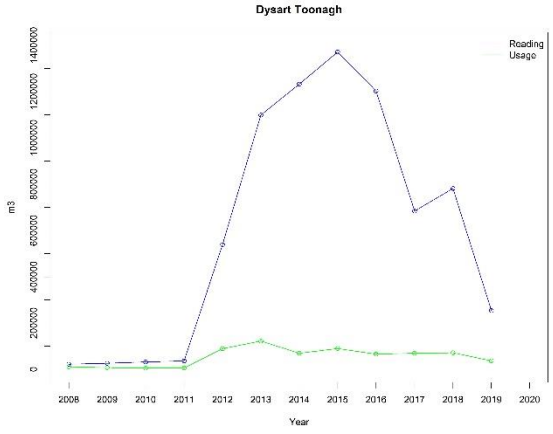
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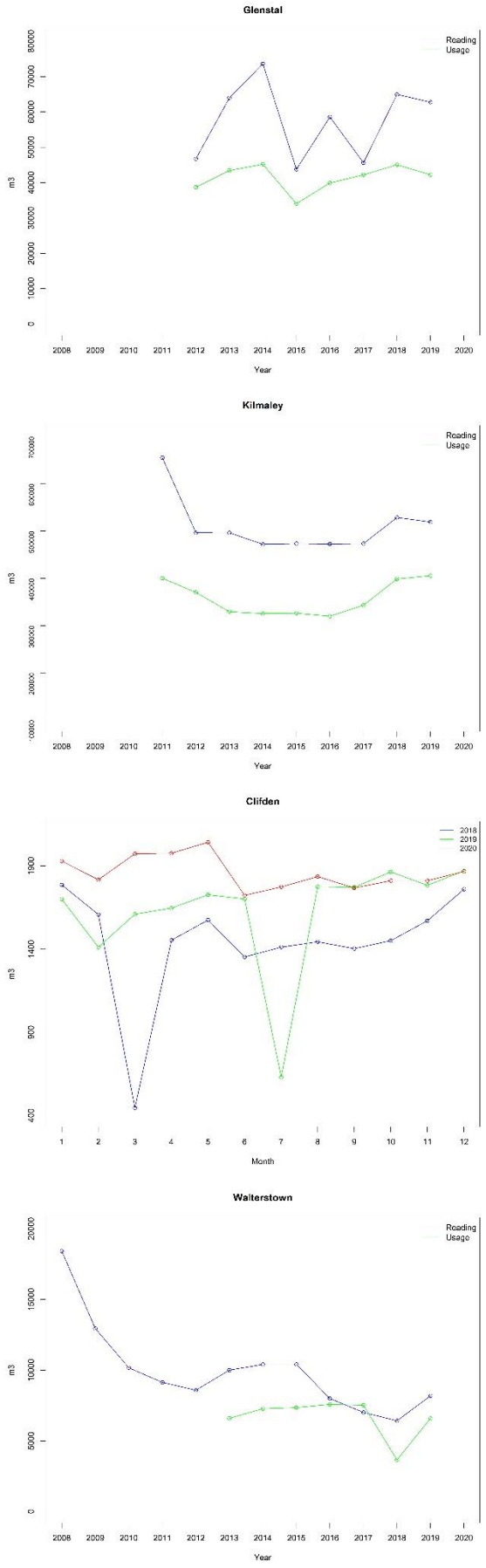


Figure 10. Yearly water demand and usage trend

Analysis of quarterly water usage among schemes from 2008 to 2020 also showed unstable trends, mainly in the third and fourth quarters of each year (Fig 12). Notably, in 2018 and 2020, some schemes recorded higher demand due to the severe drought events in the RoI leading to two consecutive water conservation orders (hosepipe ban) in each of these years. National average water demand during periods of drought, according to Uisce Éireann (the state water utility in the RoI) rises to about 30%, which is indicative of the increments in water demand among some schemes, as shown in figure 12 (Antwi et al., 2022; Irish Water, 2020a).

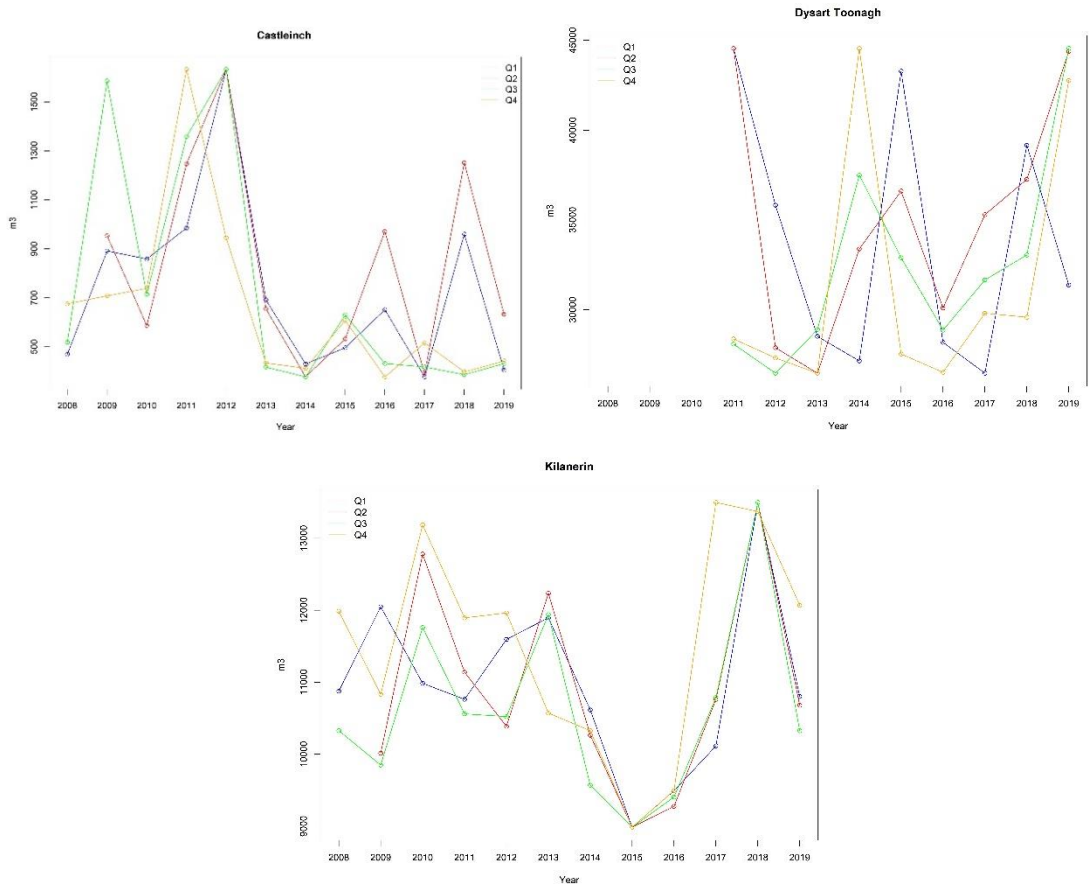
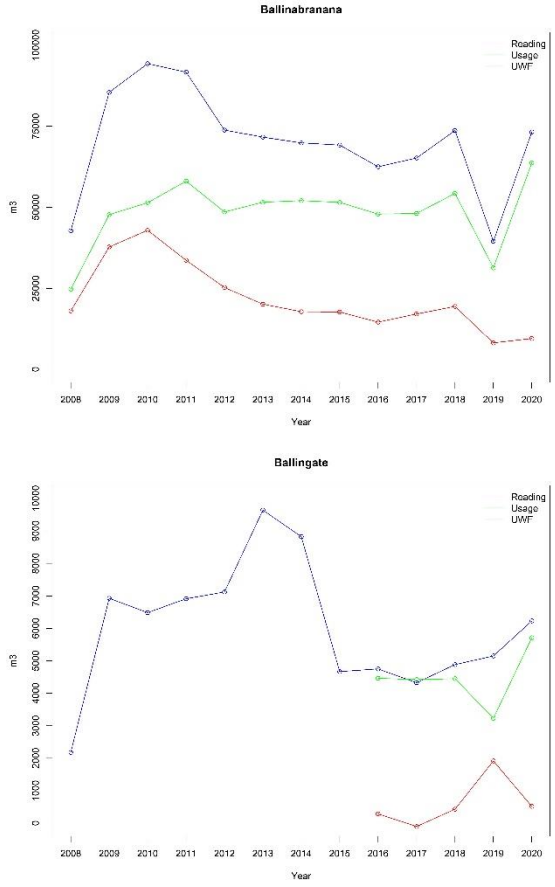


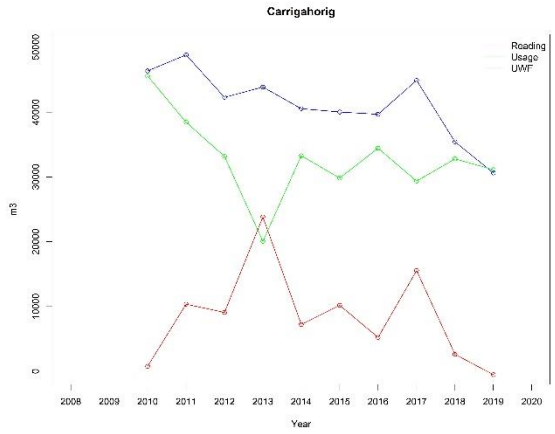
Figure 11. Quarterly water usage.

4.3.3 Unaccounted for Water (UFW)

Nationally, in excess of 40% of treated water is unaccounted for and is mainly attributed to leakages and aged water infrastructures that are unable to meet continuous demand (Brady & Gray, 2010; Irish Water, 2018b). Among GWS, the study analysis pointed to higher UFW rates resulting in a substantial increase in the cost of

water supply and management of schemes which further makes it a challenge to achieve the national threshold of 25% and the European Union average of 10% acceptable UFW rate (Brady & Gray, 2010; DECLG, 2015). Whereas UFW could not be calculated for in all schemes due to limited data, and inconsistencies in data entry and records over a period of time. Figure 11 shows that not all schemes are able to reduce their UFW because some leakages along the distribution lines are too small to detect or uneconomical to repair, thereby making some losses unavoidable or difficult to reduce or eliminate. For example, records from the Kilmaley scheme (Co. Clare) showed a variation in total water demand and UFW records (Fig 11, g). Though UFW was high in 2011, a gradual decline in conformity with total water demand pointed to an improvement in water management practices undertaken by the scheme. Also, in Ballinabranana Scheme (Co. Carlow), a continuous decline in UFW was identified from 2010, with continuous UFW fluctuations also occurring in Glenstal (Co. Limerick) in 2014, 2016 and 2019 (Fig 13, a, f).

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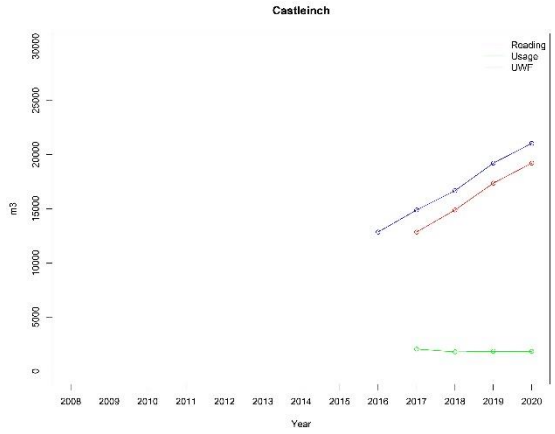
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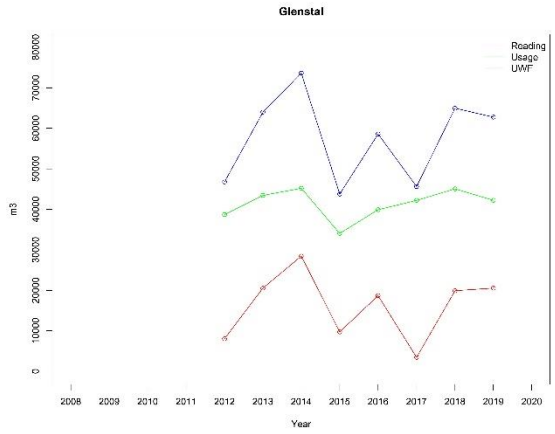
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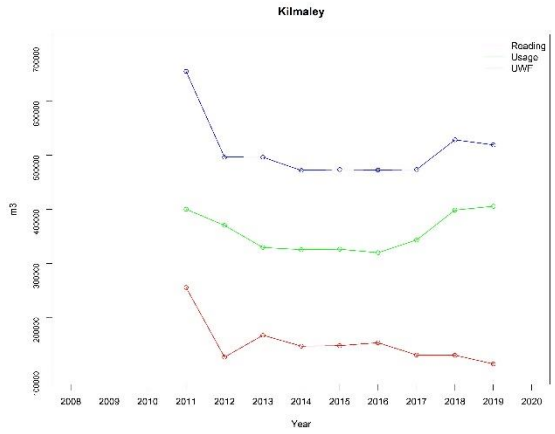
Kilmaley
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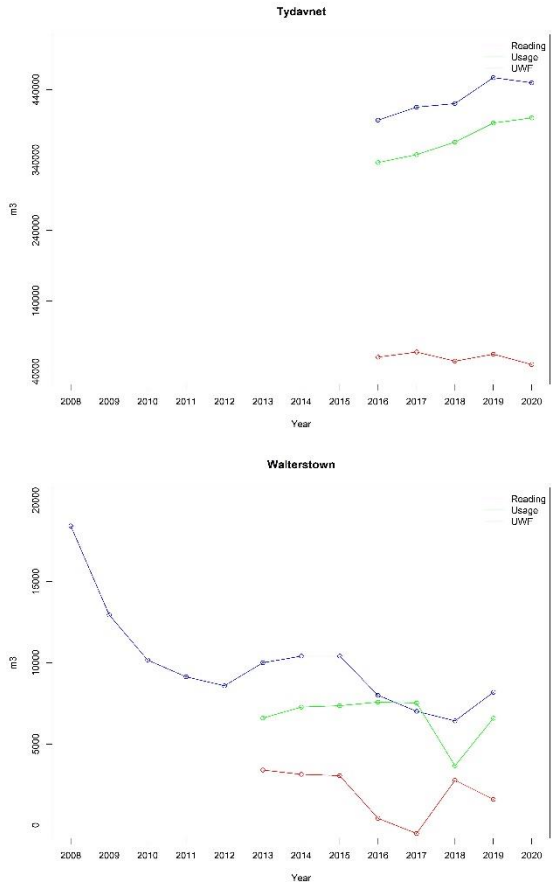

Figure 12. UFW among some selected schemes

However, the majority of respondents (76%) indicated they are taking steps to reduce UFW in their schemes. These steps are being influenced by various local and national policies such as the NFGWS 2019-2024 strategic plan, Water Services Legislation and European Union (Drinking Water) Regulations 2014, Statutory Instrument No. 122 of 2014, Water Conservation Regulation 2008 (Statutory Instrument No 527 of 2008) and the Water Services Act 2017. By 2002 the NFGWS had further developed a quality assurance system to monitor scheme activities, including the quality of drinking water supply (NFGWS, 2019a). Respondents also assigned some level of importance to a number of demand management strategies being deployed to reduce UFW and excess water demand while tracking consumption trends such as bulk metering, District Metering Areas (DMAs), and Sluice Valves (SV) to control water flow (Fig 14).

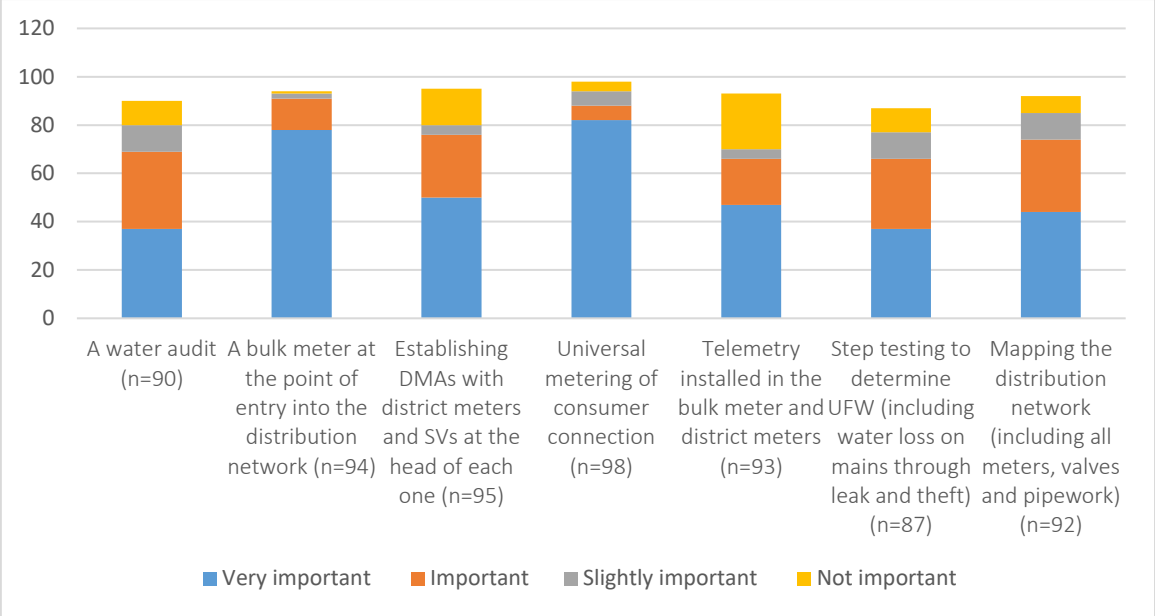

Figure 13. Factors informing water demand management strategies

Although the mapping of water networks is central to improving water supply and identifying usage, while enhancing compliance to reduce the cost of operation and undetected leaks, just over 75% of the respondent indicated that their schemes had their network mapped, whilst 25% are yet to do so. Most of these schemes (46%) had their maps on paper format, whereas 44% had theirs in both paper and digital formats. Only 10% of schemes had all of their maps entirely digitised which has implication on accurate allocation of distribution lines and spatial patterns of water resource use among schemes. Challenges with not mapping networks on time includes but is not also limited to late detection and repair of leakages, delays in excavation and future expansion works on supply lines and difficulties in tracing all networks within a scheme, especially when rapid development, re-settlement and repair works are to be carried out in a scheme.

Tracking water flow and providing information on water usage was also identified as an effective strategy in augmenting water supply services among schemes, as 100 out of 106 GWS (94%) revealed they had installed bulk meters at the entry point to the distribution network to track their flow. Eighty-seven per cent (87%) out of 105 respondents also indicated that they had meters connected to all individual connections under their scheme. High-performance devices like telemetry, which allows for remote monitoring of water flow and provides insights into detection leakages, and water supply and demand, were missing among some schemes as 72%

(of 93 responses) indicated that their consumer connections had no telemetry installed. About 43% of schemes however use telemetry in monitoring bulk meter flow. On average, all consumer connections are monitored at least once every quarter, with about 20% of schemes out of 59 respondents only undertaking monitoring when excess demand is expected.

The gradual adoption of water meters and maps based on the responses shows the commitment of some schemes in determining how much water they distribute and the quantity consumed by end-users, all of which have a long-term implication on water demand reduction and identification of leakages in real-time (Brady & Gray, 2010; Bresnihan et al., 2021). The Commission for the Regulation of Utilities in the RoI acknowledges the benefits of water meters which has resulted in the reduction of water bills among about 253 schemes (CRU, 2022). Nevertheless, while this level of progress is commendable, the absence of telemetry and monitoring among some schemes also impacts their ability to record the data needed to make policy decisions and implement comprehensive leakage programmes, which further has implications on water conservation efforts.

With regards to water auditing, 48% of 100 respondents indicated that their scheme had not undertaken any water audit to determine their average daily water demand. Approximately 17% of schemes had undertaken an audit by a professional auditor. Fewer than 9% also reported that they have had an audit undertaken by trained GWS personnel, whilst 26% had their audit carried out by a scheme member with no audit training. The use of inadequately trained water auditors, more often than not, may lead to a number of critical issues being ignored or not reported, which intend affects the assessment of a scheme's performance in terms of water demand and usage as well as management practices.

4.4 Towards water conservation among GWS

4.4.1 Conservation measures

In accordance with the NFGWS mandate GWS are expected to implement sustainable water conservation measures and also educate its members accordingly. Nonetheless, 100 responses generated on this question, showed that only 54% of schemes provide their members with water conservation advice on the potential

benefits of, for example low flow plumbing fittings on showers and taps, low capacity toilet cisterns, and turning off field troughs in winter. Other conservation measures such as rainwater harvesting in new buildings or retrofit to displace potable water for toilet use, among others were identified to be very low among schemes. Roughly 20% of respondents indicated that they have been encouraging their scheme members to take such action on rainwater harvesting. The overall conservation drive among schemes is influenced by daily water demand, consumer perception and existing policy regulations. This assumption was affirmed by 41% out of 100 respondents who indicated that water conservation is not an emergency or a matter of severe concern due to low daily water demand. Interestingly, 33% were uncertain about their scheme's benefits in encouraging members to install low plumbing fittings or rainwater/greywater harvesting systems for instance. To further encourage water conservation among non-domestic consumers, only 60% of the schemes had implemented water pricing as a conservation mechanism in line with national policy direction. This places water pricing specifically on schemes that source their water from Uisce Éireann for distribution. The Commission for Regulation of Utilities has however indicated its intention to end water charges (CRU, 2022).

For 62% of the respondents, the introduction of water conservation measures had resulted in a general reduction in excessive water demand among consumer connections under their schemes. However, as evident from water reading and usage and UFW rates, it could be asserted that schemes have achieved only a steady decline in excess water demand. This may be attributed to the degree of importance attached to some conservation measures, which has implications on conservation efforts among schemes (Table 8).

Table 8. Importance of conservation measures taken by GWS

Conservation measures	**Very important**	**Important**	**Not Important**
Metering (Consumer connections)	83	11	1
Water price increase	22	38	23
Informing consumers of suspected leaks on the properties	76	14	1

Awareness-raising includes informing consumers when demand is unsustainable	45	32	8

Water price increase, for some schemes is not a very important conservation measure, as shown in table 7, but from 2009 to 2015 for instance, a flat charge of €170 for farmers and €100 for domestic as introduced in Ballingate Water Scheme *(Co. Wicklow)* forced farmers to feed their farm animals with well water, rather than their scheme's direct supply. This resulted in a decline in water demand which hitherto was higher. The success of water pricing in Ballingate implies that there is no simple solution to water conservation matters; it may require, a combination of measures and implementation efforts to provide an effective and efficient water conservation drive among schemes.

4.4.2 Informing consumers

As water demand and usage increase amidst supply challenges, the need to explore communication strategies that can promote demand-side management and create public awareness of the need for water conservation measures becomes significantly important (Addo et al., 2019). Britton et al (2013) also indicate that communication on leakage can reduce water consumption by up to 89%, while its absence can also increase water consumption by over 52%. In line with the importance of communication, the NFGWS has been embarking on an awareness campaign by deploying various communication approaches to keep consumers informed of the impact and benefits of water conservation. In view of this, respondents were asked to determine the level of awareness of the need/benefit of water conservation among their scheme members, with 49% indicating a high level of awareness. Just about 24% of respondents were very aware, with 4% totally unaware, whilst 24% also remained partially aware of water conservation benefits to their scheme.

Approximately 64% of respondents indicated that the difference in the attitude and perceptions of water conservation between themselves and scheme members were minimal whilst 36% refuted such assertion, indicating a gap in the attitude and perceptions of water conservation between scheme representatives and members. The majority of respondents (52%) further pointed to a similar level of

awareness on perception and attitude towards water conservation between domestic and non-domestic water consumers. Although 25% of respondents believed that non-domestic consumers had a better perception and attitude towards water conservation than domestic consumers (23%). The level of communication and information sharing, especially when excessive demand is identified or when water supply is threatened (e.g. due drought, freezing weather, COVID-19 pandemic) or when repair works on the supply network are been carried out may have contributed to the reduction in the gap on perception and attitude between domestic and non-domestic consumers as well as among GWS members and consumers in general. The frequent source of protection-related education and awareness delivered by the NFGWS, such as newsletter articles, training courses and annual conferences, could also be associated with the level of perception (Rolston & Linnane, 2020).

As part of the communication process verbal communication (face-to-face or by telephone) was identified (74%) as the main means of reaching consumers, followed by written communication (in a letter, email or text message) or by a combination of verbal and written engagement. When informed, the majority (90%) of consumers address leakages on their property with only 10% failing to report or act on leakage reports. Although it was revealed that some schemes do assist their consumers in determining the exact location of leakage and offer assistance in acquiring a qualified plumber's services, roughly 10% of consumers still fail to report or act on their leakages. When excess usage rather than leakages are detected, only 54% of respondents claimed to have protocols (such as a letter of notice and fines) to deal with these.

In accordance with the NFGWS mandate, during periods of uncertainty such as the COVID-19 pandemic and the double drought of 2018 and 2020 in the RoI, the NFGWS implores consumers to re-use water, eliminate wastage and leakages responsibly, and renew their focus on water conservation both at home and on farms (NFGWS, 2020). In keeping GWS members informed, written communication (letter, text, and email), verbal communication, NFGWS and Uisce Éireann press release and a notice on local media are among a variety of approaches used in communicating and encouraging water conservation among consumers. Individual GWS also engage with different stakeholders in providing technical expertise and knowledge and for advice

on source protection as well as conservation of water through collaboration and the implementation of joint actions (Fig 15). Prior studies had identified concerns by schemes on stakeholder engagement, communication and awareness on for example, source protection, and protocols to deal with polluters and pollution events in the past (Rolston & Linnane, 2020). The result of this survey shows that there has been a considerable level of stakeholder engagement between schemes and stakeholders such as the Local Authorities, NFGWS, Teasgasc and, to a greater extent, academic institutions. However, the extent to which other relevant institutions engage with the schemes and consumers, in general, requires improvement (Fig 15).

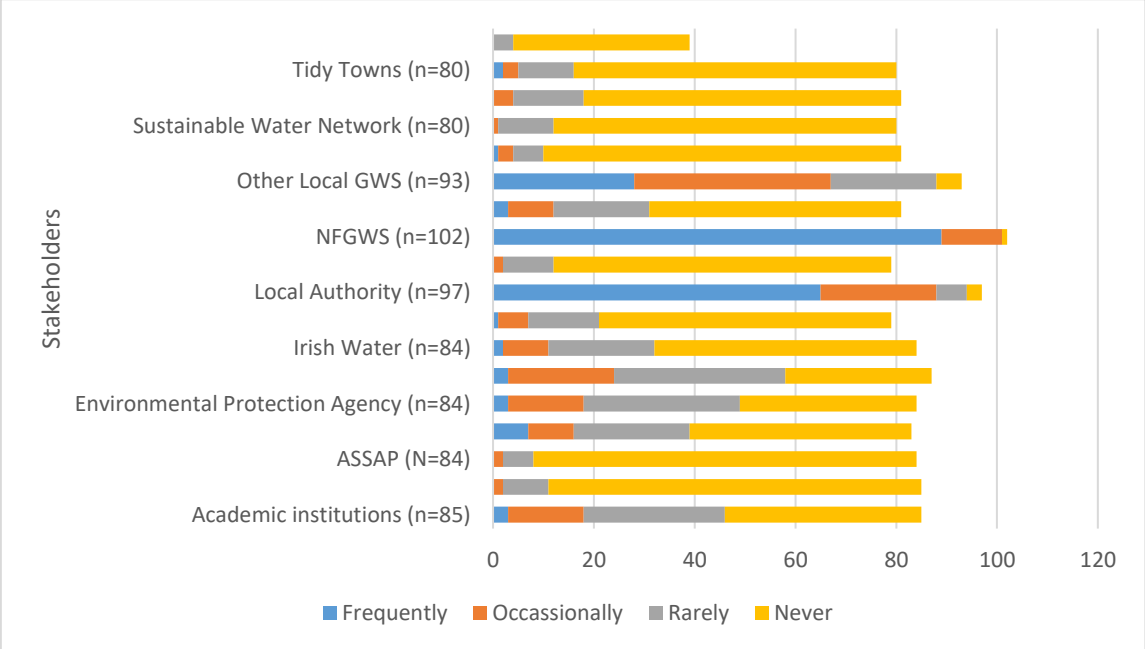

Figure 14. Frequency of stakeholder engagement

4.4.4 Limitations and recommendations

It is recognised that this study had some limitations including the potential exclusion of scheme representatives who had no computer access or computer literacy challenges. The COVID- 19 pandemic may also have had an impact as the survey took place during a period when many people were struggling to cope with restrictions as a new way of life. Within the same period, many people had to stay away from their offices or work from home. These factors invariably affected the total number of responses gathered within the survey time frame. In some cases, respondents did not answer all questions.

Moreover, due to the ethical concerns of asking for demographic data such as income and educational level, the survey questions were limited to respondents' gender, roles, and the water sources used by schemes as a measure of their demographic characteristics. However, these limitations did not affect the study's overall aim. Nevertheless, careful consideration could be required in the interpretation of the findings generated, considering the inconsistencies and gaps in the recording of meter readings and usages presented by schemes.

Accordingly, a key recommendation in this study is for training and continuing information and engagement on how scheme representatives can record and input data in standardised formats approved by the NFGWS to improve clarity in data gathered over time. In the long, short or medium-term, where applicable; communication between the NFGWS, scheme representatives, and consumers could be take advantage of modern means of communication beyond the traditional communication channels of engagement. The use of social media, regular online updates, webinar sessions, stakeholder engagement and collaboration with local community groups would help improve communication and awareness. Other forms of engagement, such as emails and physical meetings, should be continued to bridge technological gaps for those without means.

Compliance with existing penalties on excess consumption and payment of bills could also be carried out to help promote water conservation and enable schemes to raise funds for new and ongoing projects. The enforcement could also include consumers in housing schemes where domestic consumption rates are noted to be high among some schemes. Schemes could further be encouraged to report leakages on time and implement leakage reduction initiatives to reduce Unaccounted for Water (UFW) levels while efforts to revamp infrastructures like storage facilities and distribution lines through Design Build Operate Projects (DBO) processes are initiated. Revamping infrastructures will enable schemes to meet increasing demands and help avert the immediate impact of future water conservation orders on consumers. This also means that all schemes could be encouraged to install telemetry on their bulk and district meters to enhance the continuous reading of water demand and supply. Telemetry could promote labour efficiency while aiding a quicker detection of anomalies that can be investigated to determine consumption trends to

help build a clearer picture of how to develop water conservation measures for individual schemes. The drive to ensure meter installation on all connections at the individual consumer level should therefore be pursued continuously. Gender consideration should also be pursued as a key part of water management and governance for GWS for several reasons (Khandker et al., 2020; Naiga et al., 2017). First, gender equality is a fundamental principle of sustainable development, and integrating gender perspectives ensures inclusivity and fairness in decision-making processes. Women also have a distinct knowledge, needs, and experiences related to water resources, making their participation essential for effective and context-specific solutions. Additionally, involving women in GWS management could empowers them economically and socially, leading to better outcomes for communities and contributing to the achievement of broader development goals (Khandker et al., 2020).

Finally, with a growing demand for water connection among some schemes, increased capacity within scheme networks must be considered as part of any rural development plans and repair works on existing infrastructure. Schemes serving more than 50 persons as enshrined under the Drinking Water Regulations (Statutory Instrument No 439 of 2000), for instance, could be encouraged to merge or break into new schemes to promote proper data collection, water quality supply and compliance with regulations as part of rural development planning.

4.5 Conclusion

In the past two decades, the Group Water Schemes (GWS) sector has transformed itself from merely ensuring water availability and equity to rural consumers through various policies and measures that aim to address water leakages, improve water demand and quality and water conservation to becoming a good example of better practices in drinking water provision in the RoI. Using a structured online survey questionnaire, this study draws on first-hand responses from representatives of various GWS on the effectiveness of various measures and policies implemented over time.

First, the results of this survey identified the relevance of communication, highlighting the importance of regular engagement with scheme members. Most of the respondents (54%) asserted to providing their scheme members with water conservation advice on the potential benefits of low flow plumbing fittings on showers and taps, low capacity toilet cisterns, detecting and fixing leakages and cutting down on excessive water demand for instance. Secondly, some respondents did not identify water conservation as an emergency due to their low daily water demand rate; however, the re-current impact of climate change impact such as drought on water resources, amid growing water usage and demand justifies the need for water conservation to be an integral aspect of GWS activities and training. Thirdly, the gaps in scheme records of water usage and demand presented a striking challenge in calculating and identifying water consumption trends and Unaccounted for Water (UFW) rates among schemes. The higher rates of UFW further remain a significant concern against the backdrop that there has been the rigorous pursuance of water metering, mapping of water networks, and introduction of high-performance devices like telemetry and continuous monitoring of flow by various GWS as well as quality assurance system as a mechanism to monitor the quality of drinking water supplied by GWS. This has severe implications for future efforts toward water conservation among water schemes. Lastly, the analysis of stakeholder engagement and communication between consumers and GWS representatives shows progressive engagement between GWS and different stakeholders in providing technical expertise, knowledge, and advice on source protection and water conservation through collaboration and implementation of joint actions. Overall, the survey responses and secondary data from various Group Water Schemes (GWS) are indicative of the strives made by the National Federation of Group Water Schemes (NFGWS) in ensuring that schemes deliver on their roles and responsibilities in protecting water sources, conservation and delivery of clean drinking water for consumers in the RoI.

B.Socio-economic value of water resources

4.6. Introduction

Factors such as population growth, land usage, climate change and pollution, and water rationing to meet excessive demand as discussed in previous chapters have increased competition for water resources worldwide. Whereas these factors further contribute to water scarcity, they also increase consumers value of available water resources (Garrick et al., 2020; Reed & Buckmaster, 2015; Rey et al., 2019; Spit et al., 2018). Value in this context is defined as a social construction borne out of the socio-economic circumstance that considers cultural, technological and political differences (Ioris, 2013; Schulz et al., 2017). Water is this section is regarded as a substance of value because of its ability to contribute to economic and non-economic activities while also adding to cultural and aesthetic beauty, public health and overall quality of life. The value of water takes into account a mixture of direct, indirect and non-use values (Ioris, 2013). Direct value considers the provision of ecosystem services, while indirect use value also focuses on regulation and cultural ecosystem services. Non–use values depend on cultural ecosystem services (Spit et al., 2018).

A series of studies reveals that values placed on water differ among users based on perceptions, location, the type of water under consideration, income and demographic characteristics of users in the environment and basin district (Reed & Buckmaster, 2015; Shatanawi & Naber, 2011; Witt, 2019). Religious and national beliefs also influence the value attached to water resources (Veshapidze, 2020). Aesthetic benefits from water, to an extent, also influence the cost of property around areas with water due to its tranquilising (Liu, 2018). More so, educational status, legal and non-legal interests, and consumer disciplinary backgrounds consciously or unconsciously influence how water is valued in addition to services delivered by water utilities which influences the willingness of consumers to pay water bills (Clinch & Pender, 2019a; Miranda et al., 2011; Reed & Buckmaster, 2015).

The misunderstanding between treating water as a heritage rather than economic good and at the same time, recovering cost to meet water expenditures remains a bottleneck for countries especially after the 1992 International Conference

on Water and Environment (ICWE), in Dublin recognised water as an economic resources whose management approaches are to be based on economic valuations under ICWE Dublin principles approach one (WMO, 1992; Woodhouse & Muller, 2017). According to the Dublin principles, managing water as an economic good is fundamental in promoting water efficiency and equitable distribution and usages. In this regard, mechanisms such as water charges and allocation thresholds are implemented. The Water Framework Directive discreetly also promotes economic instruments in recovering cost of water which points to the economic values place on the resources. The United Nations (UN) on the other hands, encourages the historical, cultural and social usages of water resources to ensure available by recognizing water as a human right issue. The human right perspective or social value requires countries to ensure sufficient water availability for domestic and personal usages including drinking water, personal and household hygiene and proper sanitation (United Nations High Commissioner for Human Rights, 2010).

In the next sub- section, water as a social or economic value is dissected followed by methods for evaluation and a case study of consumers' willingness for pay water services, including the value they place on water resources in the RoI.

4.6.1 The economic value of water

Proponents of water as an economic good draw inferences from economic and population growth, climate change, and migration and urbanisation as factors that place extra pressure on water quality and quantity (Reed & Buckmaster, 2015). There is, however, a bone of contention on the economic value of water in Europe, for instance, which is attributed to provisions in the Water Framework Directive (WFD). The WFD preamble recognises water as a commercial product and a heritage that needs protection through all possible means. The WFD also recognises water as a common pool resource and an economic good (Preamble 1) (Santbergen, 2013). Under the WFD principle of cost recovery, member states are implored to ensure water pricing policies provide enough incentives for users to utilise water resources efficiently (Clinch & Pender, 2019b; European Union, 2000). Although the European Union WFD admits the economic importance of water through the principle of cost recovery of water services to meet costs associated with water delivery, it also stresses

the need to protect and defend water as a heritage and not just a commercial good (European Union 2000). The confusion between treating water as a heritage rather than economic good and, at the same time, recovering costs to meet water expenditures remains a bottleneck for countries.

While it is true that most members' status in the EU has varying perceptions on the water as either a public or economic good; which underpins the variation in water management and governance of water resources in the EU, some studies argue that these discrepancies stem from neo-liberal and private sector management perceptions (Berbel & Expósito, 2018; Clinch & Pender, 2019a; Santbergen, 2013; Shatanawi & Naber, 2011). Such perception has resulted in the adoption of economic mechanisms like cost recovery methods and social cost-benefit analysis as incentives for collective choice rules. However, there exists a difference in water pricing when used to recover the cost of operations, infrastructure and management of water (Shatanawi & Naber, 2011). Despite growing international support from agencies, institutions and governments regarding water as an economic good, disparities in cost recovery under the WFD do impact the measurement of the economic value of water, which also impedes the setting of the right water prices, taxes and tradable water rights as well as the provision of key decision over objectives and measures required for WFD implementation (Clinch & Pender, 2019b; Miranda et al., 2011; Shatanawi & Naber, 2011; Wright & Fritsch, 2011).

4.6.2 The social value of water

Social values on water resources has both intrinsic and extrinsic impact on decision making and collaborative action needed to implement actions in the water sector including the allocation of funds, decision on water prices, improvement in water infrastructure and protection of water resources (Wei et al., 2017). However, it has not been sufficiently addressed regarding water resource management processes, as empirical findings reveal that social values are usually mixed up with economic values (Rey et al., 2019; Shatanawi & Naber, 2011). These overlaps and the use of Total Economic Value (TEV) techniques have resulted in some studies treating the social and economic values of water as extremely independent variables. Wu et al., (2019) and Hynes & O'Donoghue (2020a) affirm this overlaps and further discuss the sparse

nature of literature on the social values of water in comparison with economic values. Clinch & Pender, (2019b), maintains that an individual's view on water as either a public or economic good is based on daily experiences and responses to a new situation such as water policies and even experiences with family and friends. In this regard, water management is expected to consider not only economic, but also water use behaviour and accord water as a social good that involves issues of affordability and equity (Araral & Wang, 2013; Clinch & Pender, 2019b). This viewpoint is further supported by several studies which contend that social values differ across jurisdictions, within a specific context and based on knowledge perspectives (Araral & Wang, 2013; Clinch & Pender, 2019a; Hynes & O'Donoghue, 2020a; Perni et al., 2012; Raymond et al., 2019).

Although literature on social values on water is sparse, by using Irish National Election data for 2011, Kenny (2019) found out that social values of water had a role in an individual's willingness to pay for water charges in RoI. This finding is essential given the inability of government to implement water charges, as the social value attached to water is still not fully known and appreciated by consumers and policymakers. A contingent valuation technique in a related study revealed that social values for individuals in water management units in the ROI also varies based on geographical proximity to a water resource (Hynes & O'Donoghue, 2020a). Willingness to Pay as a technique has also been used by Buckley et al., (2016) to examine public preferences for water quality for good ecological statutes for rivers in RoI. Stithou et al., (2012) used of choice experiment technique in evaluating the value of non-market economic benefits of the Boyne River in Ireland. Also, they explored how individual choices mattered in valuing water. In other places, like Arizona, USA, a study by Petrakis et al., (2020) revealed that biological diversity and aesthetic and life-sustaining services are among the highest social values for watersheds. Petrakis's study relied on social values for ecosystem services (SoIVES) - a GIS tool used to map and determine watersheds' social value.

4.6.3 Methods for valuation

Different methodologies have been adopted in determining the economic value of environmental resources. These valuation methodologies helps to identify factors

that influence people's economic choices and responses to resource availability. Total Economic Value (TEV) is a common theoretical framework used in this regard. The crux of the TEV framework is in identifying and structuring the different welfare values of environmental resources to determine their direct and indirect usage (Depietri et al., 2013; Emerton, 2016; OECD, n.d.; Tapsuwan et al., 2009; WAVES, 2016). TEV also helps in overcoming challenges with the undervaluation of environmental benefits by considering subsistence and non-market values as well as ecological functions and non-use benefits (Emerton, 2016). TEV encompasses different environmental resources and can be used to determine quantitative and qualitative changes in water resources. The framework highlights the different value types and various techniques to access the values of each use-values. It also depicts the particular use value to be assessed in this research (Figure 16).

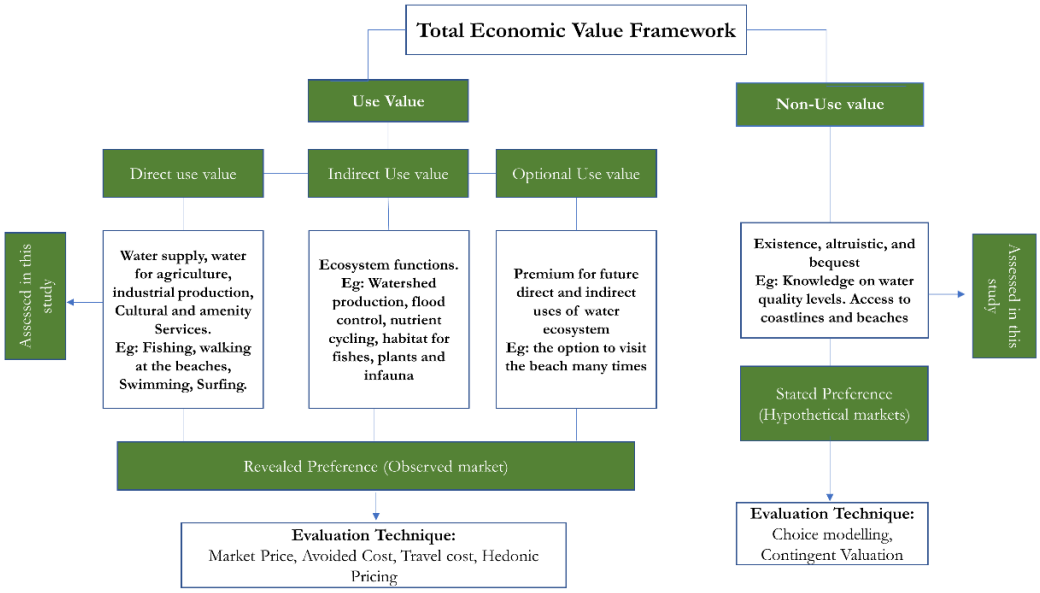

Figure 15. The Total Economic Value Framework and valuation technique. Adopted from (OECD, n.d.; Tapsuwan et al., 2009).

Aside TEV, other emerging frameworks are being used in evaluating water resource values. The World Business Council for Sustainable Development (WBCSD), framework provides numerous case studies that offer guidance and planning on the ecosystem valuation (WBCSD, 2013). Although the framework is relevant, particularly for organisations and companies on ecosystems, it offers a limited rationale on water values while emphasising decision-making processes for cooperate values on water-related ecosystem services (Morgan & Orr, 2015). The principle of economic benefit

and efficiency is also used in evaluating water resource values with consideration for socio-economic importance and factors that impedes the utmost utilisation of water (Liu, 2019). The hydro-socio-economic index (HSEI) has also been used for the sustainable assessment of water resources. HSEI considers economic, demographic, and technological factors to draw a conclusion on water values. Sarvin et al (2020) applied this index and found out that the HSEI value of many European countries ranged from 0.480 to 0.521 from 1998-2017, with severe implications for water resources planning. Some studies have also adopted the ecosystem services approach to sustainable water management. Ecosystem services is an interdisciplinary approach that helps understand the total value of ecosystems and identifications of socio-economic factors that affect the utilization of river basins. (Koundouri et al., 2016). Multiple Criteria Analysis (MCA), Cost-Effectiveness Analysis (CEA), Benefit-Cost Analysis (BCA) and Cost-Utility Analysis (CUA) are also alternative evaluation frameworks mainly for decision making, investment alternatives, and net benefit analysis of water resources (Karleuša et al., 2019; Tapsuwan et al., 2009). Beyond these methods, TEV remains extensively adopted in different studies related to the environment (see example (Admiraal et al., 2013; Emerton, 2016; Grigorescu et al., 2020; Mahlatini et al., 2020; Paul et al., 2020; Vandermeulen et al., 2011). TEV considers two main techniques, i.e. revealed preference and stated preference, to measure the value of resources. Stated preference is used to determine the value of water by asking consumers how much they will be willing to pay for water through surveys and questionnaires while revealed preferences as an indirect method, that observes market dynamics to determine water values (Shatanawi & Naber, 2011). Hedonic pricing and travel cost methods are common revealed preference techniques used in estimating values associated with ecosystems primarily for recreational purposes and to resolve values of environmental resources that are not tradeable (Birol et al., 2006; Liu, 2018; Menendez et al., 2020). These two techniques can be used to determine the values placed on local environmental resources such as water, aesthetic view and air quality.

Based on a review of a broad array of literature on water values, the Contingent Valuation Method (CVM) as a stated preference appears more prevalent. CVM estimates the value people place on a good, which is widely preferred because values

generated in contingent are based on hypothetical scenarios and descriptions of individual preferences for environmental resources (Wright & Fritsch, 2011). CVM allows respondents through surveys to state their preferences through Willingness To Pay (WTP) for environmental resources such as water resources (Boyer et al., 2017; Buckley et al., 2016; James, 2017). CVM is regarded as an appropriate method for soliciting individual responses with limited data requirement even for rural areas and developing countries. It also helps to capture a wide range of regulatory, and cultural ecosystem services and provide information on indirect use and non-use of water through the WTP survey questionnaires. The survey usually consists of three parts: 1. Questions on attitude, 2. Questions on scenarios 3. Demographic and socio-economic characteristics (Koundouri et al., 2016; Spit et al., 2018).

In the next section, Contingent Valuation Method (CVM) is used to assess the willingness of consumers in GWS to pay for water services.

*C. **Willingness to pay for improved water quality and services: A case study of Group Water Schemes in the Republic of Ireland.***

4.7 Introduction

The World Health Organization reported an increase in global access to safely managed drinking water from 107 to 115 million people between 2018 and 2020 (WHO, 2021). Although this represented a gradual increase in clean water and sanitation access, over two billion people worldwide do lack access to well-managed and clean drinking water supplies in their homes (DECC, 2021b; WHO, 2021). The existing body of research on water quality and access shows that water utilities' inability to extend supply, particularly to rural areas, institutional barriers and interrupted supply are critical challenges to clean and well-managed water supply (DECC, 2021b; Vásquez et al., 2021; WHO, 2021). These challenges are exacerbated by illegal connections, undetected leakages, demographic changes, and increased water demand and drought conditions (Antwi et al., 2022; Vásquez et al., 2021). The

extent of these challenges on cost recovery by water utilities, related illness from water contamination and poor services delivery drives consumers to seek alternative means of supply and influences their willingness to pay for improved water services (Islam et al., 2019; Vásquez et al., 2021; WHO, 2021). This is evident in the Republic of Ireland in the early 1960s when rural households had to individually source water from nearby lakes, rivers, wells and springs to meet their daily water needs due to the lack of piped water supply. Subsequently, Group Water Schemes (GWS) were formed across rural Ireland to promote access to improved water supply and access (Brady & Gray, 2010; Deane & MacDomhnaill, 2021; EPA, 2022a; Hendry & Akoumianaki, 2016; NFGWS, 2019b). Group Water Schemes (GWS) manage water distribution to mainly domestic (households) and non-domestic consumers (mainly agricultural and commercial users), where properties lie outside the distribution range of public water supplies. Currently, over 200,000 people rely on over 400 GWS for their water needs in the RoI, while the rest of the population relies on Uisce Éireann as a state utility for their potable water (DHLGH, 2020; EPA, 2022a). The GWS governance structure focuses on community members' inclusive and participatory engagement in managing schemes. Each scheme is managed by either employed or voluntary managers and committee members who are usually known and trusted within their communities (EPA, 2022a; NFGWS, 2019a). The activities of the entire GWS sector are regulated by the National Federation of Group Water Schemes (NFGWS), which has been the umbrella organisation for the sector since 1998. The NFGWS represents and liaises with individual GWS to address water quality issues and risks, improve water conservation and leakage reduction and promote best practices for schemes (EPA, 2022a; NFGWS, 2019a).

The GWS sector has traditionally faced challenges such as contamination, excess nutrient concentration, undetected leakages, excessive water usage, and limited funding for infrastructure and treatment facilities (Andrade et al., 2022; Bresnihan et al., 2021). However, the sector's role in the RoI has gained recognition in bridging water equity gaps, providing water services to mainly rural Irish populations, and providing valuable lessons for other countries (Deane & MacDomhnaill, 2021). The GWS sector is unique in implementing water conservation measures, active engagement and training in water management and quality service delivery. In the

sector, smart meters have been installed across consumers' connection points to monitor water demand and supply and to check excess usage charged at a rate per cubic metre. GWS consumers also pay fines and charges for water usage above a given allowance of 225,000 litres, although charges may vary by county and individual schemes. Following the suspension of domestic water charges in the Republic of Ireland in 2016 (Clinch & Pender, 2019b; Irish Water, 2021a), Uisce Éireann consumers with annual water usage above a given annual allowance of 213,000 litres pay a maximum water conservation charge of €500 per annum (Clinch & Pender, 2019b; Irish Water, 2021a). Interestingly, Uisce Éireann has been considering re-introducing domestic water charges, while all charging arrangements for public GWS are set to be cancelled (CRU, 2022; Irish Water, 2021a).

Not only does the absence of domestic water charges beyond the free allowance impact the economic value of water resources. It also influences the public's Willingness to Pay (WTP) for improved water services (Antwi et al., 2022; Buckley et al., 2016; Islam et al., 2019). What is known about values on water resources and the WTP for improved water services in RoI is primarily derived from the level of development across parts of the country, social class, perceptions and household financial status, as well as educational level, recreational use and environmental values at river basins district (Buckley et al., 2016; Hynes & O'Donoghue, 2020a). There is also a notable paucity of scientific literature explicitly relating to consumers' WTP for water usage (Buckley et al., 2016; Clinch & Pender, 2019b; Dwyer, 2019; Hynes & O'Donoghue, 2020b; Irish Water, 2021a). This study is particularly interested in the WTP of GWS consumers, an area that has yet to be investigated. The objective of this study is to fill this knowledge gap and contribute to the current body of literature on WTP in the RoI and beyond. As the first study of its kind, the study aims to accomplish two specific objectives: i) to identify the factors that impact the quality of water supplied by GWS, and ii) to examine the willingness of GWS consumers to pay for improved water quality and services. The value of improved water quality and services is expected to be influenced by conservation measures, risk perceptions and challenges associated with water services delivery.

A country-specific case study of GWS in the RoI using Contingent Valuation Method (CVM) as a theoretical model is employed in this study. A broad review of the

literature shows that CVM is commonly preferred in testing the desires of consumers to pay for improved water services (Birol et al., 2006; Liu, 2018; Menendez et al., 2020; Shatanawi & Naber, 2011; Vásquez et al., 2021). CVM estimates the value people place on environmental resources, such as water, based on hypothetical scenarios and descriptions of individual preferences. Mumbi & Watanabe (2021) applied CVM to measure the public WTP and participation in improved water quality in a case study of River Sosiani. Similarly, Vásquez et al., (2021) reported on household preferences for improved water services in the Galapagos' Islands using CVM. Evidence on water utilities' desire for social legitimisation, support and customer engagement reported by Guerrini et al.,(2018) also relied on CVM. The relationship of WTP with socio-economic factors such as income, accommodation and employment has also been explored by Akhtar et al., (2018) using CVM. CVM has been used in testing public WTP in other fields and studies such as agriculture (He et al., 2022), food delivery reusable food container system (Schuermann & Woo, 2022) and clean energy production (Xie et al., 2019). CVM has proven to be an effective method for eliciting individual responses with limited data requirements, even in rural areas and developing countries, as demonstrated in these studies. However, transferring WTP results from one geographic location to another may not be reliable due to the influence of social, economic, cultural, and geographical factors (Spit et al., 2018). Nonetheless, CVM is still valuable for capturing a broad range of regulatory and cultural ecosystem services and in providing information on the indirect and non-use of water through survey questionnaires (Acey et al., 2019). Such survey usually consists of respondents' attitudes, scenarios and demographic and socio-economic characteristics (Koundouri et al., 2016; Spit et al., 2018).

4.8 Materials and Methods

4.8.1 Survey Design

As a continuation of a broader research on water demand and usage trends among GWS by the same authors, this study applied a structured survey questionnaire following CVM approach (Koundouri et al., 2016; Spit et al., 2018), and distributed online using Question Pro (https://www.questionpro.com/) from June to October 2022. The call to respond to the survey was promoted through email reminders to

scheme managers and members as a voluntary exercise. Two groups of respondents were surveyed: GWS representatives and GWS members. While the responses from scheme members were used to determine their willingness to pay (WTP), those from scheme managers were used to evaluate the progress and challenges related to conservation efforts by various schemes. The decision to use an online survey questionnaire was based on practical considerations. First, the COVID-19 pandemic had made remote work and virtual meetings a more appropriate option, and people preferred this over physical meetings. Second, time constraints made it difficult to conduct in-person interviews with individual scheme members, particularly given their dispersed locations. More so, online surveys enabled data to be collected from scheme members and their representatives without the need for extensive travel and scheduling conflicts. Overall, the use of online survey questionnaires proved beneficial in collecting data in a practical and efficient manner, particularly during times of social distancing and remote work. Secondary data from published articles, newsletters and articles from the NFGWS also supplemented the study.

4.8.2 Questionnaire preparation

Following the CVM approach, the survey questionnaire for GWS members was divided into four sections to elicit information from the members (See Supplemental Material). Section one was based on the socio-demographic characteristics of GWS members. Section two focused on water quality and consumption habits. In section three, questions on water conservation actions and measures were asked. Three questions were asked to examine scheme members willingness to pay for water service improvement in section 4. These were:

- Scenario 1: If you were asked to contribute €50 annually towards improving water services (e.g., water conservation and quality measures) for your GWS, would you?
- Scenario 2: If YES to scenario 1, would you be willing to increase that contribution to €100 annually?
- Scenario 3: If NO to scenario 1, would you be willing to contribute €25 annually?

These threshold amounts were determined from the authors' prior knowledge of engagement with water schemes and responses from NFGWS staff members who have a detailed understanding of the GWS sector. To avoid biases associated with CVM scenarios where survey respondents either overstate or understate their ability to pay for improved services, scheme members were also asked in the survey how much they spend annually on water services and preferred options towards improving water quality and service delivery (Islam et al., 2019). The initial annual contribution amount asked was €50. A threshold of €100 and €25 were given as further options to test the genuine willingness of scheme members to contribute to improved water quality and services. The choice format of YES or NO answers to the WTP questions was applied to reduce the possible bias and for good validity.

The survey questionnaire for scheme representatives comprised 30 single and bounded choice and open-ended questions focused on Unaccounted-for-Water (UFW), cause of contamination, energy-saving measures, drought emergency management plan and annual water conservation cost (see supplementary material).

4.8.3 Data collection and analysis

The primary cross-sectional data were collected from 104 group water scheme members and 33 scheme representatives who responded to the survey. Descriptive statistics such as frequency distribution tables and percentages were used to analyse bio-demographic characteristics and perceptions of factors that impact water availability. A binary logistic regression model under R studio (http://www.rstudio.com/) was used to compute the significance and likelihood of occurrences and to determine how various dependent and independent variables influences scheme members' WTP for improved water supply (Eridadi et al., 2021).

4.9 Results and discussion

Table 9 presents the descriptive statistics of the variables of interest in this study. Among the 104 scheme members who participated in the survey, 59.62% were male and 40.38% were female. The majority (29.8%) were aged between 45-54 years, followed by 20.2% aged between 55-64 years (Table 9). In terms of education, 40.4%

of scheme members had completed tertiary education (third-level education), while 27.9% had completed secondary education (senior certificate) level. Employment-wise, 35.6% worked in private companies, while 14.4% were farmers or agricultural workers. According to Table 9, most scheme members (83.6%) lived in detached single-family houses, with outright ownership being the predominant (64.4%) house tenure system. Others (32.7%) also owned their homes with either a mortgage or a loan. The majority of households had a size ranging from two (28.9%) to four (33.7%), with only 16.4% having a household size of over five persons. The average daily water usage among the majority (40.4%) of scheme members was less than 200 litres, while the overall daily average ranged from 200 to 700 litres (Table 9).

Table 9. Socio-demographic characteristics of respondents

Variables	Options	Frequency	Percentage %
Gender	Male	62	59.62
	Female	42	40.38
	Prefer not to state	0	0.00
Age of Respondents	18-24 years	0	0.00
	25-34 years	6	5.8
	35-44 years	17	16.3
	45-54 years	31	29.8
	55-64 years	21	20.2
	65-74 years	24	23.1
	75-84 years	5	4.8
	85 years and above	0	0.0
Level of Education	Primary	5	4.8
	Junior certificate	11	10.6
	Senior certificate	29	27.9
	Third level	42	40.4
	Post-graduate	17	16.4
	None	0	0.0
Employment	Farmer/ agricultural worker	15	14.4
	Employed in a private company	37	35.6
	Employed in a public company	16	15.4
	Pensioner	22	21.2
	Student/learner	0	0.0
	Unemployed	5	4.8
	Others	9	8.7

Type Of Dwelling	Detached single-family house	87	83.6
	Apartment/flat	0	0.0
	Terrace/Townhouse	0	0.0
	Single story dwelling	8	9.0
	Semi-Detached apartment/townhouse	2	1.5
	Other	7	6.0
Tenure	Owned outright	67	64.4
	Rent-free	0	0.0
	Own with a mortgage or a loan	34	32.7
	Rent from a landlord	0	0.0
	Rented from local Authority	0	0.0
	Other	3	2.9
Household Size	2	30	28.9
	3	22	21.2
	4	35	33.7
	5+	17	16.4
Average Water Usage Per Day	Less than 200litres	42	40.4
	201-300 litres	19	18.3
	301-400 litres	5	4.8
	401-500 litres	8	7.7
	601-700 litres	2	1.9
	More than 700 litres	0	0.0
	Not known	28	26.9

The findings from the survey responses of the thirty-three scheme representatives suggest that they provide services to about 23,291 consumers. The schemes have a total of 12,172 connections, of which about 7670 are domestic users and 4111 non-domestic users. These schemes experience an average of ten leakages per year, which in turn contribute to the Unaccounted-For-Water (UFW) rates. It was also identified that thirteen out of thirty-two schemes have UFW rates exceeding 25%. Such high rates of UFW could be attributed to multiple factors such as illicit connections, obsolete pipeline infrastructure, and insufficient upgrades. As a results, the majority (29.2%) of the 33 scheme representatives spend over €10,000 annually on efforts to ensure water access, quality, and conservation. Conversely, 16.7% of the

representatives reported no spending on conservation or difficulty in estimating related costs (Table 10).

Table 10. Factors related to water access

Variables	Options	Frequency	Percentage %
Source of water	Local lake	19	18.8%
	Local river	0	0.0%
	Groundwater well	52	51.5%
	Combination of source	6	5.9%
	Not known	21	20.8%
	Others	3	3.0%
Means of water consumption	Tap (without filter)	71	68.3%
	Tap (with filter)	21	20.2%
	Bottled water only	3	2.9%
	Both tap and bottled sources	9	8.7%
	Others	0	0.0
GWS annual cost for water supply	€500-€1000	3	12.5
	€2000-€3000	5	20.8
	€4000-€5000	4	16.7
	€6000- €7000	1	4.4
	€7000- €9000	0	0
	€10,000-above	7	29.2
	None	4	16.7

According to the findings presented in Table 10, a considerable proportion of scheme members lack awareness of the source of their water supply, with an estimated 20.8% unable to identify its origin. Among those who could identify the source, the majority (51.5%) reported that groundwater was the primary source. Despite this, a significant number of scheme members (68.3%) consume water directly without any filtration, while 20.2% rely on filtration systems to purify their water before usage. A small percentage (2.9%) only consume bottled water, while 8.7% use a combination of tap and bottled water. Scheme members primarily determine their water quality based on sensory indicators such as look, taste, and smell (36.5%). Other members (13.5%) rely on available water quality reports, communication from their scheme representative (37.5%), or observations of the environment surrounding the water source (1.9%). Furthermore, 10.6% of scheme members presume that their water is

always safe for drinking. Additionally, scheme members incur an average annual expenditure of approximately €116.75 on water bills due to undetected leakage, excessive damage, and higher UFW rates, resulting in increased consumption above the given allowance.

4.9.1 Estimation of WTP

Scheme members' willingness to contribute financially to improve water services, such as water conservation and quality measures, based on their average annual expenditure, were used in estimating WTP. Participants were asked to consider contributing €100 annually. Of the 104 responses, 56.7% indicated an unwillingness to contribute at this rate (Table 11). Only 43.3% of scheme members agreed to contribute at this level. However, when the proposed annual contribution was reduced to €50, most scheme members (80.8%) demonstrated a strong willingness to contribute, with only 19.2% indicating no willingness to do so. Similarly, when the annual contribution rate was further reduced to €25, 72.1% of scheme members showed a positive willingness to pay, while 27.9% indicated no willingness to contribute (Table 11).

Table 11.WTP amounts for improved water quality services among scheme members

WTP €100 for improved water services			
		Frequency	Percentage
Valid	Yes	45	43.3
	No	59	56.7
	Total	104	100.0
WTP €50 for improved water services			
		Frequency	Percentage
Valid	Yes	84	80.8
	No	20	19.2
	Total	104	100.0
WTP €25 for improved water services			
		Frequency	Percentage
Valid	Yes	75	72.1
	No	29	27.9

	Total	104	100.0

Econometric regression model

The willingness of scheme members to pay for an improved service was regressed on a number of influencing independent variables by a binary logistic regression model. Several studies have investigated the relationship between dependent and independent variables in determining WTP and their relationship to improving water services using a similar approach (Akhtar et al., 2018; Eridadi et al., 2021; Islam et al., 2019). The binary logistic regression model is specified by the equation below

$$\text{WTP} = In\left(\frac{P}{1-p}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 \ldots \beta_5 X_5$$

where X_1, X_2, X_3, X_4 and X_5 represent age, (X_1) gender (X_2) household size (X_3), educational level (X_4) and employment status (X_5), respectively as explanatory variables and willingness to pay (WTP) as a response variable. The representative variables are 1 = WTP and 2= No WTP. Also, $\left(\frac{P}{1-p}\right)$ being the odd numbers and α as the constant/intercept. To draw statistical inference, age as a variable was split into three categories: 18-34; 35-64; and >65. Employment into employed (i.e., Farmer, agricultural worker, employed in a private company and employed in a public company) and unemployed (i.e., Pensioner, student/learner, Unemployed). Household size was also categorised as less than four or greater than or equal to four. Educational re-categorisation was Secondary (i.e. Primary, Junior and secondary level qualification) and tertiary (i.e. third-level post-graduate). This re-categorisation helped draw vivid insight into the relationship between dependent and independent variables in determining WTP and their relationship to improving water services (Eridadi et al., 2021). The representative variable for the gender of scheme members was 1=male 2=females. Age was a categorical variable. The representative variable for the household size was also 1 for > 4 and 2 for ≤ 4. For employment, 1 represented employed, 2 for unemployed. The representative variable for education was also 1 for secondary and 2 for tertiary. 1 and 2 also represented *Yes* and *No* for the WTP. The independent variables correlation matrix was significant (Fig 17), showing that all variables were free from multicollinearity and could be accepted under the regression model.

Figure 16. Correlation matrix table of the variables

The likelihood ratio test was employed to test the explanatory variables' significance with an associated *p*-value (0.021) and a Chi-squared value of 33.09. At a p-value < 0.05, it was concluded that at WTP rates of €25 and €50, there were significant relationships between all five explanatory variables (Table 12), compared to WTP at €100.

Table 12. Factors analysis for WTP

	Variables	**Estimates**	**Std. error**	**Pr (>| z |)**	**Odd ratio**
WTP €25	Intercept	-1.39436	0.609974	0.000**	0.24808
	GENDER (2)	0.09501	0.45882	0.022**	1.0996
	AGE(2)	0.656	0.57662	0.025**	1.927
	AGE (3)	0.494	0.45091	0.000**	1.6388
	HS (2)	0.03901	0.46152	0.012**	1.0397
	EMPS (2)	0.02496	0.44786	0.000**	1.02527
	EDU (2)	0.04889	0.32145	0.000**	1.0501
	Variables	**Estimates**	**Std. error**	**Pr (>| z |)**	**Odd ratio**
WTP €50	Intercept	-1.1662	0.65494	0.312ns	0.3115
	GENDER (2)	0.79910	0.03654	0.01**	2.2233
	AGE (2)	0.62520	0.45222	0.000**	1.8686
	AGE (3)	0.25701	0.22254	0.033**	1.2930
	HS (2)	-1.05289	0.41231	0.013**	0.3499
	EMPS (2)	-0.354	0.54145	0.0412**	0.7018
	EDU (2)	0.23798	0.33315	0.000**	1.26868

	Variables	Estimates	Std. error	Pr (>| z |)	Odd ratio
WTP €100	intercept	0.60252	0.65471	0.089ns	1.8266
	GENDER (2)	-0.07740	0.0544	0.000**	0.9255
	AGE (2)	0.17192	0.4517	0.0709ns	1.1875
	AGE (3)	0.15033	0.2221	0.0743ns	1.1618
	HS (2)	-0.31017	0.3002	0.000**	0.7333
	EMPS (2)	-0.1501	0.65007	0.000**	0.8607
	EDU (2)	0.053157	03405	0.056ns	1.0544

ns = Indicates significance, ** = the p value is significant, HS= Household size, EMPLS= Employment S=status, EDU= Education status

WTP at €25 showed that all estimates are positive and significant at *a p- value* rate of *p*= 0.000 to 0.025, indicating a considerable likelihood for scheme members to pay €25 compared to the other categories acting as reference levels. With regards to gender, the analysis shows a female is more likely to pay €25, holding all other variables constant compared to a male (Table 12). At a WTP rate of €50, all the estimates were positive except for household size and employment status. This implied that household sizes of ≤ 4 and members unemployed were less likely to pay €50 compared to a household size of > 4 and employed. However, the positive values for age, gender and education mean there was a higher likelihood of paying €50 than the reference variables. The positive relationship between education and WTP for improved water services is has been recorded in a number of studies (Eridadi et al., 2021). Comparatively, at €50 WTP, female scheme members were more likely to pay compared to males. At the same time, those who attained a tertiary level of education were also more likely to pay compared to secondary scheme members. The results of the model at €100 WTP also revealed that age and education variables were insignificant with a *p*-value of *p*=0.0709 and 0.056 respectively. However, gender, employment status and household size remained significant at *p*= 0.000. With reference to employment status, the respondent's willingness to pay €100 was 14% lower if scheme members were unemployed compared with employed respondents. The independent variables of household size, employment, education, gender and age at constant had some influence on scheme members' WTP at a range of *p*= 0.00 and 0.01. The influence of these variables, especially gender, affirms an earlier study by Mumbi & Watanabe (2021) that gender is more likely to impact WTP significantly.

4.9.2 Determinants of WTP among GWS members

The results of the binary logistic model indicate a significant association between various demographic factors, such as employment status, gender, household size, and education, and scheme members' willingness-to-pay (WTP) for improved water services. Nonetheless, the heterogeneity in responses and statistical inferences suggest that other factors may influence the willingness to pay for improved water quality and services beyond financial status, as has been observed in some WTP studies (Eridadi et al., 2021; Zetland, 2021). A study by Byambadorj & Lee (2019) on household WTP for wastewater treatment and water supply system improvement in Mongolia further supports this observation, indicating that information on water services, plans, and housing type influences WTP rather than income only.

In order to examine the impact of significant pressures on willingness-to-pay (WTP), water scheme were asked to rate their perceived levels of significant pressures on the quality of water they consumed, using a scale ranging from 1 to 10 (0 = irrelevant to water quality, 10 = highly relevant to water quality). Slurry spreading run-off (24.59%), climate change impact on available water (20.69%), and pesticide usage (18.03%) were among the prevalent factors identified to be impacting their water quality (Figure 18). Factors such as landfills (24.53%), bankside erosion (21.57%) and run-off from peat extraction operations were regarded among other scheme members to be of less impact on water quality in their scheme.

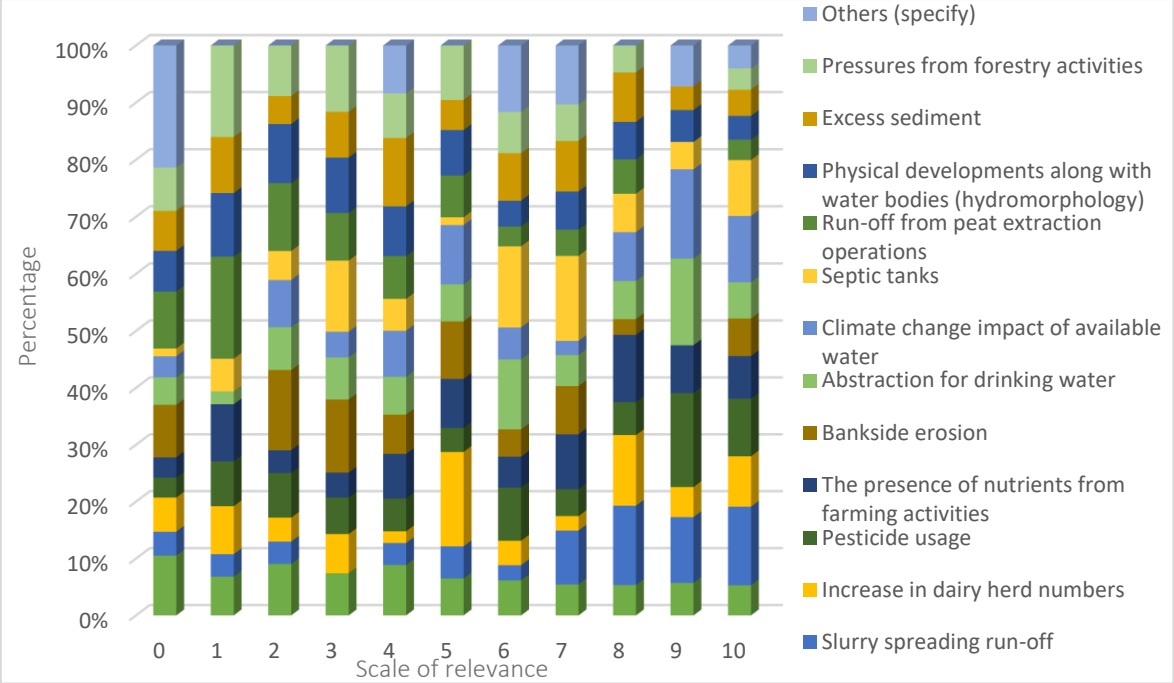

Figure 17. Significant pressures impacting water quality

GWS representatives also responded to contamination from slurry spreading run-off (16.1%), the presence of nutrients from farming activities (6.5%), excess sediment (3.2%), and other (16.1%) such as algae bloom, septic tanks, physical development from the building of motorway and silt as significant pressures impacting water supplied under their scheme. Despite these identified significant pressures, a greater proportion of scheme members (83.82%) indicated that water supply to their homes was generally clean and fit for drinking. The willingness of scheme members to pay for improved water quality services is affected by the actual improvement of water quality. However, for scheme members who experience quality and supply challenges such as planned and unplanned interruptions, water taste and odour, pollution from sewage discharge, discolouration, and supply interruptions, the likelihood of making extra payments for improved water quality services, may be higher. This aligns with the existing research on WTP, which indicates that consumers are more likely to pay for better services only when the existing water quality and services are insufficient or compromised (Byambadorj & Lee, 2019; Makwinja et al., 2019).

Drought conditions have also undeniably been affecting water availability and supply in the RoI (Antwi et al., 2022). Despite these challenges, only 16 scheme representatives have taken measures to promote climate resilience and biodiversity. Among the actions taken, 13.3% involved regulating water usage during drought,

11.7% involved communicating about climate change and water availability, and 8.3% involved managing catchments to reduce polluting runoff. Additionally, schemes implemented biodiversity-related measures, such as promoting nature-based solutions for water protection (31.3%), managing invasive species (12.5%), and increasing tree planting, particularly around water bodies (12.5%). Other biodiversity-related actions (43.8%) taken by schemes included planting bio-diversity flowers and trees, participating in initiatives like the "*let it bee project*[4]", installing drinking fountains in schools, and engaging in NFGWS climate action and biodiversity week.

Aligned with the goals of the NFGWS, several water schemes have shown a growing interest in public education and engagement efforts through water conservation curricula for schools, targeted outreach to water users, and public service announcements. Representatives from the schemes also indicated that the NFGWS has been making efforts to inform the public about factors that impact water quality and the need for conservation and water use efficiency measures. Responses from representatives of various schemes revealed that other key measures included consultation with farmers on pesticide usage and best farming practices, annual flushing of boreholes, use of UV light for disinfection, and publishing of zone of contribution to prevent identified contaminants. Some schemes have also taken unique measures, such as spiking straw bales into the lake to kill off algae or leaving areas around their pump-house unfarmed. Regular raw water audits, treatment at the source, and fencing of swallow holes were also mentioned. These efforts and their environmental consciousness motivate respondents' willingness to pay for water services when water supply and availability is scarce (Makwinja et al., 2019). They also influence behavioural changes on consumption, efficient water usage, preference for water-efficient devices and adherence to conservation measures amid drought, periods when water supply and availability is scarce. The findings of an earlier study by Hasan et al (2021) support this argument, suggesting that readily available information and understanding of water management and the underlying challenges increase consumers' willingness to pay. Scheme members also emphasized the

[4]The 'Let it Bee' campaign project employs goodwill towards bees as a means of building awareness across County Roscommon about the need for wider environmental protection, including the protection of drinking water sources. Retrieved from https://nfgws.ie/let-it-bee-project/as

importance of water quality (62%) and the GWS's efforts to meet water needs in acceptable quality (50%) as extremely important to water consumption habits and possible determination of WTP, more so than the cost/price of water and variation in rainfall and free domestic water allocation (Figure 19).

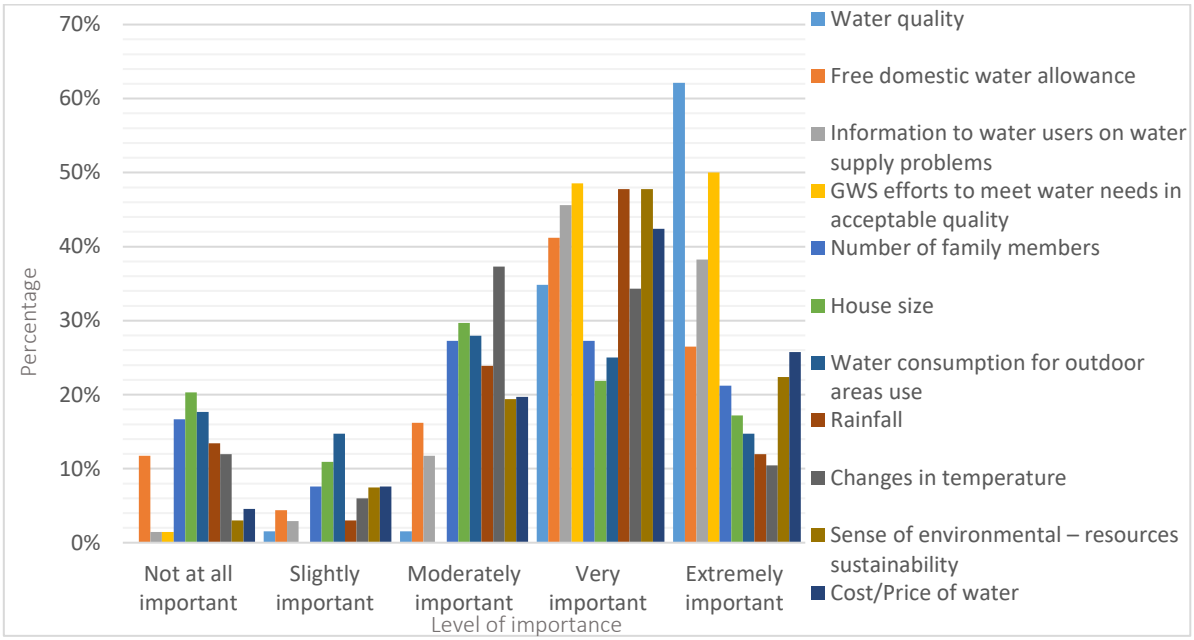

Figure 18. Factors affecting water consumption habits

In 2018, the Irish government implemented a policy decision under the Water Services Act 2017 to provide substantial "free" domestic water allocation for consumers and curb excessive water demand and usage (Irish Water, 2021a). Despite this policy, domestic water consumption among schemes (80.65%) remained unchanged. This is attributable to several factors, including continuous increase in domestic connections, leakages, larger dairy farms and new housing and business development within various scheme's operation scope. More so, grant assistance to Group Water Schemes (GWSs) is based on priorities established by the Department of Housing, Local Government and Heritage through local authorities under the Multi-Annual Rural Water Programme (DHLGH, 2020). This assistance intrinsically impacts schemes willingness to charge regular water bills or require members to pay for water charges beyond the given allowance. Although Zetland (2021) argues that optimal water allocation and pricing are problematic, from the survey response, it is evident that consumptive water charges above the given allowance have a potential role in influencing WTP and constraining excessive demand and usage. This assertion is

supported by a previous study conducted on GWSs, which showed a significant reduction in water demand and usage after the introduction of a flat rate charge of €170 for farmers and €100 for domestic users was implemented by Ballingate Water Scheme (Antwi et al., 2022).

4.10 Conclusion and recommendation

This study provides the initial findings on the willingness of Group Water Schemes (GWS) members to pay for improved water services, emphasizing the difficulties associated with water quality, service provision, and the initiatives aimed at increasing access as the various factors that influence WTP. The study also investigates potential approaches to improve the GWS sector. Using the Contingent Valuation Method (CVM) and a binary logistic regression model, the study results reveal that most scheme members are willing to pay between €25 and €50 for improved water quality and service delivery.

Based on the findings, a scheme having 2,000 connections has the potential to generate approximately €100,000 in supplementary revenue if its members decide to make an annual contribution of €50. This additional revenue stream could serve as a valuable supplement to the funding received by schemes under the Multi-Annual Rural Water Programme. It has the potential to significantly alleviate the financial burden associated with managing schemes, particularly in implementing professional management and administration systems that involve paying full-time scheme representatives for their services. More so, the revenue generated from this contributions could be utilized to promote effective campaigns and media engagement on source protection, biodiversity, and climate resilience action. This, in turn, may have positive implications on water conservation measures prescribed by individual schemes and the National Federation of Group Water Schemes (NFGWS). Additionally, implementing WTP rates could lead to long-term positive effects on consumers' social and economic values of domestic water and water resources. Members may also demand improved drinking water and wastewater services from their respective schemes, while high water consumption and usage rates could be controlled, and the use of water-saving household appliances promoted, thereby reducing human incidents that pollute water sources.

However, when interpreting the results, it is essential to take into account the limitations of this study. One such limitation is that data were collected from GWS members and representatives through an online survey, which restricts the generalizability of the findings to the entire GWS sector. The scheme members were offered the same amount, regardless of whether the amount was later doubled or halved (See section 4.8.2). A greater number of bid levels could have been used to achieve a more precise estimation of the bid curve for WTP. However, since there is no water charge, an estimated price range of €25 (minimum) to €100 (maximum) was deemed appropriate based on the prevailing annual cost of water services among schemes. The study excluded scheme members' income information, taking into consideration concerns raised during the pre-testing of the survey. It was deemed necessary to avoid personal questions related to income, especially in light of the COVID-19 pandemic and the resulting job losses. However, this exclusion poses a limitation on the ability to assess the relationship between income and willingness to pay (WTP) for improved services. To obtain more comprehensive insights, future research could address this limitation and incorporate income as an independent variable. Despite these limitations, this study to the best of our knowledge is the first to assess the willingness of the GWS sector to pay for improved water services, making a valuable contribution to the existing literature. This foundational research sheds light on the WTP for improved water services in the sector and the results have important implications for water governance and management, particularly regarding the allocation of investments and funding for GWS based on the priorities under the Multi-Annual Rural Water Programme. The WTP of scheme members further provides insight into the rate of payment for improved services, which is crucial in evaluating the trade-offs in investment allocation and future decision-making regarding water charges for consumptive use.

While the study found a positive WTP for improved water quality and services, an intense campaign is needed to promote water conservation and efficient water usage within the GWS. Tailored programs that assist agricultural water users in conserving water could help reduce demand among non-domestic connections. Active stakeholder engagement and public consultation involving key actors such as Uisce Éireann, NFGWS, and the general public could consider the factors influencing WTP

as part of efforts towards price indicators for domestic water users. In addition, further research and innovative activities, such as feasibility studies on alternative electricity sources (e.g., solar, wind, and/or hydro) for water abstraction and treatment, could reduce energy costs for schemes which adds up to the cost of managing schemes. Follow-up on conservation recommendations, biodiversity seed planting around pump houses, and bulk meters to monitor water usage, in addition to chlorine analyser loggers and kiosks, could also enhance the efficiency and effectiveness of schemes in delivering quality water supply and services. Finally, drought management plans that outline sustainable water use strategies during drought-related scarcity could help ensure that schemes are able to supply members with uninterrupted water delivery. These measures could help ensure the sustainability and resilience of GWS, especially in times of water scarcity and stress.

Chapter 5

COMMUNICATING WATER AVAILABILITY TO IMPROVE AWARENESS AND IMPLEMENTATION OF WATER CONSERVATION: A STUDY OF THE 2018 AND 2020 DROUGHT EVENTS IN THE REPUBLIC OF IRELAND

The crisis of climate change is of dire consequence, and it carries an increased risk of floods, droughts, high sea levels, heatwaves, and wildfires, which can cause severe environmental conditions. These threats pose an enormous risk to water security, including lakes, reservoirs, and other forms and sources of water sources (Woolway et al., 2021). A significant body of literature on climate change acknowledges that the RoI will face the brunt of climate change across various sectors, with water resources at its core (DCHG, 2019; McElwain & Sweeney, 2003; MECLG, 2019; O'Driscoll et al., 2018). The DCCAE (2018), confirm the higher risk of climate change on water infrastructures due to an increase in flooding and storms. In addition, increased sea level rise and higher temperatures could potentially exacerbate impacts on coastal aquifers. Analysis of long-term river flows from over 40 measurement sites has already shown a tendency for increased annual mean flows with sea surface temperature now more than 1.0°C higher than the long-term average calculated for 1961-1990 across parts of the RoI (Flood et al., 2020). The average rainfall figure recorded in 2018 was 1,224 mm per annum compared to the 912 mm per annum rainfall average in 1971, as reported by the Central Statistics Office (CSO, 2019). A recent report from Met Éireann (2019) points to 2019 as the second warmest year since observations, and the warming trend is projected to continue. Such changes in climate extremes have significant impacts on water aquifers. In places with high populations like Dublin, where water demand is always high but with no major aquifers, the water supply will be profoundly affected (Kelly-Quinn et al., 2014). The vulnerability of the RoI to climate change in recent times has also been exposed by drought conditions, which have consequences for water availability and water quality for domestic and non-domestic uses now and in the future. This chapter delves into lessons that can be learned from the 2018 and 2020 droughts and the role of public communication in generating awareness of the need for water conservation before, during, and after a drought event. A combination of methods is applied to analyse social media communication and newspaper publications, in addition to six key stakeholder interviews, to draw inferences on the importance of public communication on water availability and the implementation of water conservation measures. Section 5.1.1 of this chapter offers a comparative assessment of measures taken by the UK and RoI to

improve drought monitoring and communications with examples from other countries. The overall findings and discussions in this chapter address Research Objective 3.

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Supplementary material for this chapter is provided in Appendix E

5.1 Introduction

There is generally no accepted determination of what constitutes drought due to its varying degree of severity and condition (Bullock et al., 2018). However, it is regarded as a complex weather occurrence triggered by changes in the hydrological cycle, which causes insufficient rain, low humidity or higher temperatures which significantly impacts water availability, infrastructure, food production, and morbidity and mortality (Bullock et al., 2018; King-Okumu, 2019; Overpeck, 2003). As a slow-onset hazard, drought, in the form of either socio-economic (e.g. water supply and demand), meteorological (e.g. precipitation, low water supply), agricultural (e.g. soil moisture), or hydrological drought (e.g. groundwater recharge), can concurrently grow to affect towns, regions, countries and even continents at different degree, time and spatial scale (King-Okumu, 2019; Murphy & Noone, 2020).

The recent Intergovernmental Panel on Climate Change (IPCC) sixth assessment report shows that the world will more than likely reach or exceed 1.5°C degrees (2.7 degrees F) of warming within the next two decades, which is earlier than estimated. The striking pace of increase, according to the assessment, will intensify heatwaves, results in unpredicted rain patterns, intense drought, shorter cold seasons, coastal flooding and other climate-related risks associated with livelihoods, economic growth, food and human security and also water availability (IPCC, 2021). The phenomena also carries the tendency to increase the duration, frequency and intensity of drought and exacerbate water scarcity.

Currently, the impact of mainly hydrological and meteorological drought have changed the narrative on water availability, even in countries with extensive wetland coverage and high rainfall as water serves as a primary medium through which the world's ecosystems are influenced (UN Water, 2011). A number of studies have identified the Mediterranean areas, including northern Africa, the Middle East (Cyprus, Israel, Jordan, Lebanon, Palestine, Syria, and Turkey), and Europe (mainly Southern and South-eastern Europe) as being prone to meteorological and hydrological drought. The prevalence of drought in these areas affects not only available water quantity and quality but also cost of treatment for supply and consumption (Cook et al., 2016; Hervás-Gámez & Delgado-Ramos, 2019). Droughts in

these areas could also influence water users to fiercely compete for water resources due to scarcity (Cook et al., 2016). Within the European Union (EU) and the United Kingdom (UK), annual losses associated with drought is estimated to be over €9 billion of which 9% -20% are on public water supply alone (Cammalleri et al., 2020; European Environment Agency, 2021). Despite the complexities in estimating the exact cost of drought, it is expected to rise to about €17.3 billion/annum should global temperatures increase of which countries such as Belgium, Greece, Portugal, the UK and Ireland would be the most affected in Europe (Cammalleri et al., 2020).

From the socio-economic, environmental and health impact of drought in recent times, various management and governance approaches in building resilience and enhancing equitable water supply have been gaining roots among countries. However, while water users, policy-makers and stakeholders agree in essence to the protection of water resources against drought, this has not been reflected in the planning, management and governance at national, regional and local levels (Hervás-Gámez & Delgado-Ramos, 2019). The EU Water Framework Directive (WFD) is envisaged as the common policy that can help address such challenge, nonetheless, Drought Management Plans (DMP) development is not yet compulsory nor concisely dealt with under the WFD (Hervás-Gámez & Delgado-Ramos, 2019; Kumar et al., 2016). There is no legally binding directive, rather just technical guidance documents published within the context of the WFD and the development of the River Basin Management Plan (RBMP) to support drought risk-based management approaches exist among some EU countries (Hervás-Gámez & Delgado-Ramos, 2019). Thus, unlike the Nitrates directive (91/676/EEC), Drinking Water directive (98/83/EC), and Floods directive (2007/60/EC), drought is yet to be subjected to an EU Water Framework Directive. This inadequate link between RBMP and DMP under the WFD is evident in the Republic of Ireland's feeble approach on drought policies and management plans, as common in other drought-prone areas (Antwi et al., 2021; Hervás-Gámez & Delgado-Ramos, 2019). There are however some existing policy reviews and reports that offers general guidelines and tools in developing drought management plans that countries can utilise. Examples include the European Union Policy review on Water Scarcity and Drought, Sendai Framework for Disaster Risk Reduction 2015–2030, Sustainable Development Goals, Technical Report on Drought

Management Plan Including Agricultural and Drought Indicators and Climate Change Aspects.

Despite the RoI having no specific national scale policy dedicated to drought management and resilience building, historical reconstructions indicate that the country has experienced about 45 droughts since 1850 of which, twenty-two (22) were short term drought (less than 10 months), 19 medium-term (10 to 20 months), and 4 long term (over 20 months) (Falzoi et al., 2019; Murphy & Noone, 2020). The summer of 2018, was recorded as the driest summer in the country for 56 years, during which heatwaves were recorded in 15 meteorological stations from June 24th to July 4th 2018 (Met Eireann, 2018; Quinlan, 2018). Low water level records were documented across many rivers during the dry spell (Quinlan, 2018). Subsequently, the nation's first-ever water conservation order (hosepipe ban) was implemented from 6th July to 31st July 2018 for domestic public water supplies and commercial premises for non-commercial activities due to the prolonged drought conditions. In 2020, 31 dry conditions were recorded across the country from March 18th 2020, to April 28th 2020 (Met Éireann, 2020). On April 22nd 2020, Met Éireann (Irish Meteorological Agency), declared drought in the ROI due to a combination of stress on available water resources and limited rainfall (Ryan & Grant, 2020). The nation's second-ever water conservation order (hosepipe ban) was implemented from 9th June 2020 to 8th July 2020 to ensure continuous water supply. Simultaneously, COVID-19 protocols demanded regular handwashing under clean flowing water to break transmission and promote hygiene (Irish Water, 2020c). According to Uisce Éireann, water resource demand increased by over 20% during the COVID-19 period, while approximately 98 drinking water schemes were classed as being either in drought or at risk of drought before the conservation ban was announced (Irish Water, 2020b, 2020c).

Water deficits coupled with temperature anomalies in 2018 and 2020 also broke records in the Netherlands, Germany, United Kingdom, and Belgium, resulting in irrigation restrictions, water shortages, and crop failures (Barbosa et al., 2020; European Drought Observatory, 2020). In Northern Spain and throughout the Catalan and Jucar river basins, desiccation and groundwater depletion led to water shortages which affected urban and industrial areas (Buras et al., 2019; Kumar et al., 2016). From April 2018 to mid-October 2018, over 230 droughts hotspots were recorded in

Belgium, the Czech Republic, Denmark, Estonia, France, Finland, Lithuania, Latvia, Luxemburg, the Netherlands, Northern Switzerland, Germany, Sweden, Southern Norway, Poland, Republic of Ireland and the United Kingdom. As a result, the 2018 drought is classified as the worst European drought in the 21st century in terms of duration, extent and severity (Buras et al., 2019).

Across other parts of the world, severe drought events were recorded in 2018 and 2020. Data from the United States Drought Monitor showed expanded drought conditions which saw over 30.5 million people in California and 2.7 million in Nevada living under moderate to exceptional drought conditions (NIDIS, 2020). This has continued into 2021 according to recent data of which California, Arizona, Utah, Nevada, Colorado, and New Mexico, are among the worst affected places (NASA, 2021). In Asia, drought events posed a significant threat to water resources and the socio-economic growth of over two billion residents across Cambodia, Indonesia, Myanmar, the Philippines, Thailand and Vietnam (ReliefWeb, 2020). Similarly, drought continuously threatens the lives of millions of Africans in the Sahel regions, the horn of Africa and Southern Africa and its impact on water resources, for instance, became a global concern in 2018 when the Western Cape Province of South Africa was hit with a severe water shortage (Masante et al., 2018). Considered one of the worst water crises experienced in a metropolitan area in recent times, households in Cape Town came close to "Day Zero" as dams in the first half of 2018 almost ran dry, forcing about 4 million residents to queue for water at public taps (Enqvist & Ziervogel, 2019). A lack of trust and poor communication are some factors attributed to the near-panic situation suffered by residents in Cape Town from the threat of "Day Zero" (Enqvist & Ziervogel, 2019).

The 2018 and 2020 droughts in the RoI and across many countries reveals the extent to which water availability and supply can be affected. It further highlight the need to improve public communication surrounding forecasting of groundwater and surface water availability as a precursor in highlighting water conservation needs, especially as water demand sometimes rises to 30% during periods of drought in the RoI for instance (Irish Water, 2020a).

Improved public communication also tends to influence a positive public response to water conservation measures, increase trust between a water utility and the public,

and help achieve sustainable drought policies (Tortajada & Nambiar, 2019). Nonetheless, it has become laborious in achieving successful drought communication in the RoI for many reasons. These include the national utility's communication approach, the publics' perception of water resources availability, the level of knowledge and awareness on factors that jointly influence water supply such as over-abstraction, climate change, mean precipitation and evaporation and the extent of media coverage of drought or climate change events. In addition to changing climatic conditions in the RoI, demographic changes, socio-economic growth, and urbanisation also influence water resources available for critical use, such as drinking water, in terms of water quality and availability (Flood et al., 2020). All of these reasons influence communication intended to improve water conservation.

In this paper, we examine 1) the lessons that can be learnt from the 2018 and 2020 droughts in the RoI in terms of communicating information on water conservation and 2) provide options on how to improve public communication on water resource availability. The study's uniqueness lies in analysing newspaper coverage and social media communication on drought and water conservation during the 2018 and 2020 drought events in the RoI and combining these data and knowledge gleaned from stakeholder interviews.

5.1.1 Approaches adopted to mitigate droughts impact on water resources: An overview in the Republic of Ireland and the United Kingdom.

Drought prevalence has become a catalyst for policy change globally, with a growing number of countries developing monitoring and early warning systems and approaches to improve water sector resilience (Barbosa et al., 2020; Gregor et al., 2019; Tortajada & Nambiar, 2019).

These strategies and approaches aid robust decision-making relating to drought impact on water resources. They also influence government policies to avoid crises and introduce long-term drought management strategies. In addition, they help in meeting targets for the Sustainable Development Goals (SDGs), including SDG 6, target 6.4 on water stress and SDG 1 target 1.5 on building the resilience of those in

vulnerable situations to reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters (UN, 2015). In this section, we present an outline of approaches adopted to mitigate droughts impacts on water resources in the Republic of Ireland (ROI) and the United Kingdom (UK) (Table 13) with some examples from parts of Europe. It includes the DriDanube project, which involves ten European countries (i.e. Austria, Bosnia and Herzegovina, Croatia, Czech Republic, Hungary, Montenegro, Romania, Serbia, Slovakia, Slovenia), aimed at providing insights into the development of drought through its Drought Watch platform and through public engagement and delivery of early awareness of drought and water-related learning curriculum to schools (Gregor et al., 2019). The Integrated Drought Management Programme for Central and Eastern Europe (IDMP CEE) also raises public awareness and understanding of drought. It aims to encourage public participation in reducing drought risk among Bulgaria, the Czech Republic, Hungary, Lithuania, Moldova, Poland, Romania, Slovakia, Slovenia and Ukraine (Melvyn, 2019). Emphasis on the RoI and UK is due to their shared drought events and environmental characteristics (Murphy et al., 2020). The two countries are also found to implement similar drought mitigation, awareness, and communication approaches with a shared drought trend in the British and Irish Isles (Vicente-Serrano et al., 2020).

Table 13. Approaches adopted to mitigate droughts impact on water resources in the Republic of Ireland and the United Kingdom.

Republic of Ireland (RoI)
a) Irish Water's National Water Resources Plan (NWRP), identifies and assesses water resources and droughts impacts on their availability (Irish Water, 2020a).
b) National hydrometric bulletin developed by EPA promotes access to environmental information[5].
c) *The EPA maps*[6] managed by the EPA provide information on hydrogeological status, risk and all water bodies' status.
d) The Office of Public Works (OPW) webpage offers information on development works and upgrades along with the latest information on water levels from across several gauges in the country[7].

[5]National Hydrometric Bulletins https://www.epa.ie/water/wm/hydrometrics/bulletins/
[6]EPA Maps https://gis.epa.ie/EPAMaps/Water
[7]Public Works Office https://waterlevel.ie/

e)	*Catchments.ie*[8] provides information on all waterbodies in Ireland and encourages people to value their water bodies and the environment through story sharing and profiling of environmentally related programmes and projects across catchments.
f)	Public campaigns and community awareness on water quality improvement and biodiversity by the EPA Catchment Unit (EPA Catchments Unit, 2020).
g)	Irish Research Council Coalesce funding stream supporting research to understand drought pattern and conditions in Ireland. Irish Water also commissioned research in 2018 with the Irish Climate Analysis and Research Units (ICARUS) under the Climate Sensitive Catchments Project to understand catchment characteristics (Irish Water, 2020a).
h)	During the COVID-19 pandemic (April to July 2020), the Catchments Unit of the EPA delivered a series of online training and communications to support communities to undertake activities to improve water quality.
United Kingdom (UK)	
i)	A number of environmental laws and legislation that helps in monitoring, reporting and implementing actions to mitigate droughts impact on people, business, the environment and water resources (eg National Drought Plan, 2012, Flood and Water Management Act, 2010) (Environment Agency, 2012; Environmental Protection Agency, 2017).
j)	Farmers encouraged to form water abstractor groups to enhance relationships with the Environmental Agency and promote sustainable farming and water management (Environmental Protection Agency, 2017; Melvyn, 2019).
k)	Environmental Information Platform[9] managed by the UK Centre for Ecology & Hydrology (UKCEH), provides information on drought in the UK by allowing a user to explore over 50 years of drought statistics, rainfall patterns and water resources.
l)	Information on future hydrological conditions across the UK provided through a hydrological outlook webpage managed by the UKCEH[10].
m)	£12 million committed towards a five year (2013–2018) interdisciplinary research project by the Natural Environment Research Council of UK on drought and water scarcity (UKRI, 2018). *About drought*[11] is a dedicated website developed from the research funding to provide information on drought and water scarcity in the UK.
n)	Greater emphasis on drought communication, community engagement, awareness creation and campaigning on the adaptation of conservation measures at home and business (Lange et al., 2019; Ofwat, 2018).

Even though the RoI and UK have developed a suite of tools and approaches, the UK is considerably more progressive, having developed several legislative instruments and policies tailored specifically towards protecting the water sector and consumers against the impact of drought (Table 13). Water companies in England and Wales, for instance, are obliged to produce a drought plan every five years under the Water

[8]Catchment.IE https://www.catchments.ie/
[9]Environmental Information Platform https://eip.ceh.ac.uk/
[10]Hydrological Outlook http://www.hydoutuk.net/
[11]About Drought https://aboutdrought.info/

Industry Act 1991 as amended by the Water Act 2003. A company's plan must state how it will maintain a secure water supply and protect the environment during dry weather and drought (Bryan et al., 2019; Environmental Protection Agency, 2017). Communication between water utilities and consumers has also become paramount in coordinating responses on the impact of drought and other factors that impact water supply and availability in the UK. This approach has steadily yielded results for consumers with an improvement in the timing of communication and reach to consumers on water resource availability and conservation (Larbey & Weitkamp, 2020). In contrast, in the RoI, drought impacts on water resources are traditionally managed as a crisis situation. In our review of literature, no specific national-scale policy dedicated to drought and water resources availability, except for a few sectoral policies developed by Uisce Éireann climate actions that partially discusses drought management were found (Irish Water, 2020a). The actions and objectives of the national biodiversity adaptation plan could not explicitly state how droughts' impact on water resources are to be addressed, although there is acknowledgement of cross-sector links to biodiversity and the need to protect biodiversity from climate impacts (DCHG, 2019).

5.2 Material and methods

All data used in this study are based on social media posts (i.e. Twitter and Facebook) of Uisce Éireann, newspaper articles, and key stakeholder interviews. Emphasis was placed on Uisce Éireann because it is the only public water and wastewater utility in the RoI (Irish Water, 2018a). The analysis of social media posts and news articles aimed to identify trends and communication frames used mainly during extreme weather conditions like drought in the RoI (Culloty et al., 2019; Wagner & Payne, 2017). The methodology used to assess each media form is outlined separately below.

5.2.1 Newspapers

The keyword string "climate change" AND "water resources" OR "drought" OR "Water Conservation" was used to collect relevant newspaper publications online from January 1st, 2018, to December 31st, 2020, in the RoI from the LexisNexis

database. Raidió Teilifís Éireann (RTÉ) News, which is Ireland's national public service media, was considered because it is the most popular and trusted online news source in the country (Bohan, 2019). In total, 268 online articles fitting the search strings were collected and filtered accordingly. Ninety-six articles were discarded as they were out of scope either geographically or in terms of content, despite the headline suggesting relevancy. Some articles were also filtered out because they had less than 100 words, which did not offer enough details, or their contents heavily focused outside of the RoI. For example, the Belfast Telegraph reports were, understandably, Northern Ireland centric. Duplicates or articles of very high similarities were also removed; leaving a final set of 172 articles that adequately reflected all keywords and were re-grouped for frame analysis (Fig. 20).

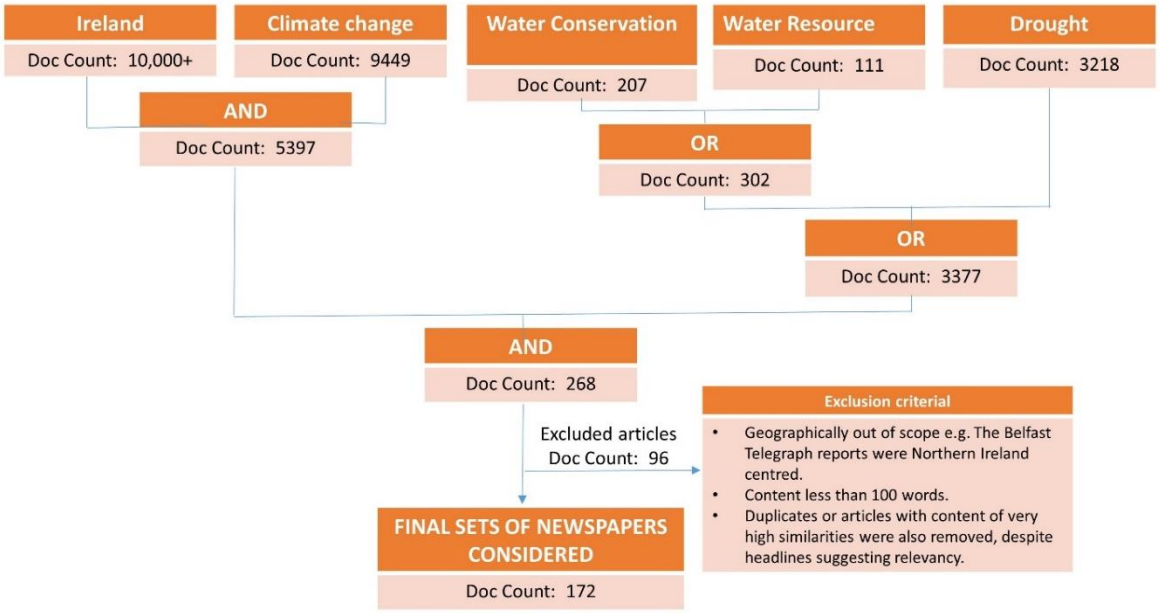

Figure 19. Newspaper search results using LexisNexis.

To analyse the frames used in newspaper coverage of drought events, we adopted political and economic frames from Culloty et al (2019) and Wagner & Payne (2017), based on their work on climate change framing in the Irish media space. Other established frames applicable to climate change communication like technical/policy, uncertainty and risk frames were also adopted. An Eco-hydrological frame was also distinctively used in this study to show the growing connection between hydrology, ecology, and ecosystem services. The frame provided insight into the growing interest in the linkages between ecological status and ecosystem services and the potency of

eco-hydrology processes in, for example, addressing water quality issues and values on water resources and climate change adaptation and coping strategies (European Environmental Agency, 2020; Sun et al., 2017).

5.2.2 Social media

Given that social media data have been used in varying academic fields to gain insights into public discussion and understanding of issues like climate change and water resources (Culloty et al., 2019; Quinn et al., 2016; Samantray & Pin, 2019), we gathered Facebook and Twitter posts associated with water conservation or drought published by the national utility Uisce Éireann and responding comments made by the public. A total of 1,627 tweets were collected from 2018 to 2020 from Uisce Éireann's official Twitter handle (@IrishWater) using the open-source software *vicinitas.io.*(See supplementary material). We focused only on Twitter and Facebook, given that between them, they attract 90% of social media users in Ireland as of 2020 (CSO, 2020b; GlobalStats, 2020; Tankovska, 2021).

5.2.3 Key stakeholder Interviews

Six key stakeholders comprising four journalists who have written extensively on the water sector in RoI, a political representative and a water and communication expert with experience in the Irish and UK water sector were interviewed via Zoom. Uisce Éireann also supplied a written response to a set of interview questions through its communication unit. The stakeholder's availability, expertise and roles were some factors that influenced the selection following a similar approach used in assessing stakeholders' perspectives on water governance and management in the RoI (Antwi et al., 2021). This process ensured informed and outcome-oriented contributions towards generating understanding and fostering consensus on drought communication and implementation.

5.2.4 Data analysis

Seminal contribution to improving water resource management and climate change communication, especially, have been made using sentiments analysis since sentiments offer insight into the nature, intensity and opinion of the public and also

have implications on how communication is received and acted upon (Culloty et al., 2019; Haselmayer & Jenny, 2017; Quinn et al., 2016; Samantray & Pin, 2019). Following a similar trend, we tested the sentiments of 1,671 tweets by Uisce Éireann over the period using Azure machine learning[12], which is a predictive and analytical tool for identifying and classifying sentiments in sentences. The Sentiment analysis was obtained from the Azure Machine Learning platform, which runs on a cluster algorithm to generate predictions from inbuilt models (Harfoushi et al., 2018). The Azure Machine learning studio allowed for the dragging and dropping of user text obtained from the *vicinitas.io* dataset. The dataset consisted of 16 columns and 1,671 tweets (Supplementary Material). The associated column included: *Tweet ID, Text, Name, Screen name, User time zone (UTC), Created At, Favourites, Retweets, Language, Client Tweet, Type, URLs, Hashtags, Mentions, Media Type, Media URLs.* The Text column from the dataset was transformed into predictive results categorised into three groups- positive, neutral and negative and calculated on a scale of 0% (very negative) to 100% (very positive). The scores generated were rounded up manually to eliminate the decimals figures (See Supplementary material). All the software used for this study were open-source to allow for easy replication except Nvivo 12 pro, the use of which was provided under licences by Dundalk Institute of Technology.

5.3 Results and discussion

5.3.1 Newspaper coverage of drought events

The *Irish Times* newspaper led in the reporting of drought impacts on water resources by 42% (n=73), followed by *The Irish Independent* 31% (n=54) and *The Irish Examiner* 11% (n=18) (Fig 16). Although there have been concerns on how factors like political control, ideological settings, ecological modernisation and communication complexities influences newspaper reportage on climate phenomenon in the RoI (Fegan, 2020; Fox & Rau, 2016; Wagner & Payne, 2017), these numbers signify both an increased severity of drought and a growing media interest on its impact on water resources in recent times (FitzGerald, 2018; Houston, 2019; Moran, 2020). Key stakeholders also alluded to the growing trend in media coverage, for example:

[12]Azure learning Machine. At https://azure.microsoft.com/en-in/services/machine-learning/ , accessed 15 December 2020

"You know, you just have to report as carefully as you can when things happen and talk to the right people and rely on science and rely on the data that shows you what's happening. And so like, I think the only problem that has arisen in the last few years is people underestimated the threat of climate change and climate disruption. And so, you know, maybe you didn't get enough media coverage as a consequence. But I think that that's not the case anymore. Like, climate change is getting a lot of coverage now and more and more with each passing year, which is the right thing, because it is such a big threat to humanity, and, and to the planet. So it's, you know, it's less of an issue"(R 5)

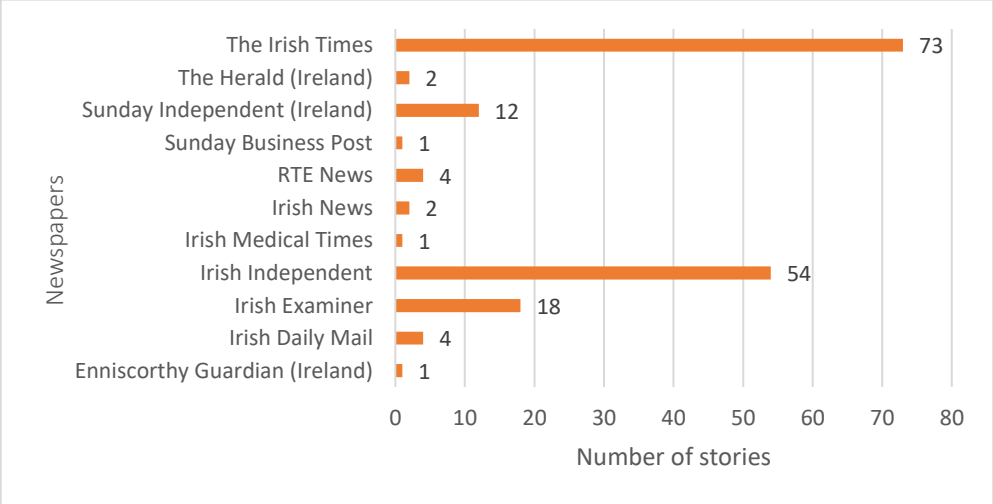

Figure 20. Total number of newspaper stories on drought events (2018–2020)

In most newspaper publications, the associated terms usually appeared from June to August and between September and November, i.e. periods characterised by hydrological drought and post-spring and summer conditions (Fig 22). While 2019 maintained a relatively lesser but consistent media focus (n=63), there were heightened media reports on the 2018 drought (n=68) compared to post 2020 (n=41).

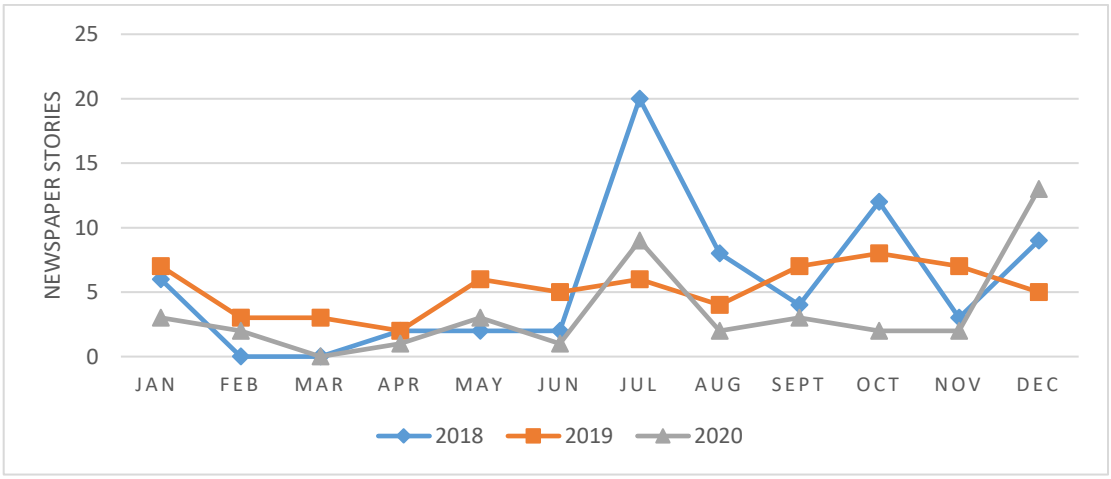

Figure 21. Newspapers coverage of research terms from 2018-2020 per month

Our analysis revealed that the impact of the COVID-19 pandemic took the media's spotlight away from the drought conditions of 2020. This finding is consistent with a recent study of over 26 million news articles from the front pages of 172 major online news sources in 11 countries, which pointed out that COVID-19 coverage accounted for approximately 25.3% of all front-page online news articles between January and October 2020 (Konrad et al., 2021).

Although the pandemic garnered greater attention from newspapers, it was not the only parameter that influenced reportage. Other related factors, and not necessarily drought conditions, also influenced the media's attention. For example, the announcement in 2018 to separate Uisce Éireann from Ervia (the semi-state multi-utility responsible for delivering Ireland's national gas and water infrastructure) and services to enhance probity, accountability and transparency in its activities by 2023 (Oireachtas, 2018). In addition, the establishment of An Fórum Uisce|The Water Forum, as a statutory stakeholder body, to promote public engagement on socio-economic resources, the environment and water resources led to increased media attention (The Water Forum, 2018).

5.3.2 Common Irish Newspaper frames

Given the impact of frames in determining how communication influences understanding, reactions and decision, and in determining how communication triggers public awareness on the impact and challenges of water supply and availability during drought (Badullovich et al., 2020; Davis & Goffman, 1975) we categorised all 172 newspapers articles under five frames (Fig 20). Uncertainty and risk emerged as the common frame (41%) under which newspapers covered droughts impact on water resources. Within this frame, drought impacts were presented as a threat to society with profound effects on citizens' wellbeing and health due to rising temperatures and risk associated with stormy conditions, heatwaves, and prolonged dryness (See Table 14 and Supplementary material). Although news publications under this frame also considered acute water supply and availability during periods of extreme conditions, the content avoided or rarely used words like water scarcity to discuss the long-term impact of drought on water resources. Such a spike in uncertainty and risk frame used by newspapers carries the potential in reducing public

support and engagement for climate change communication and also undermines effective climate change adaptation and mitigation actions, including domestic water conservation during drought events, rather than stimulating it (Culloty et al., 2019; Stecula & Merkley, 2019; Tavares et al., 2020). Eco-hydrological frame also accounted for 18% of all frames, followed by economic frame (16%), which had stories focused primarily on the cost of extending water supply, repair works and general investment into the water sector to make the sector resilient against extreme conditions like drought. In contrast to previous studies that identified political frames as the most dominant in Irish newspaper coverage of climate change events (Culloty et al., 2019; Wagner & Payne, 2017), political frame represented only 12% for this study period, coming after a technical/policy frame (13%). This rather contradictory result on political frame stems from previous experiences encountered in an attempt to reintroduce domestic water charges which was met with public protests, resulting in a parliamentary recommendation that led to the abolishment of the water charges in the RoI (Clinch & Pender, 2019a; Quinn et al., 2016). Table 23 displays examples of newspaper articles under the five identified frames in this study.

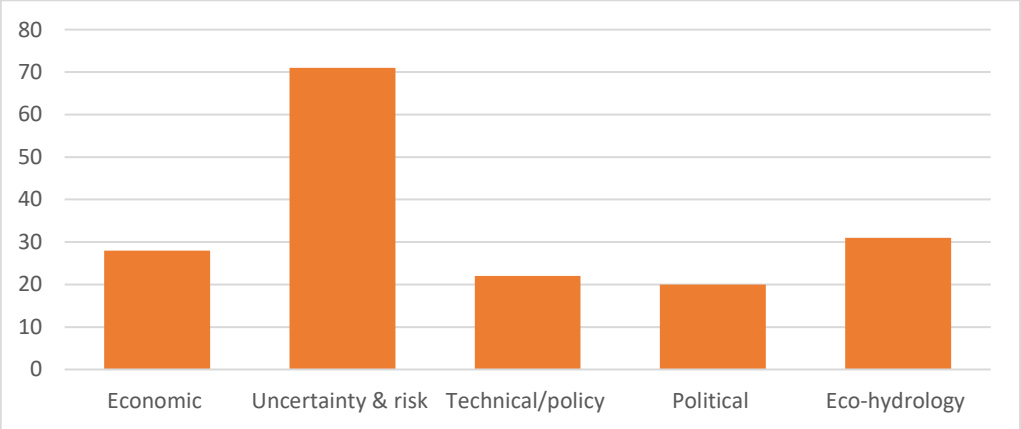

Figure 22. Coverage of drought under-identified frames

Table 14. Excerpts of newspapers articles under each frame

Date	Newspaper	Frame	Title	Phrases
Aug, 4th, 2020	Irish Independent	Political	Shannon pipeline 'is needed' Green Party Minister claims	...to questioning, Minister Noonan said the pipe is needed to address climate change and to ensure the supply is fit for purpose and can withstand extreme weather such as droughts and storms. "It will

				enable the provision of treated water to...Cuffe last year said the government should prioritise water harvesting and water conservation to reduce the need for new supplies. "Pumping water from Lough ....to the project. The project, which represents the biggest investment in Ireland's water infrastructure in more than 60 years, has faced public ...
July, 21st, 2018	Irish Independent	Economic	Water price to pay for inadequate in the investment and a lack of planning;	...water is the most precious vital human commodity. We face further climate change of drier summers and wetter winters. Simultaneously, we aim on the ..... householders; scuppered (EURO) 240m of lost revenue; farcically paid out unconditionally (EURO)100 water-conservation grants, costing (EURO) 94m. The principle of paying for water was abjectly ..... evasion has compelled collection to switch from An Post to Revenue. Ireland is the only EU state that does not require householders to ..... the nous to consider this blindingly obvious antidote to the national drought? Dream on....
Dec, 3rd, 2020	Irish Daily Mail	Eco-hydrology	Forecast is for more weather like 2020's	... so they can monitor, protect, preserve and report on the impact climate change is having in Ireland on our environment and biodiversity.' A Department of the Environment, Climate... Forecast is for more weather like 2020's...record-breaking weather this year is further evidence of climate change, claims Met Éireann. The year saw the wettest February and ... as an already wet month, that's a lot of rain. 'In

				Ireland we expect to see more heavy rainfall during the winter and longer droughts during the summer. This year happens to reflect a good example ..... continue. It is set to be the ninth warmest year that Ireland has experienced and globally the third. Worldwide lockdowns will have done...
July, 10th, 2018	Irish Independent	Uncertainty and risk frame	Ireland at risk of becoming a drought 'hotspot' warn climate change experts; Droughts to get more common as global temperatures rise, according to Maynooth scientists	...Ireland at risk of becoming a drought 'hotspot' warn climate change experts Droughts to get more common as global temperatures rise, according to ....the Balkans, the south of Britain and Ireland . Ireland hasn't suffered a major drought since the 1970s, but the low rainfall during May and June this year has led experts to believe that more droughts could be on the way. Recent decades have witnessed severe drought events across Europe, with serious impacts including reductions or loss of ..... the farming community, in particular, speaking to those who experienced past droughts will give others an indication as to how we coped in such extremes." After the intense drought of 1976, it took until August 1977 before conditions returned to normal. Drought impacts included reduced levels in reservoirs supplying water to Dublin city...two exceptionally long events are found on record - the continuous drought of 1854-60 and the drought of 1800-09.
	Irish Independent	Technical/Policy frame	Activists consider appeal after losing climate	...Properly tackle carbon emissions and protect against the risks of

Sept, 20th, 2019	action policy case	floods, drought, fires, ecological destruction and loss of life that climate change poses. The government accepted the flaws in the plan and replaced ..... focused on implementing the Climate Action Plan. "Our plan will give Ireland a cleaner, safer and more sustainable future," a spokesperson said. The ..... by a coalition of environmental groups and 16,000 public signatories, took Ireland's first climate litigation case against the Government's National Mitigation Plan.....this way. Reacting to the ruling, Jennifer Higgins of Christian Aid Ireland said aspects of it were valuable in affirming the responsibility of.

With regards to the breakdown of newspaper coverage of stories under each frame (see Supplementary Material), The Irish Times reported thirty-two times on risk and uncertainty, followed by the Irish Independent with twenty stories. The Irish Times and Irish Independent reported ten stories each under the political frame, followed by The Irish Examiner with seven. The Irish Independent had the highest number (13) of stories on economic frame, whereas the Irish Times had fourteen under the eco-hydrological frame. The Irish Times reported under technical/policy frame with ten stories and the Irish Independent with six stories. Interestingly, the content of 23.13% (n=62) of all stories reported by Irish newspapers under the search terms was predominately outside the RoI. These stories focused on the impact of drought in countries like Kenya, Zimbabwe, the Sahel regions of Africa, flooding in Mozambique, bush fires in Australia, and other environmental concerns in the USA. The RTE News carried the majority of these stories, though such stories were filtered out, the finding is consistent with a considerable body of literature that shows that developed countries emphasise climate change impact in developing countries, rather than portraying the climate crises in their own locality (Tavares et al., 2020; Vu et al., 2019).

5.3.3 Organisations speaking on drought and water resources

While a strong political interest in water and issues that affect its quality and supply exists, there seems a reluctance to discuss it openly in the media. Interviewed participants argued factors influencing such level of involvement and the awakening interest in matters of the environment, climate change and droughts impact on water resources.

> *"... Water is a bigger issue for TDs, [Irish Members of Parliament] because their constituents are telling them about dirty water or low water supply or whatever it might be. I think the conversation around water quality in Ireland has been distorted by the water charges controversy again, because the idea of charging for water is seen as so politically toxic, now that it's very unlikely to come back on the agenda over the next five years if even then, at two. I personally would be in favor of water charges. But I think we are at a stage now where that's very unlikely to happen in in the immediate future. I think the only thing that could shift that would be if we were starting to have these Issues of pollution and water shortages every year in the major urban areas. And it sorts of scared people into thinking" (RI 03)*

> *"And I think politicians are beginning to get more and more aware of it and aware of the consequences. And also, they're beginning to understand how climate change is a threat to all that. So they're recognising that we need to undertake action." (RI 4).*

Despite their reluctance, political parties made pronouncements in the years under review (n= 16, 9%). The Green Party (the environmental, political party) were the most outspoken among all political organisations. The party made frequent calls on the government to consider its climate actions and projects in the water sector, including the €1.3billion Shannon to Dublin water pipeline to ensure continuous water supply amidst extreme conditions such as storms and drought conditions (Moran, 2020). The party also formed a coalition government in 2019, resulting in a greater prominence of climate and water-related actions on the programme for government. Research-based institutions, including the Environmental Protection Agency (EPA), Science Advisory Council, and An Fórum Uisce | The Water Forum, communicated the most (n=46, 27%). There were also commentaries/editorials from environmental advocates and other sector experts than politicians (n=43, 25%), followed by other governmental and non-governmental institutions such as Climate Change Advisory Council and Sustainable Nation Ireland (n=31, 18%).

5.3.4 Sentiment analysis of Uisce Éireann (Irish Water) Tweets

The results of our sentiments score from all 1,671 tweets showed 63% (n=781) of Uisce Éireann's tweets being generally positive, 16% (n=575) as negative, and 21% (n=375) neutral. The positive and neutral sentiments stemmed mainly from campaigns and initiatives that Irish Water was involved in to promote water quality and conservation measures. The negative sentiments were mainly attributed to external factors like droughts and storms, over which the utility has limited control (Supplementary material). Despite the positive sentiment, comments and reactions to conservation messages suggested disdain among Uisce Éireann followers on Twitter (Table 15). The limited engagement between the utility and the public and the difficulties that exist in simplifying the highly technical and engineering nature of its work to the consumers, according to Uisce Éireann accounts for the public's reaction towards its communication on social media (Uisce Éireann , Pers. Comm).

Table 15. Exemplar Twitter comments during the 2020 drought.

Tweets by Uisce Éireann (Irish Water)	**Reaction**	**Comments**
With people heeding advice & staying at home during #Covid19, water use at home has increased by an average of 20%. We're urging people to choose "handwashing over powerwashing" and check out our tips to #ConserveWater that will not impact on hygiene. *May 12th, 2020*	Likes 42. Retweet 35. Quote tweets 16	• We are conserving all our water as it is brown and toxic. But hey, at least we are conserving water right? F2 • Why are you not calling for rain water harvesting in all new buildings and retrofitting existing buildings? • Makes no sense to be flushing toilets with drinking water instead of captured rain. • But business use has dropped by 80%, did all that extra water just evaporate?? You cant collect it, you cant store it, you cant clean it ,what exactly can you do?? #scrapirishwater, 9 months rain ,80% drop in business use the past two months ,and you are still blaming the people
With more of us at home, more water	Likes 133. Retweet 50.	

is being used, and with low rainfall over the last 2 months, this is putting pressure on our water supplies around the country. Let's work together to #ConserveWater, while continuing to wash our hands. *May 25th, 2020*	Quote tweets 15	• From a street to 5 houses my and my neighbor's water comes true 1 pipe then it splits to all 5 houses more then 1 year ago I called council for bad water pressure and it leaks water on that pipe 1000 liters in hour it's more then 370.000L of water time to come and fix F4 • There is a lot of misunderstanding just how much water an average house uses. I run a 7500litre rainwater collection tank for toilet flushing. Two adults one 11 yr old. Three weeks ago it had less than 300litres in. Really opens your eyes to water wastage v rainfall.
Water use at home has increased by an average of 20%. Let's work together to #ConserveWater. Taking a shorter shower can save 10 litres of water per minute. *May 25th, 2020*	Likes 185. Retweet 85. Quote tweets 21	• As we have been advised to thoroughly wash our hands for 20 seconds, this is hardly surprising. F15 • Aw would u be quiet! You want us to conserve, the government wants us to wash our hands every half hour, there's the usual house hold usage on top of the fact for 2 months there's a massive increase in people staying home. Give it a rest! Lets work together & #beatthevirus. Gobshites! F19 • How much has business usage decreased by? F29 • Fix the **leaks, we've been locked down for the past 9 weeks you lot could have had the roads to yourselves to fix the ** leaks!!!! F14
Very low rainfall in recent months, and more water being used in our homes and gardens, is putting pressure on our capacity to supply enough treated water to meet demand around the country. We need to work together to#ConserveWater	Likes 142. Retweet 42. Quote Tweets 22	• No- you need to do a better job of managing Ireland's most abundant resource • It's been pissing rain get your act together!! • Fix the pipes or build more reservoirs. F 26 • Should have used all that water metering money to fix the pipes. F 14 • Easy to conserve water when some communities have been on a boil water notice since 31-10-2019Angry face Pouting face F 6 RT 1 • Are the Data Centres going to be asked to cut back on their water usage? F 28, RT3

, while continuing to wash our hands. *June 15th, 2020*

**F= Favourite *RT= Retweet * some comments were not sampled because they contain offensive content.*

Some of the comments made by consumers further support the assumption that RoI is a wet country that does not suffer from water scarcity. When asked, interviewees suspected that some people were unable to connect drought/climate change to scarcity in water supply despite growing public awareness on climate awareness:

> *"I do think that people understand that there is a link between climate change, and how water reacts to climate change, and how water levels react. The prediction is that we have drier, longer, hotter summers in the east, and more and more intense rainfall events in the West and in the winter across the country. So I think there is a growing awareness, I would say it is probably still at a low-level people understand that climate change is happening, they understand that water is important. They probably haven't made that exact connection between water quality and demand" (RI 2).*

A number of these comments (Table 15) had many Twitter reactions (i.e. quote tweet, likes and retweets), showing levels of endorsement of the response content. These comments further reveal insufficient engagement between consumers and Uisce Éireann and other agencies in the environmental sector in relation to the external factors that threaten water supplies, such as drought. Although Uisce Éireann argues that it maximises traction and amplifies campaigns and key messages through media/public relations, internal communication, stakeholder engagements, and the use of both above the line (Press, radio, campaigns) and below the line (Website, digital and social media, direct mail/email) communication strategies in addition to creative advertisements to reach its customers (Uisce Éireann Pers. Comm), the utility's overall media engagement and response rate on Twitter was low. We also found Uisce Éireann managing a second Twitter handle (IrishWaterCare @IWCare) dedicated to customer care. The handle contained some educational posts, videos and tweets on water conservation; nevertheless, customer engagement on that handle was also limited.

5.3.5 Uisce Éireann (Irish Water) Facebook Page

Uisce Éireann had more engagement on Twitter than it did on Facebook, despite Facebook being the most popular social media platform in RoI and also the platform through which most communities receive their trusted information on water availability (GlobalStats, 2020; Norton, 2019; Tankovska, 2021; Veerkamp et al., 2018). Nonetheless, the Facebook comments and reactions on the 2020 drought were similar in content to that of Twitter (Table 16).

Table 16. Exemplar Facebook comments during the 2020 drought.

Facebook Post	**Reaction**	**Comments**
Ireland's much-loved celebrity chef and television personality, Neven Maguire launches the Think Before You Pour campaign. Neven is appealing to the public not to use their kitchen sink as a bin this festive season. Disposing of your fats, oils and greases (FOGs) in the bin, rather than pouring them down the sink, can have a hugely positive effect on our environment and wastewater system. The Think Before You Pour Christmas campaign is operated by @CleanCoasts in partnership with Irish water. For more information and to be in with a chance to win a signed copy of Neven Maguire's Perfect Irish Christmas Cookbook courtesy of Clean Coasts and Neven Maguire, check out the link below *December 18th 2020*	Likes 345. Comments 69. Shares 86	• I don't use my dishwasher anymore. No grease leaves my house… roast duck fat used for roasties. Other warm fats soaked up in bread for the birds. Cold fats scrapped from plates, etc, spread on bread, again for the birds, sprinkled with birdseed. • No binning, no waste. Only two of us.. I use a basin for kitchen wash up and watch the birds feasting while I wash up.. Everyone wins. L 4
Most leaks happen underground and aren't visible, resulting in precious water being lost. The national Leakage Reduction Programme in partnership with the Local Authorities works, to find and fix leaks. This is one way we are reducing leaks. The rate of leakage nationally in 2018 was 46% and we are on course to achieve a national leakage rate of 38% by 2021. #FixingLeaks	Likes 188. Comments 144. Shares 14	• The biggest waste of money they do nothing, still putting fluoride (industrial waste to other countries but in Ireland were told its great for teeth L 12 • Some leaks are caused by Irish water workers, and not fixed for weeks. You should have seen the mess they left in our estate while installing meters L 13 (IW replied).

August 18th 2020

This leak repair, carried out under the First Fix Free scheme, was recently completed in Laurel Park, Galway. We offer free leak investigations & repairs where a constant flow is found on an external water supply pipe. See more on #FixingLeaks at www.water.ie/reducingleaks.. *July 9th, 2020*	Likes 17, Comments 5. Shares 1	• There been a leak up the road from my house. I've living in the area for 17years and in that time I've lost count of how many times the road was dug up to fix the problem, but it's still not fixed, wonder what the problem is..... • Phone local authorities, they say log it with Irish water, but it's hard to log a problem if no one answers the phone... Some plan, now did I mention I've lived in the area for 17 years and the problem still exists... One i found a while back nice to see it done
Listen back to Managing Director, Niall Gleeson, on Morning Ireland earlier discussing the lack of rainfall, increased water use at home and the need to conserve water where possible while continuing to wash our hands - https://www.rte.ie/radio/radioplayer/html5/#/radio1/21766956 *May 12th, 2020*	Likes 39, Comments 9. Shares 6	• Yes water should be conserved, however turning it off without notice for the 4th day is a row is not good enough!!! • How much has overall water consumption decreased since the closure of businesses and educational premises? • Broken pipe outside our house since last night phoned this morning at 8. am was told they would be with me within 4 hours now six in the evening water still running down the road , two old age pensioners in the house no water to wash or heat the house , now tell me how to save water and wash my hands . (IW replied)
Increased hand washing to prevent the spread of Coronavirus is putting extra demand on water supplies. As we work with our Local Authority partners to maintain supplies, we're asking the public to be mindful of ways to conserve water. Check out http://water.ie/conservation for helpful tips.	Likes 32, Comments 23. Shares 24	• No water for the last few days, The whole road with no water. Got email this morning asking for my Eircode. Tried to phone the number given on the email, keeps cutting off. We cannot wash our hands or anything... is this the way to save water? Does this mean that we are allowed to go to family members' houses to wash

March 19th 2020	ourselves? Thought we were to be in locked down…..Weekend is here and it looks like nobody is going to do anything…….😣😣 (IW Replied) • Water Supply off again 3rd time in a month, can't wash our hands, Rathanny (IW Replied)

**L= Like *IW= Irish Water*

When compared to Twitter, the Facebook page contained fewer posts from Uisce Éireann. On average, there was one post every 4 to 6 days. Undeniably, domestic water demand has the potential to increase during holiday/festive periods, yet Uisce Éireann made few social media posts over the Christmas periods of 2019 and 2020, suggesting a missed opportunity in creating awareness around domestic water consumption rates. Although we reckon that water scarcity is rare over the Christmas periods, compared to Easter periods where summer conditions mounts, we believe conservation measures must be continuous throughout all holiday periods. It is worth mentioning that Uisce Éireann's website showed that calls to report leakages, flooding, water quality issues and pollution were billed to the caller. This observational finding has implication on the publics' willingness to report leakages on time. In addition, the utility's YouTube comment section was closed, thereby limiting the publics' ability to ask questions or make comments on videos shared. From the perspective of effective communication, especially during drought events (Larbey & Weitkamp, 2020; VanDyke & King, 2020), it can be argued that the 2018 and 2020 communication approach of Uisce Éireann only spread knowledge about drought which does not significantly influence behavioural changes on domestic water consumption.

Given that drought periods are occasions when public awareness of water demand is likely to be high, they represent an opportunity to further raise awareness and provide educational materials on how water demand can be reduced. Showcasing good water conservation behaviour may help influence and empower the public to reduce their water consumption (Lede et al., 2019; Seyranian et al., 2015). Along this line, and contrary to expectations, this study also found less institutional collaboration and support in drought communication despite the enormous benefits such collaboration

and support could have on drought management and communication on water scarcity, availability and conservation (Larbey & Weitkamp, 2020; Melvyn, 2019).

5.4 Recommendations for policy consideration

Many of the foundations for real-time data and interactive river flow forecast systems are already in the RoI. Adding to effective drought preparedness through monitoring and early warning systems as found in parts of Central and Eastern European countries, the UK and the USA (Melvyn, 2019; Noel et al., 2020); it would be beneficial for the RoI to have a consolidated National Integrated Drought Information System (NIDIS) to coordinate, monitor, forecast and help plan and inform national, regional, and local levels of drought issues, while also serving the general public, stakeholders, policymakers and the media. This is increasingly important as climate projections indicates wetter winters and drier summers with a high probability of intense future drought events in the RoI (Cammalleri et al., 2020; Murphy et al., 2019). Such a NIDIS could be managed by the Environmental Protection Agency, given their experience and vast data repository. It could also be accessible online, user-friendly and designed to provide actionable, shareable and easy to understand information and visuals/maps that highlight present and historical drought conditions across different parts of the country.

Countries with a history of prevalent drought, such as Spain, Cyprus ,France, Australia and the Netherlands are still fond of re-developing and re-assessing their strategies and operative management tools and policies to meet droughts changing dynamics and to simplify approaches to drought resilience based on past drought events (Antwi et al., 2021; Hervás-Gámez & Delgado-Ramos, 2019; Kirono et al., 2020). Given the frequency of drought and the fact that periods of droughts are characterised by water demand above 30% in the RoI (Irish Water, 2020a), there should be a roadmap towards bridging the dearth in policy and management approaches by developing a national drought plan to examine drought governance, preparedness, responses and recovery and to bolster adaptation and mitigation while enhancing resilience in the water sector to meet drought-driven water scarcity situations. Such policy could be included as an annexe in the third RBMP of 2022-2027

or as a supplementary document as in the case in Spain and Cyprus (Antwi et al., 2021; Hervás-Gámez & Delgado-Ramos, 2019).

Additionally, regular media (i.e. print and electronic) coverage of drought events could also increase public interest in conservation actions. As a link between policymakers and the public, the media could publicise government policies, plans, and interventions relating to the water sector, drought and climate change effort. Having a constant media spotlight on progress regarding drought resilience could impel policymakers to remain committed to climate efforts in general. It is also paramount for environmental interest institutions and groups to be cognisant of drought communication as an emergency requiring collaborative efforts to promote public awareness. Prioritisation in investments and funding allocation for water-sector infrastructural development, particularly in drought-prone regions as part of resilience building, could more so be matched with public education as our findings indicate that the amount of work 'behind the tap' is a mystery to many of the public per the comments and feedback on social media.

The success of "WaterWise House Calls" in California, 'dob-in line' in Southern Australia, water-saving tips in Los Angeles and water scarcity communication in the UK have all proven effective in reducing residential water consumption, in conserving water during drought and changes in water consumption behaviours (Addo et al., 2019; Larbey & Weitkamp, 2020; Seyranian et al., 2015). Such a conservation approach could be replicated through a toll-free number for the public in the RoI to report suspected water-related issues like leakage or excess usage and answer consumers' queries on time. Engaging the public on social media and allowing them to be active participants in decision making on water conservation measures could also lead to the fulfilment of the Water Framework Directive on public engagement and involvement and increase the trust between the general public and utility company (European Union, 2000).

By fitting a million smart water meters in the next 15 years, it is estimated that the UK could save about one billion litres of water and reduce greenhouse emissions by 0.5% (Arqiva & Waterwise, 2021). Thus, considering the climate benefits and impact of water metering in promoting water conservation and the long-term sustainability of water supply amidst uncertainties driven by drought, we recommend

consensus-building towards the adaptation and implementation of smart water meters as a conservation measure in the RoI. And, perhaps more importantly, to ensure that drought resilience around the water sector is built not as crisis management but as a proactive approach which could require active stakeholder engagement involving state institutions and the private sector, individuals, academic and financial institutions. Such stakeholder engagements and collaboration on drought should take place before, during and after drought to encourage commitment to long-term actions and resilience building. In the RoI, An Fórum Uisce | The Water Forum could lead the stakeholder engagement as under Water Services Act 2017, the forum is tasked with providing an enabling environment to strengthen democratic input into decision making regarding water resources and to facilitate stakeholder engagement on all water issues at the national level (The Water Forum, 2018).

5.5 Conclusion

This study has provided useful insights into communications on drought and water availability during the 2018 and 2020 drought events in the RoI. For policy, our findings provide evidence for improving engagement between water utility, the media, policymakers and the public on droughts impact on water resources. With continued drought prevalence and the need for water conservation measures towards a sustainable water future for all, further studies could be undertaken to explore how media (e.g. press releases, social media, reports, television, radio stations and advertisement etc.) coverage of water availability influences consumers' behaviour regarding water consumption. Such a study can create space for tailored media approaches in communicating water conservation to promote water stewardship and increase awareness of factors that impact water supply and availability, such as drought.

Chapter 6

RESEARCH INSIGHTS AND CONCLUSION

In this final chapter, the overarching objectives of the research and findings are laced together to draw conclusions that (i) answer the research questions, (ii) are of practical relevance for policy implementation and (iii) reflect on the utility of the research lens and the significance of the findings. The research lens of the OECD Multi-level Approach to Water Governance and the concept of the principles provide the framework for understanding and interpreting the governance and management practices in the Republic of Ireland (RoI). This is complemented by analyses based on a Theory of Change and the Rounds model to offer clarity and increase the coherence of the research, enhancing its validity and credibility. This chapter also reflects on the past (where we are coming from), the present (where we are), the future (where we are going), and the research limitations and lessons for different research audiences.

6.1 Addressing the research questions

The overarching goal of this research was to provide a first-known assessment of the changes in water governance and management practices in the water-rich Republic of Ireland (RoI), highlighting significant events and preparedness for future challenges. This was guided by three research questions answered as follows.

RQ 1: How have significant historical events led to key water policy changes in the Republic of Ireland?

The initial step in answering RQ1 was through a historical and literature review of water governance and management practices in the Republic of Ireland (RoI) in the last seven decades. By adopting a historical viewpoint, water governance in the RoI is viewed as an economic and socio-political pathway towards inducing water resource access, equity and quality over time through active stakeholder engagement in management processes. Adopting a Theory of Change lens and drawing on the Rounds model, key historical events leading to major water policies were categorised into the rural era (1950-2003), integration era (2003-2021) and future challenges (2022 -) and were explored in Chapter 2. The review indicated that governance and management changes and evolution in the rural era were primarily influenced by pollution and a decline in water quality and water charges, access and equity. Water policy and legislation within these periods were identified as reactive in the attempt to protect the environment as a collective good without much emphasis on water governance and management as a distinct endeavour. Generally, water governance was reactionary, with few proactive measures being taken, and this persists today. In the Integration era, water policies were influenced by intense agricultural activities and demographic and land use changes, affecting many pristine water sources.

Nevertheless, the adoption of the WFD and related statutory laws and regulations has resulted in a shift in policy and management practices through the introduction of a comprehensive framework for drinking water source protection using a catchment-centred approach and the adoption of River Basin Management Plan (RBMP). RBMP provides the basis for a three-tier governance structure with various statutory bodies and agencies working together towards achieving good

ecological status for water resources. This includes the formation of Agricultural Sustainability Support and Advisory Programme (ASSAP), to promote agricultural sustainability in RoI. The RoI has also signed and attempted to enforce a number of national and international directives such as the Good Agricultural Practice for Protection of Waters Regulations, Statutory Instrument No. 605 of 2017, Common Agricultural Policy (CAP) and EU Biodiversity Strategy 2030 as guidelines in protecting and restoring ecosystem through organic farming while protecting water bodies and tackling non-compliance on phosphorus and nitrate. The introduction, removal and subsequent reintroduction of water charges and challenges with implementation were also identified to be critical factors shaping water policies with the sheer lack of political will and perhaps fears of elections and popular votes influencing the decisions surrounding water charges and its implementations. The formation of Uisce Éireann as a state utility was noted to have improved water supply despite underlying challenges with leakages, investment and growing demand and usage.

The role of GWS has also been vital in shaping water availability, equity and access and overall policy on rural water supply. In Chapter 2, section 2.2.1, a brief overview of Group Water Schemes is provided and further expanded in Chapter 3 as a case study.

In an attempt to move beyond the reactionary approach and to ensure that past and present policies meet future demands and challenges, a move towards Integrated Management of Water Resources (IWRM) in RoI was identified. Several statutory instruments to promote environmental sustainability initiatives and maximise the socio-economic benefits of water resources were also observed. This demonstrates a conscious effort toward a decentralised water governance system approach, where the power held by the Water Policy Advisory Committee (WPAC) is being influenced by stakeholder engagement under the auspices of the An Fóram Uisce|The Water Forum, and the National Co-ordination and Management Committee (NCMC), which also engages with all 31 local Authorities (Figure 10). The engagement among these actors further indicates attempts toward integrated management of water resources and the transformation from the old top-down water management approaches to an evolving and coherent strategy that embraces stakeholder participation in water management. Despite the appreciable levels of

reform in the water sector, they have not been a panacea in addressing water quality issues with just over half of water resources in the RoI being ecologically healthy. The continuous loss of high-status water quality signified a relaxed enforcement of the reforms particularly in the agricultural sector which remains a major contributor to poor water quality standards.

In summary, the RoI has historically experienced setbacks in the quest to implement water governance and management approaches. However, in recent times, the narrative has been changing with WFD adoption. The juxtaposition of the WFD with the laws of the RoI has enabled a shift from the traditional water governance and management paradigm into an integrated and coordinated framework with planning timelines based on the concept of RBMP and a gradually increasing alignment to IWRM. The implications of WFD in RoI laws and implementation of RBMP are manifold: Institutional challenges and fragmentation are being resolved with agencies such as LAWPRO and ASSAP taking an active role at local levels and with interest groups such as farmers becoming involved. Statutory bodies such as the An Fóram Uisce|The Water Forum have also been created to lead national stakeholder engagement processes. Trust is also building up among various institutions within the water sector towards the common goal of improving water quality. Thus, the combination of activities post-WFD has resulted in a gradual shift from a heavily centralised towards a decentralised water governance system with traces of multi-level governance visible across the board.

RQ 2: To what extent have recent changes in water policies affected the value placed on water?

Historically, water is regarded as a precious source of life and an integral cultural and natural part of Irish society, with numerous myths, folklore and names that resonate with its social and cultural value. From the holy wells to the salmon of knowledge, the socio-cultural values of water are held high. Water as a resource is, thus, regarded as a heritage that must be protected, defended and valued. However, the socio-economic and cultural values placed on water resources in the RoI are impacted by several water governance and management reforms.

Attempts to economise water through charges have not been successful due to limited political will and caveats under WFD Article 9. The non-binding nature of the Article's principle on cost recovery for water services, including environmental and resource costs, has provided the RoI with an escape route on policy decisions around domestic water tariffs. Additionally, nationwide protests between 2014 and 2017 impeded the implementation of charges and meter installations (Section 2.4.1, Table 3). The broad literature review revealed that the RoI has not been able to fully transpose the economic principles of water pricing into policy implementation. Water charges and, by extension, other economic instruments such as the 'polluter pays all principle' that are needed to recover water treatment and supply costs have not yet been harmonised.

Public perception of water availability and the factors that impact supply and the need for conservation are also sketchy. While these influence water policy formulations and the values attached to the resources, climate forecasts on water availability have recently been driving both policy changes and considerable public attention on the resource (Chapter 5). Values on water resources are also shaped by reforms and policy decisions, such as free domestic water allocation, water conservation orders and campaigns. More so, catchment protection and stakeholder engagement actions, and the quality of water supply and delivery services (Chapter 4, section A, B) have all placed considerable value on water resources.

Additionally, the formation of Uisce Éireann (Irish Water) in 2013, as a national utility with oversight responsibility to manage water services in the RoI, has injected some urgency into values placed on water, mainly on the domestic water supply and on wastewater services. The GWS provides water and water supply services to rural areas out of reach of public supply by Uisce Éireann, thereby influencing the development and the socio-economic value of water resources among rural consumers. The case study of GWS highlights the increasing recognition of the value of water resources, as evidenced by the majority of GWS members Willingness to Pay (WTP) for improved water quality and services. Based on a WTP rate of €50 per annum, GWS schemes with about 2,000 connections could potentially raise an additional €100,000 in revenue annually. Among other things, this revenue generated could significantly support public campaigns and education programmes to improve

awareness of water conservation and inform the socio-economic value attached to water resources (Chapter 4, section C). The case study further provided a comparative overview between rural and urban Ireland on water charges implementation, socio-economic value of water resources and climate change adaptation practices. One interesting finding that the case study implies is that consumers' WTP for water services may be influenced by the sector's previous implementation of water charges for consumption prior to the dissolution of water charges through Uisce Éireann (and subsequently for equity through the GWS). It also provided baseline information that can be used by policymakers to conduct cost-benefit analysis and gain insights into consumers' expectations for improved water services (Chapter 4, section C).

To continuously enhance the socio-economic value attached to water and to protect the cultural values attached to these resources, it is suggested in various chapters that catchment actions, integrated planning and biodiversity actions that impact water quality and community involvement are pursued across all water policy and management initiatives.

RQ 3: How have policy responses to recurrent drought events impacted water conservation actions in the Republic of Ireland?

Chapter 5 considered the vulnerability of water resources to climate change and the consequences of conservation measures on water availability and supply. It introduced a more comprehensive perspective on how communication impacts public perception and action towards sustainable water use. Using the 2018 and 2020 drought events as a unit of analysis, social media (Twitter and Facebook), newspaper publications and six key stakeholder interviews were analysed to draw inferences on the importance of public communication, climate change adaptation and policy implementation for effective water conservation. A comparison between the UK and RoI on approaches adopted to mitigate drought impacts on water resources are presented in Table 13. The comparison was influenced by the shared drought trend in the British and Irish Isles and similar mitigation, awareness and communication approaches.

Conspicuously, the aftermath of many climate change discussions had not yet manifested in implementation or mitigation programmes until the Climate Action Plan, Water Quality and Water Services Infrastructure, and Climate Change Sectoral Adaptation Plan was published in 2019. Prior to that, no policy document had fully conceptualised climate change and water resources as a specific sector. However, to contend with worsening drought events, Uisce Éireann launched a National Water Resources Plan (NWRP) as a guideline for adopting and mitigating drought impact on water resources while working out approaches to ensure supply amidst a rise in water demand, ranging from 20% to 30% during drought periods. The RoI also draws significant policy inspiration from the RBMP and the Biodiversity Adaptation Action Plan in protecting water resources from externalities such as drought and in promoting public campaigns and community awareness on water quality improvement and biodiversity through the EPA Catchment Unit (EPA Catchments Unit, 2020). The water conservation order (hose-pipe ban) was also used as an ad-hoc measure in controlling water usage and supply amidst limited rainfall and excess water demand during drought periods.

Nevertheless, the sporadic discussion of climate change's impact on water resources, a general dearth in policy direction on drought and the resultant effects of limited media attention and Uisce Éireann's communication style before, during and after drought events have been impacting conservation efforts. This was evident from the public perception of RoI and sentiments about water availability as sampled from social media comments and reactions (Table 14 and 15). In addition to inadequate policies and the growing impact of climate change, demographic and land-use changes on water resources, the intensity of agriculture, and challenges with emission reduction from the sector are hurdles that consequentially affect climate change policy implementation. Given these shortfalls, various recommendations (section 5.4) are made to improve communication, enhance public awareness and policy formulation, and improve water conservation before, during, and after drought. These recommendations include the urgent need to develop policy and management approaches through a national drought plan that spells out the means of adaptation and mitigation while enhancing resilience in the water sector to meet climate-driven water scarcity situations. An assessment of current water management policies

against the issue of climate risk and adaptation intervention is also needed to prepare RoI for climate change impacts on available water resources.

6.2 Reflections on the Research

This research was motivated by the need to close some identified water resource governance and management gaps (Chapter 1, section 1.1.2) through an assessment of water governance and management practices in RoI. Whereas the research does not offer a complete solution to the identified problems in the water sector, it acknowledges the benefits of bottom-up stakeholder engagement and socio-economic values attached to water resources as fundamental to sustainable water resources management in RoI. A composite lens drawing on the OECD Multi-Level Approach and Governance Principles concept, a Theory of Change and the Rounds model was adopted in this research as this acknowledges the benefits of interdisciplinary perspectives, communication and multi-level participation in ensuring a more coherent national approach to managing water resources. Also, using various methodological approaches as a basis for addressing the research objectives created space to delve into the complexities inherent in governance and management reforms and outcomes in RoI, and to facilitate a transition to a sustainable water future.

The reflections on the research approach and the findings in this section, therefore, offer the opportunity to assess why certain methodologies and lenses were deployed and what could have been done differently under prevailing conditions.

Research methodological approach

The research approach adopted was descriptive and concurrent in addressing the research questions on water governance and management in RoI. The use of Multi-Level Approach and Governance Principles, a Theory of Change, and the Rounds model as the theoretical lenses in this research provided a comprehensive and nuanced understanding of water management transitions, challenges and opportunities for a sustainable water future for RoI. They also helped to identify key drivers of change, the most effective strategies for intervention amid climate

uncertainties, and the long-term consequences of different water governance and management practices. The lenses also helped in recognizing that water management involves actors and processes at multiple scales, including local, regional, and national levels. These lenses allowed the research to consider the complex relationships between the actors, the processes of engagement and key leverage points for intervention. This resulted in a deep understanding of the role of these actors, various government agencies, water management organizations, and local communities in water governance and management within the RoI context. The theory of change framework also provided a structured approach to understanding the pathways by which different interventions lead to desired outcomes, such as improved water access, quality, and management practices. In the context of this research, the Rounds model also helped to understand the cyclical interactions between actors and processes and the role of various policies and interventions that have shaped water governance and management since 1950. Irish society also uses water in different ways and at different scales. Hence, capturing the complexities of water-use sustainability within a policy context with these lenses is regarded as a sound choice, enabling an understanding and categorising of various policy interventions, demand side management and conservation practices in the RoI.

Using a historical perspective as a basis for exploring the research objectives also created space to delve into the complexities inherent in governance and management reforms and outcomes. It helped to understand how these practices have evolved. It also provided insight into the drivers and barriers that have shaped water governance and management in the country, which leads to informed recommendations in this research. The pragmatic worldview adopted in the research gave the advantage of recognising the socio-economic, historical and political context within which water governance and management practices have been formulated since 1950. It also allowed for the use of mixed methods in collecting data and analysing data (Creswell, 2014). The study employed a range of research methods to gather both qualitative and quantitative data, including reviews, interviews, case studies, and surveys. To overcome the limitations inherent in any one method, a concurrent approach was used in this research to gather more comprehensive and in-depth information. For example, while interviews can be time-consuming and prone

to biases, using interviews in conjunction with case study analysis and online surveys allowed for engagement with stakeholders and enhanced validation opportunities. By leveraging these various approaches, the study was able to provide nuanced information and understanding from multiple stakeholder perspectives. In particular, online surveys and Zoom-based interviews were effective in reaching a large and diverse sample of participants within a relatively short timeframe. The concurrent mixed-method approach played a crucial role in gaining a broader understanding of the challenges and opportunities present in the research context. This approach enabled the research to gather rich and diverse data, providing a more complete picture of the research context, providing a solid foundation for drawing conclusions and making recommendations.

Despite the advantages of the research methods used, no cross-comparison with the GWS case study was undertaken. On a reflection, it would have been interesting to cross-compare the WTP of GWS and Uisce Éireann consumers, who may rely on different management approaches and strategies to water demand and supply. Although circumstances did not permit it, it is acknowledged that face-to-face interviews with key informants and stakeholders could have provided more in-depth insights into the perspectives and experiences of different actors, such as government agencies, community organizations, and farmers, through field visits. However, since data collection for this research coincided with the COVID-19 pandemic and lockdown, no timely research methodologies other than the above could have been used to collect, analyse and interpret data gathered. On the other hand, delving into public perception and sentiments on droughts and communication on social media as a research tool offered a unique perspective that could not have been obtained solely through interviews with a limited number of water stakeholders.

Research findings

In light of this research, several key findings warrant further reflection. First, the level of challenge associated with water governance and management prior to this research could easily be trivialised when one considers how rich RoI is with water resources. However, the snapshot of the significant events and activities leading to

the decision to end direct charges on domestic water consumption and the progress made, as presented in Table 3, depicts how water and water services charges have been divisive since 1977. The historical context of water governance in the earlier 1970s underscores how central government funding and reliance on prescriptive regulations to control pollution were the basis of environmental and water policies in the 1970s. Quite surprisingly, pollution until now remains a burden on available water resources (quality and quantity).

In Chapter 2, the discussion on water policy changes is explored under three headings; past, present, and future challenges to effective water policy implementation. What stood out from past practices is how regulations and amendments demonstrated reactive attempts to protect the environment as a collective good without emphasising water governance and management practice as a distinct endeavour. Lessons from the past have, however, been influencing present management practices. But, while the plethora of policy and legal provisions since 2003 have clarified the overall ambitions of water governance as a route to sound ecological status for water bodies and the sustained provision of services, it has not simplified water management on the ground in the RoI. For instance, the 1st RBMP cycle could not help resolve the challenges in water resource management, but through threats of non-compliance to WFD directives by the EU, the RoI has altered its governance processes to contribute to water quality improvement. Also, several institutions have either been formed or reconstituted to refocus their actions toward catchment protection and stakeholder engagement. Even so, the late implementation of RBMP, in addition to the background, interest, preferences and organisational structure changes, impedes efforts toward water quality improvement. As a result, the ecological health of water resources has not significantly improved as it should. It is, however, interesting to note the rate at which trust is building up among actors in the water sector. However, this research suggests more work regarding stakeholder engagement could be done, particularly in the agricultural sector. There is a need for a focus on compliance and efforts to curb intensive agricultural practices affecting water quality not comprehensively integrated and enforced into governance and management practices.

Ironically almost all water policies and frameworks are up to date with international standards yet policymakers - mainly politicians it would seem - think more about the next elections and fears of electoral repercussions, and are overly cautious of actions they take. It, therefore, appears that "nobody" (e.g. politicians, institutions and key actors in the water sector) want to offend "anyone" (e.g. farmers, domestic and industrial water users) in the process of implementing reforms and directives. It could be that the Irish have a compassionate and forgiving nature and even though may internally strongly disagree with some policies and directives, they generally choose to avoid conflict and submit to it[13]. However, to achieve long-term goals and aspirations in meeting set environmental targets and compliance benchmarks within the necessary timeframe, no policy or plan of action can be successful without encountering some level of resistance and feedback that is necessary for future learning, reformations, and adjustments. This may require a strong political will, courage and leadership in the water sector to ensure sustainable implementation of various actions and directives.

The economic crises also left an indelible mark on all sectors of the Irish economy. However, one controversial benefit of the EU stimulus package during the economic crisis was the establishment of Uisce Éireann as a single national entity tasked with managing the national provision of drinking water outside of the rural water sector. Despite some considerable challenges, the contribution of Uisce Éireann to water services delivery in RoI has been positive (Chapter 2, section 2. 4. 2). Insights into the GWS sector also clarified consumers' WTP for water services which contrast with the large section of the public on water charges and the diversity in water management practices, particularly on water conservation, demand and usage trends.

Whereas historical and political will have impacted the ability to implement agricultural reforms and compliance measures, including CAP, nitrate directives, and water conservation measures. It has contributed to the lateness in the policy implementation, such as the 1st RBMP and institutional coherence in the water sector. It is again evident from Chapter 3 that the permissive nature of the WFD allowed RoI

[13]Scroope, Chara (2017) "*Culture-atlas Communication".* Accessed from https://culturalatlas.sbs.com.au/irish-culture/irish-culture-communication

to get away with some compliance due to caveats such as quantifying the cost of the socio-economic and environmental effects of using water services under the WFD Article 9(4). To some extent, such contradictions in the WFD influenced the indecisiveness in the implementation of water charges in the RoI. It has also been one anchor on which RoI stands as the only EU member state with no domestic water charges except for the usage above the given allowance.

Basically, the seventy-year-plus history of rich water availability in the RoI contrasts with the future challenges to supply occasioned by climate change impacts and anticipated long-term shifts in demographic characteristics, land use planning, and intense agricultural activities. Nevertheless, the anticipated impact of these factors on water resources has been a driving force in policy and water governance reform in recent times, evident in several ongoing legislation and debates on climate change resilience and adaptation measures which hitherto were more rhetorical than practical. The insights garnered from this research further suggest that considerable scope exists for water governance and management practices to pick up lessons from the past to inspire present policies that can embrace future challenges and offer inspiration to build resiliency in the face of climate uncertainties and events such as the COVID-19 pandemic. Regardless, the efficacy of action plans and efforts in achieving real change in water management practices and building resilience in the water sector in the RoI remains to be seen in the coming years.

6.3 Implications for policy and practice

To what extent can the findings of this research translate into practice amid prevalent factors that undermine water demand and supply? In this section, practical recommendations and policy-relevant insights, with a focus on improving water resource governance and management practices are suggested.

6.3.1 IWRM Principles in governance and management practices

Integrated Water Resources Management (IWRM) offers extensive coverage in addressing water-related challenges. Its multi-disciplinary approach and dialogue with stakeholders are feasible with a proven record across Europe (Kelly-Quinn et al., 2014). IWRM's emphasis on catchment management offers a window of opportunity in the protection and efficient management of water resources because of its high regard for land, water, and the entire biodiversity as shared importance that cannot be traded off for the benefit of one against the other. It also acknowledges the concerns of stakeholders and offers them the opportunity to be an integral part of decision-making with scientists and policymakers (Daly et al., 2016; Fenemor et al., 2011; Mitchell & Hollick, 1993). Not only does IWRM ensure that the numerous functionalities of water resources are protected together in an integrated way it also allows water users across all scales to be involved in management processes to promote participatory governance processes, which goes a long way even to impact socio-economic growth of countries (GWP, 2011; Metz & Glaus, 2019). Although IWRM is not without challenges it is foremost in dealing with efficient and equitable water resources allocation due to its design, which uses a cross-sectoral approach to substitute the old approach that has been used over time in managing and governing water resources in different countries (Al-Jawad et al., 2019; Duncan et al., 2019; Fulazzaky, 2014; GWP, 2011; Hidaka et al., 2011; Kumar et al., 2019; Nesheim et al., 2010; Yu et al., 2014). IWRM processes consider a web of actors to function through trust and active participation, which grows over time. Chapter 2 and 3 revealed the extent to which IWRM principles are being integrated into present water policies in the RoI, its adaptation into water governance and management is evolving and demands coherent strategies in embracing stakeholder participation to achieve the full potential of IWRM in solving challenges within the water sector. To actualise the full potential of IWRM will require some of the elements listed below.

Multi-level participation

A critical assessment of the existing governance structure in RoI indicates that despite reforms and progress made, the governance structure still has public participation deficiencies (Chapter 3 section 3.4.2 and 3.4.). In essence, a governance model that emphasises the involvement of stakeholders at each stage of planning may be required to bridge public participation gaps. While such a multi-level participatory mode may not be immune to unseen challenges, its latent aim will be to improve active stakeholder participation from the catchment to the national level.

The integrated participation approach may allow the public as much as possible to make input in decision-making while building the capacities of individuals and institutions. Multi-level participation may also empower citizens to become aware of the situation of their water bodies through first-hand information and involvement. When citizens are fully aware of their catchment challenges it enables them to identify appropriate solutions to rectify anomalies. Public participation has been a key driver of successful attainment of Water Framework Directive (WFD) targets among some EU countries in Spain, for example, public participation has led to the creation of river basin committees, which bring together stakeholders to develop plans for improving water quality. In Germany, public engagement has been critical in the implementation of the WFD, with citizens actively participating in decision-making processes and monitoring activities. Similarly, public engagement in the Netherlands has led to the adoption of innovative water management strategies such as water recycling and green infrastructure development, while in France, the involvement of various stakeholders including local authorities, water users, and environmental NGOs has been instrumental in the implementation of the WFD, particularly in the development of river basin management plans (Benson et al., 2014; Jager et al., 2016; Rowbottom et al., 2022; Van der Heijden & Ten Heuvelhof, 2012). For many other countries, there is a move away from the conventional top-down approach to a more localised decision-making structure that enables citizens, state and non-state entities, among others, to make valuable inputs on matters of environmental laws, policy, and governance models through public participation. Whereas a series of literature also supports public participation as essential in

achieving environmental objectives such as WFD, there are some obvious challenges, particularly with cost, time, and the lack of training on stakeholder interactions usually cited as a concern (Albrecht, 2016; Jager et al., 2016; Liefferink et al., 2011; Rowbottom et al., 2022; Wright & Fritsch, 2011). Nonetheless, the positive aspects of participation outweigh those negative concerns by helping to minimise the tendency of a decide-announce-defend posture, which can mar the spirit of involvement, transparency, and information sharing regarding water resources governance and management. Continuous improvement and engagement of stakeholders in the RoI could therefore drive efforts toward meeting various goals enshrined under different environmental legislations.

Gender and Youth inclusivity

In many contexts, gendered dynamics play a critical role in water management, with women often responsible for providing water for domestic needs while men predominantly make decisions regarding the management and governance of water resources at both the local and national levels. However, there is also a broad body of literature on the significant roles women can play in managing water resources sustainably, particularly in developing countries. The involvement of women in water management is critical as women possess significant stakes and involvement in domestic and agricultural water use (Khandker et al., 2020). Women also have a significantly higher willingness to contribute to improved water quality and services, yet in policy and program frameworks their viewpoints and contributions to water management remain generally unacknowledged (Naiga et al., 2017). However, it appears gender in water resource management slips off policy and development agendas and this is a worrying trend across developed countries (Ahlers & Zwarteveen, 2009; Cleaver & Hamada, 2010; Das, 2014; Ifejika & Bikketi, 2018). Literature on the potential impact of gender on water resources in Europe remains sparse with limited systematic and comparative assessment (Allwood, 2013). In the RoI, Uisce Éireann has about 50% of its senior management team as females; however, the active involvement of women at the local government level and in stakeholder engagement is not that considerable compared to their male

counterparts (Irish Water, 2019b). This is further evident among GWS where gender bias exists in the management of schemes. The absence of women in local water management poses a significant challenge and an untapped opportunity for achieving the Sustainable Development Goals and ensuring sustainable water demand and usage. Importantly, women played a pivotal role in the influential "Turn on the Tap" campaign in 1960, further underscoring their potential contributions. Consequently, there exists a clear opportunity to engage women as integral participants in source protection and management in RoI, harnessing their expertise and contributions to enhance water management practices and foster sustainable outcomes. A World Bank study on women in water utilities reveals that a greater representation of women in stakeholder consultations, policy, regulatory roles and leadership positions can efficiently influence water resources management (World Bank, 2019). The relevance of women in water governance therefore cannot be underestimated; hence the recommendation for a peculiar interest to be given to women at both local, regional and national levels of water resource management and governance in RoI. Encouraging and allowing women to be an integral part of water governance processes at all stages can help deal with influences that produce gendered outcomes, as seen in political voices, access and livelihood, for instance (Batchelor, 2007; Cleaver & Hamada, 2010; Das, 2014). Delving further into the area of inclusivity, the youth also have a crucial role to play in water governance and should be given the needed opportunity to be part of such processes. They are usually vulnerable to the impact of climate change, for example, but lack the power to make decisions. Young people have historically been excluded from various forms of management and policymaking. Additionally, their roles as custodians of the future, particularly in the context of environmental and climate crises, have not been fully recognized nor integrated into actionable plans. As a result most young people feel uninformed about water management in RoI from the local to regional and national levels. A forthcoming paper by Linnane et al., (n.d.) highlights that about 64% of young people in the RoI are uninformed about local water management and water quality issues. On average, 51% of respondents in the survey felt uninformed about water management in the RoI. In this light, promoting youth and gender inclusivity in water governance is necessary to significantly contribute to active stakeholder engagement in water

management and to keep the present and future generations informed about water management and other environmental concerns.

Communication

Communication is also vital to the governance and management of water resources and every person, by default, is a stakeholder when it comes to matters of the environment. However, most people and communities need to be informed and be part of environmental discussions to enable them to recognise how their voices and thoughts matter on such issues. In such a process, modernised means of communication options should be activated to simplify public engagement and participation processes and allow wider access. Although a dedicated website (catchments.ie) and the Blue Dot Catchments Programme exist, offering data and outcomes on all River Basins in RoI, other communication options like social media and free-to-download Apps and the use of short skits and films could also be used to facilitate swift information dissemination and encourage public participation in water governance and management.

Regarding the improvement of water conservation communication during drought, several recommendations have been made in Chapter 5 (section 5.4), including a consolidated National Integrated Drought Information System (NIDIS). The NIDIS could be accessible online, user-friendly, and designed to provide options for sharing and easy-to-understand information as well as visuals/maps highlighting present and historical drought conditions across different parts of the country. In addition, public libraries could have relevant documents available. They could also provide space and facilities for persons currently unable to make online contributions to RBMP consultations. It is also imperative for Uisce Éireann to increase its efforts in communicating with consumers by deploying dialogical communication strategies. Yang et al. (2010) hint that dialogical communication helps create discussion between stakeholders, and promotes engagement, public participation, and trust while clarifying misunderstandings and perceived thoughts that may not necessarily be a reality. The values, ethics and perspectives of different stakeholders may also be brought to bear through dialogical communication, which leads not only to the

acceptance of water conservation messages but also an improvement in the public reputation of a utility agency, its online presence and the willingness of consumers to act on their communique, especially during periods of drought (Jamieson et al., 2017; VanDyke & King, 2020).

Through effective communication the public can be awakened to the realities of climate externalities like drought, affecting the water they view as a free gift of nature and in abundance in RoI. Already, effective communication towards achieving WFD and other ecological objectives has been gaining ground in Austria, where a digital channel for disseminating information and a single portal where citizens can interact and share concerns on environmental policies and related issues are in place (O'Leary, 2019). The UK has a unique tool to assist decision-making on sustainable natural resources management. Portugal also has a platform for monitoring and inspecting agricultural lands and water bodies with an environmental permit platform in operation (O'Leary, 2019). All the efforts in these countries aim at improving environmental governance through public participation, which the RoI can learn from to enhance its public communication and engagement efforts as part of achieving not only the WFD but also environmental objectives such as the SDGs and climate change adaptation and mitigation efforts.

6.3.2 Water charges and investment

Uisce Éireann (Irish Water) has formulated a 25-year strategic plan aimed at establishing a world-class water infrastructure that can provide secure and sustainable water services, which are critical for health, communities, the economy, and the environment. The plan will be achieved through responsible stewardship, efficient management, and strong partnerships (Irish Water, 2015). The strategic plan is crucial because relying on outdated 19th-century water systems will not be adequate to meet the demands arising from growing demographic changes, socio-economic development, and an increase in water usage in the RoI (Chapter 2). However, the plan may be overly ambitious if the water sector does not receive the necessary investment. This is because central government funding alone may be insufficient for the water sector to thrive, considering that Uisce Éireann estimates an annual funding

requirement of about €11 billion to cover operational and expenditure costs, infrastructure, and assets by 2024 alone (Irish Water, 2019a).

Although the issue of water charges proved to be politically contentious and had electoral consequences for certain parties, funding the water sector is ultimately necessary.

Domestic and non-domestic water charges in addition to direct government provision could help improve water supply and its reliability, and could partially fund the revamp of water infrastructure and services which ultimately benefits consumers. Water charges can also help promote responsible usage of water and discourage wastage. Without water charges, it will be challenging to maintain high-quality water services, and the burden of paying for these services would fall solely on taxpayers. Although there are still controversies and political ramifications around the implementation of water charges (Chapter 2), some reports indicate the public's desire to pay for domestic charges (Irish Water, 2016). Also, the findings from the case study of GWS (chapter 4), further suggest a willingness to pay for improved water quality and services. Such findings suggest there is a need for ongoing active stakeholder engagement to address consumer concerns in an attempt to re-introduce charges to guarantee improved water supply and availability. In the process, efforts towards water conservation ought to be thoroughly pursued to manage water demand and usage and to enhance public awareness of factors that impact water availability. Stakeholder engagement and water conservation measures could raise public awareness of the value of water and water services and also improve transparency in the sector. As a step towards digitalisation of the water sector for effective and efficient output, the installation of smart meters would be required to provide real-time data on demand and usage that can help consumers to manage water productively. It would also allow for earlier detection of anomalies in supply and the restoration of services. Also, continuous research and development would position Uisce Éireann Water as a utility that delivers secure and sustainable water services with state of the act knowledge and efficiency.

6.3.3 Agriculture

As explained in Chapter 2, the historical and economic importance of the agricultural sector in relation to other industries is associated with the sector being the most significant contributor to water quality deterioration in the RoI (DHPLG, 2018a). Almost half of river bodies (43%), a quarter of groundwater (24%) and one-fifth of estuarine and coastal water bodies (22.2%) have excessive nutrient levels mainly from intense agricultural activities (Trodd et al., 2021). Emission reduction targets of 25% in the agricultural sector will also be difficult to realise due to the intensive practices in the agricultural sector. This counteracts efforts to improve water quality and attain the required WFD standards, thereby necessitating policy changes and actions toward protecting water bodies (EPA, 2020a). A new Climate Action Strategy (2022-2030) by the Agriculture and Food Development Authority (Teagasc) has indicated systematic steps to reduce greenhouse gas emissions from the agricultural sector in 2030 while increasing farmers profitability without harming the environment (Teagasc, 2022).

The EU Common Agricultural Policy (CAP), as a subsidy system and support programme for agriculture, has also been undergoing reforms to set new requirements for farmers to encourage responsible pesticide usage and probably non-chemical weed control methods in farming (EPA, 2020b). Nonetheless, CAP as a policy alone, as explained in Chapters 2 and 3, is not enough to prevent the growing pressures from agricultural activities. Instead, a holistic approach that involves the establishment of effective and accountable initiatives that will deliver not only environmental targets but also on-farm efficiencies and market access through collaborative engagement across the agricultural sector concerning source protection, biodiversity and climate change is indispensable (EPA, 2020b). More so, an improved level of interaction and discussion between the Department of Agriculture, the Irish Farmers Association, industries, individual farming bodies and the Dairy Sustainability Council would be required. Continuous collaboration between local authorities and farmers with input from the agricultural, processing and dairy industry, catchment scientists, and ASSAP farm advisors could be a further positive step owing to the role each of the above stakeholders plays in the agricultural sector

and their overarching importance to water quality improvement and catchment management.

6.3.4 Climate change

The changing climatic conditions in RoI are confirmed by climate models, data, and projection analyses. Such analysis and projections are essential in managing and planning for the future in various ways because climate changes have extensive socio-economic impacts on the economy, society and the environment, including water resources. Ironically, we are the first generation with a vivid picture of climate impact and the last with the opportunity to sustain our environment in the face of climate-induced destruction. Nonetheless, the approaches adopted to manage the climate crisis especially in the RoI have been inadequate.

Although, existing climate and environmental policies and ambitions are in alignment with international benchmarks and standards, they are loosely tied and less consistent with implementation actions at the national to local levels due to guidelines and enforcement inconsistencies. The RoI obviously does not lack climate ambition and vision but overall implementation appears to be lacking. The discourse on climate change policies and the adaptation and resilience measures have been more rhetorical than practical, leading to low awareness levels of climate adaptation, with corresponding lower levels of willingness for various stakeholders to take practical actions. The co-benefits approach to climate change migration measures are also underexplored. The few existing climate change actions and efforts in the RoI are mainly focused on coastal erosion and inland and coastal flooding compared to freshwater resources, with very narrow discussions and plans on climate actions towards water resources (Flood et al., 2020; Keskitalo et al., 2019). Despite developing a Climate Action Plan and a National Adaptation Framework in 2018, the lack of political will and missing dimensions in climate change actions means that the RoI will undoubtedly miss its climate change targets set for 2030 (CCAC, 2020). But given that climate phenomena such as drought are predicted to increase the magnitude of various impacts, especially on water resources, means that the impacts must be addressed through concrete mitigation and adaptation actions that are fully

integrated into all local and national policies and programs toward improving socio-economic recovery, equity and resilience building.

This research has already shown a wide variety of drought impacts on water resources in Chapter 5 but has also indicated how communication could be utilised to improve public awareness of water conservation during drought events. For policymakers, water resource and drought mitigation measures should be implemented not as a crisis management approach but as a sustainable long-term measure towards ensuring continuous water availability before, during and after drought. Integrated stakeholder engagement that involves state and non-state agencies and bodies such as religious bodies, educational units, private businesses and the general public is required in creating resilience amid climatic shocks and impacts. The media (i.e. print and electronic) also has a key role in increasing public interest in conservation actions. As a link between policymakers and the public, the media could frame and amplify government policies, plans, and interventions relating to the water sector, and how they impact drought and climate change efforts. Having a constant media spotlight on progress regarding drought resilience could impel policymakers to remain committed to climate efforts in general. It is also paramount for environmental interest institutions and groups to be cognisant of drought communication as an emergency requiring collaborative efforts to promote public awareness.

6.3.5 Interdisciplinary perspectives

The problems in the water sector are complex as they are linked to other disasters such as drought, flooding, poverty and even conflicts; and for most of the issues highlighted in this research about the RoI, they are interconnected. For example, intensive agricultural activities and climate change affect water quality and quantity, food production, healthy biodiversity and economic growth. Declining biodiversity and water scarcity during droughts also impact environmental outcomes. Demographic growth and land-use planning also have a consequential impact on water demand, supply and infrastructural development. In turn, efforts to redress these challenges are carried out in isolation, with separate state and non-state

institutions tasked to address them. Some of the well-known solutions to these problems have also resulted in unintended consequences with little to no solutions to them. A new attempt at solving the various water challenges may require a resilience system thinking approach that embraces broader and integrated perspectives drawn from linkages between different fields like energy, social sciences, economics, engineering, hydrogeologist and behavioural psychologist perspective as water cuts across all sectors and has a consequential impact on actions taken in other sectors (Fallon et al., 2022).

In related attempts, the An Fóram Uisce|The Water Forum has taken a step to introduce multi-sector perspectives into water governance and management through the adoption of Integrated Land and Landscape Management (FILLM) as a system that allows for the inclusion of all aspects of the environment and policies, viz: the SDG, WFD, CAP, Flood and Habitats Directives, Urban Waste Water Treatment Directive, Drinking Water Directives, Spatial planning, Water and Soil conservation, climate change adaption and mitigation, sustainable agriculture and forestry etc. in environmental management (Water Forum, 2021). FILLM also takes collaborative place-based strategies in working with stakeholders from the local to the national level as an integral part of IWRM practices towards improving water quality, its effective management, and improved access and availability. FILLM could help RoI to attain improved environmental outcomes that conceptualise social-economic development and environmental benefits in a single plan or policy framework. Such an approach is essential given the interconnected nature of water to other sectors of the economy and the potency it carries in sustaining socio-economic and infrastructural outcomes while enabling policymakers to navigate potential challenges in implementing environmental policies and ambitions (Raymond et al., 2017; Ürge-Vorsatz et al., 2014).

6.3.6 Demand Side Management and Consumer behaviour

Water scarcity and volatility brought on by climate change and rising demand are managed in RoI via water conservation orders. Uisce Éireann as a utility also employs social media campaigns to involve customers in water conservation

efforts (chapter 5). The NFWGS has also enacted policies that support water conservation efforts, such as encouraging the use of water-efficient appliances and rainwater harvesting (chapter 4). To enhance demand, consumption, and efficiency in the water sector, responses to water demand and usage have often been centred on infrastructure investment, water conservation orders, and encouragement for the adoption of technology. Even with the implementation of water allowance to limit excessive use, these efforts have not entirely resulted in a reduction in water usage.

Very little has also been done about demand side management (DSM) and behavioural traits of water consumers. Demand-side management and consumer behaviour are however crucial for water conservation for several reasons. Firstly, there is a growing need for water in RoI, and DSM can help meet that need by influencing customer behaviour and promoting water-saving habits like addressing leaks, installing water-efficient appliances, and limiting water use during peak hours. Secondly, DSM can help consumers be more effective, which can save costs and benefit the environment in terms of the amount of water that must be abstracted to meet demand and preserve the ecosystem. Thirdly, using DSM rather than creating additional infrastructure to accommodate rising demand may be more affordable. Demand reduction makes it possible to postpone the construction of new infrastructure or treatment facilities for sewage and water. Finally, DSM demand-side management and consumer behaviour can be extremely important in promoting sustainable behaviours and preserving accessible water resources for use in the future. Pursuance of DSM can also foster a water conservation culture in RoI that will benefit consumers through behaviour changes and the promotion of sustainable practices.

6.3.7 COVID- 19 Pandemic

The COVID-19 pandemic claimed over 6 million lives as of August 2022[14], with an excess of 500 million pushed into various degrees of socio-economic hardship (Jones et al., 2020). In Europe, the pandemic was regarded as the most perilous since World War II. Water played a central role in promoting hygienic practices such as hand washing under clean flowing water as recommended by the World Health Organization (WHO, 2020). Water scarcity caused by increased demand, declining rainfall patterns, drought conditions and exacerbated COVID-19 challenges left many countries in despair. Their situation was deepened by fragile water policies and approaches built over time to try and deliver equitable and sustainable water supply and management. A review of governmental interventions shows that only eleven out of twenty-seven European countries implemented at least one policy intervention that considered the water sector. The interventions were mainly short term, involving deferment or full-cost absorption of water bills (Antwi et al., 2021). The pandemic also tested the pulse of the seemingly robust systems built by countries and revealed the extent to which unforeseen uncertainties can have a very negative impact on water supply, distribution and demand, which have a latent effect on other sectors of an economy in areas such as tourism, transport and health.

The COVID-19 pandemic was, thus an example of how unforeseen eventualities can stretch the water sector. It however offers an opportunity for re-strategizing and the prioritisation of interest and focus on water governance and management practices. Looking into the future without losing sight of imminent externalities, offers for instance the RoI the opportunity to build resilient systems for epidemics, demographic growth and climatic disasters such as flooding, drought and bushfires. This can be possible through active public and private sector engagement in water governance and management practices, healthy catchment and ecosystem protection and adoption of smart technologies, infrastructural development and investment and collaborative research and studies. The RoI can also learn lessons from the digitalisation drive in the water sector, such as the installation of smart meters

[14] COVID-19 deaths worldwide as of August 15, 2022, by country. Accessed: https://www.statista.com/statistics/1093256/novel-coronavirus-2019ncov-deaths-worldwide-by-country/

which were of great benefit in deferring water charges during the COVID-19 pandemic in other countries (Antwi et al., 2021). To achieve further equitable and sustainable water management, reforms in communication, policy implementation, water leakage reduction, and water efficiency in product design and monitoring would also be required to build resilience against future eventualities.

6.4 Linking the threads together

As explained in Chapter 1, the theory of change aided in drawing together the threads on why, how and when significant changes occurred in the water sector and the impacts on future policies and implementation activities in the RoI (Maru et al., 2018). These changes are further encapsulated under three cycles using the rounds model to examine the complexities of decision-making processes and competitive elements in the policy process over time (Bontje, 2017; Teisman, 2000). An overview of where we are coming from (past), where we are (present) and where we are going (future) is crucial in gaining an understanding of the progress made and the challenges ahead. Insights into the historical evolution contributed to a deeper understanding of water governance and management issues in RoI. They also provided a context for evaluating the toxicity of water charges and reactive legislations governing water resources since the early 1950s.

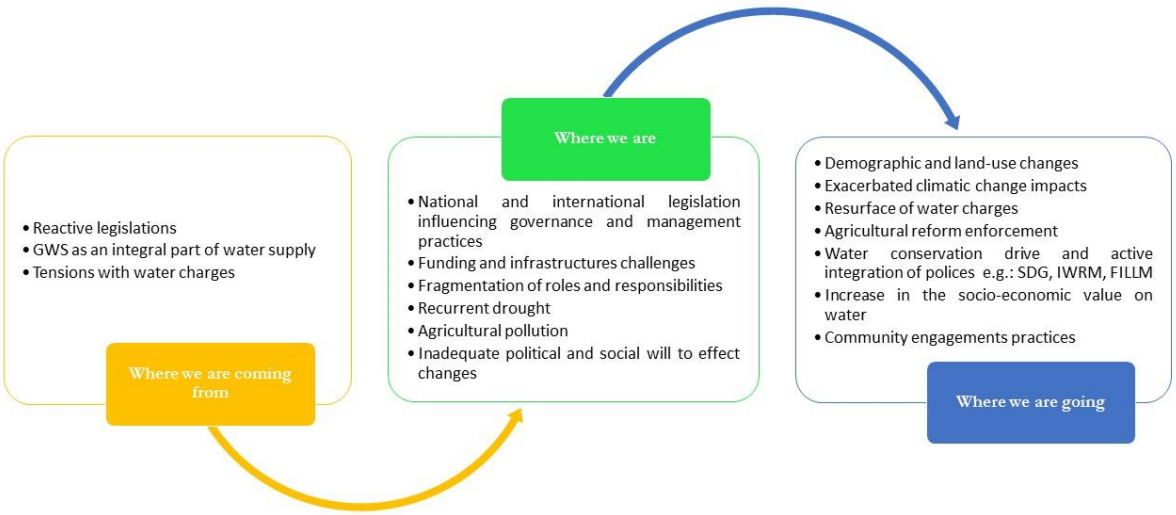

Figure 23. A thread from the past to the future

At present, the RoI is at a stage where the exploration of synergies between stakeholders in the water sector has been fostering active catchment engagement through establishing various institutions and agencies that work directly with water consumers and the public in general. The manifestation of climate change and pollution from intensive agriculture has been affecting water quality despite the influx of many local and international laws and directives aimed at improving water resource management and quality issues. In drawing the threads together from the past to the present, the complexity of factors driving water governance and management practice in the RoI becomes evident. Many reforms and interventions implemented so far have not fully manifested. However, looking to the future, it is expected that water conservation and the SDGs, for instance, would be fully integrated into various policies in addition to consideration for climate adaptation and resilience. Figure 24 provides a direction on the scope of past and present management challenges and acknowledges future eventualities that can impede accelerated actions towards achieving good ecological status for all water resources in the RoI. It is expected that sequencing research, and policy decisions to be coherent, and reinforcing from national to regional and local could help ameliorate some of the future consequences. A systems thinking perspective that embraces alternative approaches and integrated disciplines could be essential in such pursuit.

6.5 Lessons for research audiences

The findings of this research contribute theoretically and practically to the body of knowledge on water governance and management, which is useful in policy planning and implementation with four key research audience: policymakers who develop and implement water and environmental policies, water management practitioners from local to national levels (e.g., Uisce Éireann and NFGWS), the public and public representatives (e.g., An Fóram Uisce|The Water Forum) who use water for domestic and non-domestic purposes or advocate for constructive stakeholder engagement, and researchers who analyse water governance and management practices to improve the quality of water resources, sustainable management, and equitable access to water services.

Overall, the research challenges the perception of RoI as a water-rich country, with the present availability influenced by climatic changes, among other factors. In this regard, for policymakers who develop and implement water and environmental policies, more efforts towards effective measures are required to ensure a continuous water supply to meet growing needs amidst demographic changes, intense agricultural activities and climatic events, which threaten water availability and quality. FILLM for instance offers a more comprehensive and participatory framework for managing land and landscapes. By considering the interconnectedness of environmental, social, and economic factors, FILLM can help to address complex environmental challenges and ensure a sustainable future through a co-design and benefits approaches that connect water quality, climate change, flooding, biodiversity issues, food and energy production, transport and tourism etc. The narratives in this research can also be useful in understanding how these expectations could be met in the short to medium and long term, including how the activities of stakeholders can either improve water quality, its conservation and efficient usage or affect it in diverse ways.

With regards to the complexities with management and the unpredictably of water availability due to climate change, the narratives in this research create an awareness of how public perception of water usage can contribute to supply and demand during periods of scarcity such as drought. This means consumers and the public and public representatives who use water for both domestic and non-domestic activities or advocate for constructive stakeholder engagement, have a functional role in ensuring that stakeholders are informed about water resources with the capability and ability for source protection towards water quality improvement as outlined in this study.

Generally, the outlined recommendations also provide valuable content on effective management practices and engagement from local to national levels. The comparative assessment and the case study, for example, provide valuable content for the National Federation of Group Water Schemes to improve its efforts toward water schemes. Consumer water demand and usage trends can also serve as a guideline in the design of conservation actions and evidence to Uisce Éireann relating to introducing water charges measures for the future. The emergent trends that

characterise policy formulation and management practices illustrated in this research are of interest to researchers who analyse governance and management practices to improve the quality of water resources and provide clues to co-design strategies and the evaluation of water quality measures.

6.6 Limitations and suggestions for future enquiry

This research primarily focussed on outcomes leading to significant water governance and management changes by assessing past, present and future events in RoI. However, despite the comprehensive approach taken, it is worth noting that the attempt to investigate over seven decades of governance and management reforms and address the research questions were met with some limitations (see Chapter 6 section 6.2 on research reflections). One of the prime limitations was the COVID-19 pandemic and associated restrictions on movement which posed a significant challenge to the planned face-to-face interviews, resulting in delays and necessitating the use of online interviews via the Zoom virtual teleconference application. However, this approach was not without its challenges, as some interviewees were hesitant to participate, and a few were initially reluctant, adding to the difficulties encountered in data collection. Furthermore, the ethical implications of gathering some bio-demographic data of respondents' also meant that some key variables were not considered for analysis which may have limited the comprehensiveness of some results. Nonetheless, the overall research findings provide a comprehensive and reliable analysis of the water governance and management changes in RoI and offer pragmatic recommendations to address several gaps identified.

Areas that may warrant further research exploration may include a study into the interlinked relationship between media coverage of water issues and its influence on consumer behavioural changes. A study of these relationships can create space for tailored media strategies in communicating water conservation to promote water stewardship and increase awareness on factors that influence water supply and availability. Further qualitative and quantitative research regarding the narrative on the current state of integration, awareness and scientific trends in the Sustainable Development Goals (particularly Goal 6), using an open bibliographic data repository

could also contribute to the global discussion on SDGs and their corresponding link to water governance and management practices now and in the future for the RoI.

More so, given that a single case study approach was adopted in assessing GWS consumers' willingness to pay for water services and efforts towards water conservation, a future research opportunity exists to determine Uisce Éireann's consumers' willingness to also pay for water services beyond the current water allowance given. This can inform thinking on water charges and the perception of consumers towards water usage, its conservation and the desire to secure the supply for the future. Further research on the ability of existing and/or future River Basin Management Plans to deal with anticipated impacts of climate change, land-use planning and demographic changes on water resources will also be required to test the resilience of present water policies in tackling uncertain future eventualities. This could include a cost-benefit analysis of climate risk to the socio-economic development of the RoI, which could help to inform the appropriation of the needed finance and support required to implement sustainable climate actions. Finally, it remains to be seen what the governance and management practices in RoI will look like in the face of imminent challenges confronting water availability and supply. A comparative analysis of water governance and management practices in other countries to identify key learning for the RoI regarding the engagement of diverse stakeholders in the water sector will form a vital contribution to a sustainable, water-secure future for the RoI.

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APPENDICES

Sample Participant Information Leaflet

Research project: River Basin Management Plan in Ireland: Past, Present and Future

Researchers Name: Sarpong Hammond Antwi

You are being invited to take part in a research study before you decide whether or not you wish to take part, you should read the information provided below carefully. You should clearly understand the risks and benefits of taking part in this study so that you can make a decision that is right for you. This process is known as 'Informed Consent'. You can change your mind about taking part in the study any time you like, even if the study has started, you can still opt-out, and you are not required to provide us with a reason.

Why is this study being done?

This study is being conducted to understand the progress and challenges that have arisen during the implementation of the 2nd phase of the River Basin Management Plan, specifically on governance and management. The results of this study will contribute to the researcher's PhD project on the socio-economic impact of past, present and future water resources management in the Republic of Ireland. The study is also timely because its findings can contribute to the strategies and plan of actions for the next River Basin Management Plan from 2021-2027, particular on water governance and management. All the information provided will be private and confidential. The results of this study will contribute towards understanding governance and management challenges with the RBMP and lessons that can be drawn for the next plan from 2021-2027.

Why you have been invited to take part and what it will involve?

You have been invited to take part in this study because you are a member of an organisation involved with the implementation of the River Basin Management Plan in the Republic of Ireland. This is voluntary interview with no financial remuneration or benefit. The entire interview will be remote via a means of communication channel you find comfortable.

What are the benefits?

The benefit of taking part in this survey is that it will help in providing an overarching understanding of the progress and challenges with the current water governance structure in the Republic of Ireland.

What are the risks?

While the researchers will ensure confidentiality in reporting and protecting individual's responses, there is a minimal risk that the information you share will be shared with other parties who are not part of the research project. All information will be stored as per DKIT research confidentiality rules and regulations.

Is the study confidential?

Identifying information such as your name, address, or email will not be attached to your questionnaire. When reporting results from this study, precaution will be taken to ensure

anonymisation and that, each participant's identity will not be compromised. The information received from this research study may be kept and used to build upon for further research. All necessary measures to protect the identity of individuals participating in the study will be taken. In addition, the information provided by you will be stored on a personal laptop in folders that are password encrypted. All data will be backed up on DkIT OneDrive, which will also be password encrypted and accessible only to the researcher and supervisors of the project. A copy of the findings will be made available to you on request.
All information will be retained for as long as they are of continuing value to the research and once published all research data will be retained for a minimum of 7 years as per DkIT's policy on Research Record Maintenance. After this time, all information will be securely shredded, and data will be permanently deleted from the secure server.

Where can I get further information?
If you need any further information now or at any time in the future, please contact the researcher:
Name: Sarpong Hammond Antwi
Email: Hammond.Sarpong@dkit.ie
Mobile number: 0838166227

Sample Consent Form for Participants
Research project: River Basin Management Plan in Ireland: Past, Present and Future

I have read and understood the information provided about this research project. The information has been fully explained to me and I have been able to ask questions, all of which have been answered to my satisfaction.	**Yes** □	**No** □
I understand that if I agree to participation now that I can later withdraw or withdraw permission to use my data from the study at any time without providing any reason.	**Yes** □	**No** □
I have been assured that information about me will be kept private and confidential.	**Yes** □	**No** □
I understand that I can contact the researcher involved in the study to seek any further information or clarification about the study or about my personal information/soil samples.	**Yes** □	**No** □
I have been given a copy of the Information Leaflet and this completed consent form for my records.	**Yes** □	**No** □
I understand that under freedom of information legislation, I am entitled to access the information I have provided for any time while it is in storage.	**Yes** □	**No** □
Storage and future use of information: I give my permission for information collected about me to be stored or electronically processed for the purpose of research and to be used in related studies or other studies in the future but only if the research is approved by a Research Ethics Committee.	**Yes** □	**No** □

To be completed by the participant:

Please tick the appropriate box:

❒ **YES,** agree to take part in the project titled: An assessment of water demand trends and consumer attitudes to water and water conservation among group water schemes in the Republic of Ireland

❒ **NO,** I do not agree to take part in the project titled: An assessment of water demand trends and consumer attitudes to water and water conservation among group water schemes in the Republic of Ireland | |

Participant Name (Block Capitals) | Participant Signature | Date

To be completed by the researcher:

I, the undersigned, have fully explained to the above participant about the nature and purpose of the study in a way they could understand. I have explained what is required from the participant, and I have explained all risks and possible benefits associated with the study. I have invited them to ask any questions on the aspect of the study that involved or concerns them.

| |

Name (Block Capitals) | Signature | Date

Appendix A: Key Informants Interview on RBMP Governance in the Republic of Ireland

Dear Sir/Madam

Thanks for accepting to be part of this interview. The information provided will contribute significantly to understanding the governance and management challenges with the RBMP and lessons that can be drawn for the next plan from 2021-2027. All of your responses are confidential and will be used for the intended purposes only.

Thank you

The interview will begin with questions that will help inform the governance and management challenges with RBMP in Ireland

1. What have been the key challenges with the present RBMP in terms of water governance and management?
2. What have been the most significant successes?
3. What are the/your expectations for the next plan in terms of governance and management?
4. To what extent can Ireland meet the objectives of the WFD based on current progress?
5. Have the Sustainable Development Goals been considered or integrated under the current water governance systems in Ireland?

END OF QUESTIONS: Thank you for your time and response

Appendix B: Survey on Water demand trends and consumer attitudes to water and water conservation

Section 1: Background Information

1. What is your role on your Group Water Scheme (GWS)?
    1. Employed manager
    2. Voluntary manager
    3. Employed caretaker
    4. Voluntary caretaker
    5. Committee member

2. What is your gender? (Please state)

3. Where is your GWS located? (Select as appropriate)
    1. Carlow
    2. Cavan
    3. Clare
    4. Cork
    5. Donegal
    6. Dublin
    7. Galway
    8. Kerry
    9. Kildare
    10. Kilkenny
    11. Laois
    12. Leitrim
    13. Limerick
    14. Longford
    15. Louth
    16. Mayo
    17. Meath
    18. Monaghan
    19. Offaly
    20. Roscommon
    21. Sligo
    22. Tipperary
    23. Waterford
    24. Westmeath
    25. Wexford
    26. Wicklow

4. What is the source of water for your GWS?
    1. Ground water (ie. spring, dug-well, bore- well)
    2. Surface water (ie. river, lake)
    3. A mix of groundwater and surface water sources

Section 2: Water demand management

5. How important do you think water demand management (including Unaccounted for Water (UFW) reduction and water conservation) is to your GWS?
    1. Very important
    2. Important
    3. Slightly important
    4. Not important
    5. If you answered "important" or "very important" and your scheme is managing water demand, to what extent have the following factors prompted your focus on this area? (slide to answer for each factor)

7. To what extent have the following factors influenced your scheme's approach to managing water demand? (tick one option for each)

	Very important	Important	Slightly important	Not important
Policy/management of own GWS	❑	❑	❑	❑
Environmental awareness	❑	❑	❑	❑
EU policies	❑	❑	❑	❑
Policy of NFGWS	❑	❑	❑	❑
Extreme weather events/climate change	❑	❑	❑	❑
Vulnerability of source	❑	❑	❑	❑

8. What do you think was your scheme's average daily water demand in 2019? (please tick)

1. 5.1-25m3
2. 25.1-50m3
3. 50.1-100m3
4. 100.1-250m3
5. 250.1-500m3
6. 500.1-1000m3
7. >1000m

9. Is this higher or lower than daily demand in previous years, or has demand remained much the same? (please tick)

1. Higher
2. Lower
3. Much the same

10. If you answered "higher" or "much the same", which of the following might account for this? (tick as they apply)

1. Lack of interest on the part of the GWS board/committee
2. Lack of personnel to implement demand management even where it is GWS policy
3. Lack of finance to install demand management tools/measures
4. Lack of motivation for domestic consumers to reduce consumption
5. Lack of a charging policy for non-domestic consumers that encourages water conservation
6. Lack of national policy guidance
7. Lack of NFGWS guidance
8. Lack of training
9. Other (please type here) _____

Section 3: Tools/mechanisms informing daily water demand strategy

11. Is your GWS network mapped?

1. Yes
2. No

12. If you answered YES to the above question, can you indicate the mapping format?

1. A paper map
2. A digital map
3. Both paper and digital maps

13. Please select YES or NO to the following

	YES	NO
A. Is your GWS equipped with a bulk meter at the point of entry to the distribution network?	❑	❑
B. Is your GWS network organized into district metered areas (DMAs), with district meters and stop valves at the point of entry into each DMA?	❑	❑
C. Is there a meter on each individual connection	❑	❑

14. If your GWS has meters installed, which meters have telemetry to allow ongoing remote monitoring of flows in your GWS?

	All	Some	None
Bulk meter	❑	❑	❑
District meters	❑	❑	❑
Meters on consumer connections	❑	❑	❑

15. How regularly does your GWS monitor flow? (select answer for each)

	Constantly	Daily	Weekly	Monthly	Quarterly	Annually	Bi-annually	Never
A. through bulk meter at the point of entry into the distribution network	❑	❑	❑	❑	❑	❑	❑	❑
B. through district meters at the point of entry into DMAs	❑	❑	❑	❑	❑	❑	❑	❑
C. through the meters at individual connections	❑	❑	❑	❑	❑	❑	❑	❑

16. Do you take steps to distinguish Unaccounted for Water from excessive consumer usage?

1. Yes
2. No

17. Can you indicate the estimated percentage for both UFW and excessive usage the first time such an estimate was made or that step testing was completed? (please provide the answers)

	cubic metre (m3)	Percentage (%)
Unaccounted for Water (UFW)	❑	❑
Excess demand on metered connections	❑	❑

18. How important would you say that each of the following has been in informing the focus of your water demand management strategy? (please answer for all)

	Very important	Important	Slightly important	Not important
A water audit	❑	❑	❑	❑
A bulk meter at the point of entry into the distribution network	❑	❑	❑	❑
Establishing DMAs with district meters and SVs at the head of each one	❑	❑	❑	❑
Universal metering of consumer connections	❑	❑	❑	❑
Telemetry installed in the bulk meter and district meters	❑	❑	❑	❑
Step testing to determine UFW (including water loss on mains through leak and theft)	❑	❑	❑	❑
Mapping the distribution network (including all meters, valves and pipework)	❑	❑	❑	❑

Section 4: Addressing excessive demand on individual connections

19. Has your scheme ever completed a water audit to determine what its average daily water demand should be (i.e. its "theoretical" or "legitimate" water demand)?

1. Yes, by a professional
2. Yes, by our GWS person trained in water audit
3. Yes, by our GWS person with no water audit training
4. No, water audit undertaken

20. Is your GWS universally metered?

1. Yes
2. No
3. Don't know

21. Has your scheme taken any of the following steps to reduce water demand on the consumer side of the connection? (please answer for each option)

	Yes	No
Issued general water conservation advice to members	❑	❑
Encouraged the fitting of low flow plumbing fittings	❑	❑
Encouraged rainwater harvesting (for activities, such as toilet flushing, where potable water is not required to displace treated water tap water)	❑	❑
Issued advice to members when normal supply is threatened (e.g in times of drought)	❑	❑

22. If your scheme is not universally metered, do you still monitor daily water demand?

1. Yes
2. No

23. If YES, how often are individual consumers meters monitored?

1. On an ongoing basis using telemetry
2. At least once a month
3. At least once a quarter
4. At least bi-annually
5. At least annually
6. Only when excessive demand is suspected

24. If you have introduced consumer metering, what do you feel has been the trend in water demand since its introduction?

1. General increase in water demand
2. General decrease in water demand
3. No change in water demand

25. When excessive demand is confirmed due to monitoring, is the consumer informed without due delay?

1. Yes
2. No

26. How is this information communicated to the consumer?

1. Verbally (face-to-face or by telephone)
2. Written communication (in a letter, email or test message)

27. Please tick a YES or NO to the following

	YES	NO
A. In your experience, do consumers generally address leakage on their property when informed of it?	❑	❑
B. Does your scheme have a policy for dealing with consumers who fail to address leakage having been informed of it	❑	❑

28. Where excessive usage is suspected rather than leakage, is there a GWS protocol for dealing with this?

1. Yes

2. No

29. If YES, does the policy include direct engagement with the consumer?

1. No
2. Yes

30. How would you rate the effectiveness of these forms of engagement? (slide to answer for each option)

	Very effective	Effective	Less effective	Not effective
Verbal (either face-face or by telephone)	❑	❑	❑	❑
In writing (either via letter, email or text message)	❑	❑	❑	❑
A combination of verbal and written engagement	❑	❑	❑	❑

31. Which of the following are adopted by your scheme for consumers for whom leaks have been identified?

1. Help determine if the leak is outside or inside a building
2. Help to locate the leak
3. Fix the leak
4. Advise the consumer on how to establish the location of the leak
5. Advise the consumer to retain the services of a qualified plumber

32. As part of the engagement, would your scheme inform the consumer on what their demand ought to be, based on similar property and number of persons?

1. Yes
2. No

33. Is water conservation advice provided either to individual consumers or to the members in general, including the potential benefits of low flow plumbing fitting on showers and taps, low capacity toilet cisterns, turning off field troughs in winter, etc?

1. Yes
2. No

34. Is rainwater harvesting encouraged in new building / or as a retrofit to displace potable water for toilet use, farmyard washing and other situations where human health will not be compromised?

1. Yes
2. No

35. If you answered NO to either of the last two questions, can you indicate which of the following might best explain the reason?

1. Our daily water demand is low enough
2. We don't want to lose income from non-domestic members
3. We are unsure if there would be benefits to our scheme in encouraging members to install low-flow plumbing fittings or rainwater/greywater harvesting systems
4. Other (please type here) _____

36. Please provide an answer for the following

	YES	NO
A. Is water pricing used to incentivise water conservation by non-domestic members of the GWS?	❑	❑
B. Do you think excessive demand for consumer connections has generally decreased as a result of your water conservation efforts?	❑	❑

37. If a reduction in excessive demand on domestic and non-domestic metered connections has been achieved, can you indicate the importance or otherwise, of the following to achieving this? (answer for each option)

	Very important	Important	Not important
Metering (consumer connections)	❑	❑	❑
Water price increase	❑	❑	❑

Informing consumers of suspected leaks on the properties	❑	❑	❑
Awareness-raising including informing consumers when demand is unsustainable	❑	❑	❑
Others	❑	❑	❑

38. In your opinion, how aware are the members of your GWS of the need for/benefit of water conservation? (tick as appropriate)

1. Very aware
2. Aware
3. Somewhat aware
4. Unaware

39. Do you think there is a difference in attitude and perception towards water conservation between GWS management and consumers?

1. Yes
2. No

40. If there is a difference in attitude and perceptions, which consumers do you believe are most aware of the need for water conservation?

1. Domestic consumers
2. Non-domestic consumers
3. Similar awareness between domestic and non-domestic consumers

41. How responsive are your members to conservation advice during times when supply is threatened (e.g drought, freezing weather)?

1. Most are responsive
2. About half are responsive
3. A minority is responsive
4. None are responsive

42. Can you indicate the effectiveness of the following in encouraging water awareness in times of water shortage? (slide to answer for each)

	Very effective	Somewhat effective	Effective	Not effective at all
Verbal communication (face-to-face or telephone)	❑	❑	❑	❑
Written communication (letter, text, email)	❑	❑	❑	❑
A notice on local media	❑	❑	❑	❑
An NFGWS press release	❑	❑	❑	❑
An Irish Water press release	❑	❑	❑	❑
The announcement of a hosepipe ban on broadcasting media	❑	❑	❑	❑

43. Which of the following external stakeholders does your GWS engage with and to what extent? (answer for each)

	Frequently	Occasionally	Rarely	Never
Academic institutions	❑	❑	❑	❑
An Taisce	❑	❑	❑	❑
ASSAP	❑	❑	❑	❑
Department for Housing, Local Government and Heritage (DHLGH)	❑	❑	❑	❑
Environmental Protection Agency (EPA)	❑	❑	❑	❑
Geological Survey of Ireland (GSI)	❑	❑	❑	❑
Irish Water	❑	❑	❑	❑
LAWPRO	❑	❑	❑	❑

Local Authority	❑	❑	❑	❑
National Parks and Wildlife	❑	❑	❑	❑
NFGWS	❑	❑	❑	❑
Non-governmental organizations (NGOs)	❑	❑	❑	❑
Other local GWS	❑	❑	❑	❑
River Trust	❑	❑	❑	❑
Sustainable Water Network (SWAN)	❑	❑	❑	❑
Teagasc	❑	❑	❑	❑
Tidy Towns	❑	❑	❑	❑
Others (please type here)	❑	❑	❑	❑

44. Are you aware of the United Nations Sustainable Development Goals (UN SDGs)?
    1. Yes
    2. No

45. Which of the following has your scheme implemented to build resilience and reduce reliance on carbon-based energy sources? (selected as they apply)
    1. Completed energy audit
    2. Solar energy
    3. Wind energy
    4. Viable speed drive pumping
    5. Installation of a back-up generator or point connection such as a generation
    6. Water conservation
    7. Improved pressure management
    8. Other (please type here) _____

46. Do you have any other additional comments or suggestions you may like to make regarding water demand and water conservation within your GWS (Please type comment below)

Appendix C: Consumers Willingess to pay for water charges among GWS consumers

NFGWS/DKIT/WF SURVEY 2

Hello:You are invited to participate in this survey on Water consumption and conservation among Group Water Scheme members in the Republic of Ireland. This survey is a collaboration of the NFGWS, the Centre for Freshwater and Environmental Studies at DkIT and An Fóram Uisce. This survey will take approximately 20 minutes to complete. Your participation is completely voluntary and if you feel unable or unwilling to answer particular questions, just skip them. Your survey responses will be treated with strict confidentiality. If you have questions about the survey, you may contact Sarpong Hammond Antwi by email at Hammond.sarpong@dkit.ie Please start with the survey now by clicking on the button below

Section One: Demographic characteristics of respondents

1. What is your gender?
    1. Male
    2. Female
    3. Prefer not to state
    4. Other _____

2. What is your age? (this is optional)
    1. 18-24 year old
    2. 25-34 year old

3. 35-44 year old
4. 45-54 year old
5. 55-64 year old
6. 65-74 year old
7. 75-84 year old
8. 85 years and above

3. In which county is you GWS located? (Please select)

1. Antrim
2. Armagh
3. Carlow
4. Cavan
5. Clare
6. Cork
7. Derry
8. Donegal
9. Down
10. Dublin
11. Fermanagh
12. Galway
13. Kerry
14. Kildare
15. Kilkenny
16. Laois
17. Leitrim
18. Limerick
19. Longford
20. Louth
21. Mayo
22. Meath
23. Monaghan
24. Offaly
25. Roscommon
26. Sligo
27. Tipperary
28. Tyrone
29. Waterford
30. Westmeath
31. Wexford
32. Wicklow

4. What is the highest level of education completed? (optional)

1. Primary
2. Junior cert
3. Senior cert
4. Third level
5. Post-graduate
6. None

5. What is your employment status

1. Farmer, agricultural worker
2. Employed in a private company
3. Employed in a public company
4. Pensioner
5. Student/learner
6. Unemployed
7. Other (specify) _____

6. How many individuals live in your household?

1. 2
2. 3
3. 4
4. 5+

7. What type of dwelling are you living in?

1. Detached single-family house
2. Apartment/Flat
3. Terrace/Townhouse
4. Single Storey dwelling
5. Semi-Detached apartment/townhouse
6. Other (specify) _____

8. What is the tenure status of your dwelling?
    1. Owned outright
    2. Rent-free
    3. Own with a mortgage or a loan
    4. Rent from a landlord (including voluntary/co-operative body/occupied free of rent)
    5. Rented from Local Authority
    6. Other (Specify) _____
9. What is the total number of rooms in your house?
    1. 1 room
    2. 2 rooms
    3. 3 rooms
    4. 4 rooms
    5. 5 rooms
    6. 6 rooms and more
10. Does your house have any of the following? (select all that apply)
    1. Washing machine
    2. Dishwashing machine
    3. Outdoor Tap
    4. Bathtubs
    5. Backyard swimming pool
    6. Other (specify) _____
11. Do you have any of the following water saving and improvement device?
    1. Slow-flow showerhead
    2. Low-flush /dual flush toilet
    3. Water filters
    4. Reverse osmosis
    5. UV treatment
    6. Other

Section 2: Water consumption and quality

12. Is your household water supply connection metered?
    1. Yes - with a connected/working meter
    2. Yes – but the meter is not connected/not working
    3. Yes – but I don't know if the meter is working or not
    4. No
    5. I don't know
13. Do you know where your drinking water comes from?
    1. Local lake
    2. Local river
    3. Groundwater well
    4. Combination of sources
    5. I don't know
    6. Other (specify) _____
14. Do you drink water from
    1. Tap (without filter)
    2. Tap (with filter)
    3. Bottled water only
    4. Both from the tap and bottled sources
    5. Other (specify) _____
15. What do you think is your average household water usage per day?
    1. Less than 200 litres

2. 201-300 litres
3. 301-400 litres
4. 401-500 litres
5. 601-700 litres
6. More than 700 litres
7. I don't know

16. Rank from 0-10 how each of these factors influences your water consumption habits (0=irrelevant to the amount you consume,10=highly relevant to the amount you consume)

	Not at all important	Slightly important	Moderately important	Very important	Extremely important
Water quality	❑	❑	❑	❑	❑
Free domestic water allowance	❑	❑	❑	❑	❑
Information to water users on water supply problems	❑	❑	❑	❑	❑
GWS efforts to meet water needs in acceptable quality	❑	❑	❑	❑	❑
Number of family members	❑	❑	❑	❑	❑
House size	❑	❑	❑	❑	❑
Water consumption for outdoor areas use	❑	❑	❑	❑	❑
Rainfall	❑	❑	❑	❑	❑
Changes in temperature	❑	❑	❑	❑	❑
Sense of environmental – resources sustainability	❑	❑	❑	❑	❑
Cost/Price of water	❑	❑	❑	❑	❑

17. Evaluate from 0-10, what you perceive as the most significant pressures impacting your GWS water quality? (0=irrelevant to the amount you consume,10=highly relevant to the amount you consume)

	0	1	2	3	4	5	6	7	8	9	10
Landfills	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Slurry spreading run-off	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Increase in dairy herd numbers	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Pesticide usage	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
The presence of nutrients from farming activities	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Bankside erosion	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Abstraction for drinking water	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Climate change impact of available water	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Septic tanks	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Run-off from peat extraction operations	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Physical developments along with water bodies (hydromorphology)	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Excess sediment	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Pressures from forestry activities	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Other…(specify)	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑

18. Do you experience water quality warnings such as boil water notices on your GWS?
1. Often
2. Rarely
3. Never

19. How do you decide if your tap water is safe for drinking?
1. By look, taste and smell
2. By available water quality reports

3. By the environment around the water source
4. By communications from my GWS
5. I just presume it is safe to drink
6. Don't know
7. Other (specify) _____

20. Have you ever sought information relating to any drinking water supply issues you or your GWS have faced?

1. Yes
2. No
3. If NO please continue to section 3

21. If YES, to question 19, which is your preferred source of information?

1. Social Media (e.g. Facebook, Twitter)
2. TV
3. Radio
4. NFGWS Rural Water News Magazine
5. GWS Newsletter
6. Phone call with GWS representative
7. In-person conversation with GWS representative
8. Government Agency (e.g. Environmental Protection Agency or Government Department)
9. Friends/family/neighbour
10. None of the above
11. I have never sought information
12. Other (specify) _____

Section 3: Water availability and conservation

22. Which of these water conservation measures do you regularly undertake? (tick as they apply)

1. Turn off the tap when brushing teeth
2. Have showers that are less than 5 minutes
3. Have showers not baths
4. Use the half-flush on my toilet (if you have a dual-flush toilet)
5. Fix leaky taps and pipes as soon as they occur
6. Replace older shower heads with a water-efficient shower head
7. Purchase a low-water-use (typically front-loader) washing machine when the current one needs replacing.
8. Put a device in my single-flush toilet cistern to reduce flush by one litre.
9. Use a rainwater collection tank
10. Restrict garden watering to early morning or evening
11. None, I don't practice any water conservation measures
12. Other (please describe) _____

23. What do you consider when buying household appliances (example: power shower, dishwaters, washing machines) (tick as they apply)

1. Price
2. Energy efficiency
3. Colour
4. Water efficiency
5. None of the above
6. Other (please list them) _____

24. To what extent are you also aware of the United Nations Sustainable Development Goals (UN SDGS)?

1. Very much aware
2. Somewhat aware
3. Not aware
4. Don't know

Section 4: Sustainable water management and economic planning

25. What do you think of the quality of the water supplied to your household? (tick as they apply)

1. Very clean
2. Quite clean, we don't need to boil or treat it again
3. A little contaminated, we boil it for drinking
4. It varies, sometimes it is contaminated and then we boil it
5. Always contaminated

26. How much do you spend annually on water supply in your home? (Please provide answer in Euro)

27. Which of the following options do you think are priorities for improving water services in your scheme? (tick as they apply)

1. Construction of new water supply projects (e.g. water storage reservoirs & delivery network)
2. Drinking water quality improvements
3. Improvement in wastewater treatment and septic tank
4. Reducing water consumption through water conservation measures
5. Better metering system to provide improved data availability for both managers and consumers
6. Charges for water consumption per unit of volume used
7. Early detection and fixing of leakages
8. Stricter water conservation policies and legislation
9. Other (specify) _____

28. If you were asked to contribute € 50 annually towards the improvement of water services (e.g. water conservation and quality measures) for your GWS, would you?

1. Yes
2. No

29. If YES to question 28, would you be willing to increase that contribution to €100 annually?

1. Yes
2. No

30. If NO to question 29, would you be willing to contribute €25 annually?

1. Yes
2. No

31. Which other action do you think could encourage water conservation and improve water quality? (rank as they apply)

1. Water conservation messages from Local Group Water Scheme
2. Stricter water conservation policies and legislation
3. Subsidies to encourage the purchase of more water-efficient technology
4. Higher rates on excess allowance are based on how much an individual or business is using.
5. Real-time information and data on your household water consumption
6. Radio/ TV or social media campaign
7. Others (please list them)

8. Other (specify) _____

Appendix D: Survey with GWS representatives

1. What is the current number of total connections in your GWS? (please provide answers)
How many are Domestic connections? How many are Non-Domestic?
2. What is the total number of people you serve under your GWS? (please provide answer)
3. Has your GWS carried out a research and innovation activity in the last two years? If YES, can you name that?
4. How many reports about leakages do you record per year?
5. Is your Unaccounted-for-Water (UFW) below 25%?
   1. Yes
   2. No
6. If YES, to Question 5, what accounted for the decrease in UFW in your scheme? If No, to Question 5, what accounted for this level of UFW in your scheme?

7. Which users in your scheme tend to consume the greatest volume of water? (Rank in order of usage from 5 (Highest)-to 1 (lowest) as they apply to your GWS)
   - Farmers _____
   - Households _____
   - Schools _____
   - Businesses _____

Other (specify) _____8. How frequently does source protection appear on the agenda for GWS committee meetings?'
   1. Very often
   2. Often
   3. Rarely
   4. Not at all

9. Which of the following have at some point caused contamination to the water supplied by your GWS? (please select as apply)
   1. Landfills
   2. Slurry spreading run-off
   3. Increase in dairy herd numbers
   4. Pesticide usage
   5. The presence of nutrients from farming activities
   6. Bankside erosion
   7. Septic tanks leakages
   8. Run-off from peat extraction operations
   9. Physical developments along water bodies (hydromorphology)
   10. Excess sediment
   11. Pressures from forestry activities
   12. None

Other (Specify) _____
10. What actions have been taken to prevent the identified contaminates? (please provide answer)

11. Has your GWS undertaken any of the following climate-related actions relating to water demand management?'
   1. Encouraged on-farm water storage and water harvesting
   2. Implementation of pressure management and active leakage control.
   3. Catchment management to reduce polluting run-off

4. Regulation on water usage during drought
5. Communication on climate change and water availability
6. Enhanced infrastructure development and expansion
7. Other (please specify)

12. Has your GWS undertaken any of the following biodiversity-related actions in the last two years?

1. Invasive species management.
2. Increased number of trees, especially around water bodies
3. Organised a local biodiversity day
4. Promoted the use of nature-based solutions for water protection
5. fundraising exercise to support water conservation efforts

Other (specify) _____

13. What energy-saving engagement in water supply has been undertaken in the last two years?

1. Installation of solar panel to reduce dependence on fossil fuels.
2. Installation of power-generating Pump as Turbine (PAT) on network
3. Use of Solar energy in water abstraction
4. Water Treatment
5. Use of solar energy in controls (programmable thermostats).
6. Efficiency planning
7. Natural Gas savings
8. Other (specify) _____

14. Has the increase in the national government's support towards providing a substantial 'free' domestic water allocation led to an increase in water demand and a change in public attitudes to their water supply?

1. Yes
2. No

15. Has domestic water demand increased since 2018? If so why?

16. Do you have a drought management plan for your scheme?

1. Yes
2. No

17. Do you have an emergency management plan describing procedures for handling water emergencies during periods such as drought?

1. Yes
2. No

18. If NO, to question 17, do you have a schedule and timetable for developing an emergency/drought management Plan?

1. 6 month
2. 6-12 months
3. 2 years
4. 5 years
5. 10 years

19. What is the estimated annual water conservation effort costs including personnel cost in your scheme?

1. €500-€1000
2. €2000-€3000
3. €4000-€5000
4. €6000-€7000
5. €7000-€9000
6. €10000 and above

7. Other (specify) _____

20. What is the funding source(s) for these efforts? (please provide an answer)

21. If NO, do you have a schedule and timetable for developing a written conservation program?
    1. Yes
    2. No

22. Do you conduct an annual water audit of your system?
    1. Yes
    2. No

23. If YES, when was the last water audit performed?

24. How frequently do you conduct a full leak detection program for your distribution system?
    1. Every year
    2. Every two years
    3. Every three years
    4. Four years or more

25. Do you provide educational literature about the installation of water-saving devices and water conservation savings to scheme members?
    1. Yes
    2. No

26. Do you have a public education plan on water conservation?
    1. Yes
    2. No

27. If YES which of these items are included in your outreach program.
    1. Targeted outreach to the largest water users
    2. Water conservation curriculum for schools
    3. Public service announcements or announcements in other media
    4. Water conservation workshops for the general public.
    5. Multilingual materials (English and Irish).
    6. None of the above
    7. Other (specify) _____

28. Does your water supply system provide water to significant agricultural users?
    1. Yes
    2. No

29. If YES, do you have a program to assist agricultural users in conserving water?
    1. Yes No

30. Assign a value from 0-10 to indicate the priority you assign to the following factors as future policies for your GWS (0=low,10=high priority)

	0	1	2	3	4	5	6	7	8	9	10
Immediate response of the GWS managers when leakages and other anomalies occur	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Application of an appropriate pricing policy for excess usage	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Maintenance – necessary network & reservoirs updates	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Monitoring – checking the network for losses	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Investments in wastewater treatment Plants	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Use of water-saving/filtering devices	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Consumers' information and education	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑

Training personnel	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
Instilling a sense of environmental resources sustainability within your consumers	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑

Appendix E: Key Informant Interview on Water and Climate change in the Republic of Ireland

1. What do you think is the public perception of climate change in Ireland?
2. Is climate change a different topic for debate because it is political?
3. To what extent does climate change feature in economic discussions in Ireland?
4. Are there some challenges with reporting climate change (i.e. drought, water quality) in Ireland as a journalist/policymaker?
5. How do we ensure climate change and science news are reported in the public interest?
6. With the signing of the Paris climate agreement, do you think it can influence Ireland's climate policies

Appendix F: Stakeholder Interviewee Institutions

Institute of Public Administration
Irish Creamery Milk Suppliers Association
Irish Farmers Association
An Taisce
An Fóram Uisce | The Water Forum
Irish Water
Sustainable Water Network
Agricultural Sustainability Programme
National Federation of Group Water Schemes
Department of Housing, Planning and Local Government
The Local Authority Waters Programme
Environmental Protection Agency
University College of Dublin
Irish Examiner
Irish Independent
Irish Times
Fianna Fail Party
Maigue River Trust

About the author and overview of dissemination

The Author

Sarpong Hammond Antwi, is a native of Boukrom in the Ashanti Region of Ghana. He obtained his Bachelor's degree in Integrated Community Development from the University for Development Studies in Wa in 2016. He subsequently pursued a Masters degree in Energy Policy at the Pan African University Institute of Water and Energy Sciences in Tlemcen, Algeria, graduating in September 2019. In October 2019, Hammond commenced his doctoral studies at the Centre for Freshwater and Environmental Studies of Dundalk Institute of Technology, funded by the Irish Research Council Landscape programme. His research focused on water resource governance and management, with a particular interest in the Group Water Schemes (GWS) sector.

Under the supervision of Dr Suzanne Linnane, Dr David Getty, and Dr Alec Rolston, Hammond evaluated water conservation measures and the willingness of GWS consumers to pay for water services. He also drew insights from past events in the Republic of Ireland to examine how they impact sustainable water supply and availability in the future. Hammond was awarded a research bursary by An Fóram Uisce to undertake a study on communicating water availability during drought periods in the country. During his three years at DkIT, Hammond authored six research papers, two book chapters, a policy brief and a technical report. He presented his work at several national and international conferences and received recognition for his research contributions. In addition to his research activities, Hammond volunteered for the Louth Volunteers' Society and served as a board member for the Louth Employability Services. He also represented the Republic of Ireland on the Island Innovation Program and currently holds the role of a Climate Ambassador for the country. In addition, Hammond represented postgraduate students on the Graduate Research Studies Board (GRSB) at Dundalk Institute of Technology for two academic years, demonstrating his commitment to academic excellence and leadership. In 2023, Hammond commenced a post-doctoral research position at TU Delft in the Netherlands, where he continues to expand his research and explore new avenues of interest in Water-Energy-Climate nexus.

Overview of dissemination

Scientific articles related to this dissertation

Published

1. Antwi, S.H, Rolston A, Linnane, S, Getty, D, Slinger, H. J (2023). A historical perspective on water governance in The Republic of Ireland, *International Journal of Water Governance 10*(1). https://doi.org/10.25609/ijwg.10.2023.6486
2. Antwi, S. H., Getty, D., Linnane, S., & Rolston, A. (2021). COVID-19 water sector responses in Europe: A scoping review of preliminary governmental interventions. *Science of The Total Environment*, *762*, 143068. https://doi.org/10.1016/J.SCITOTENV.2020.14306
3. Antwi, S. H., Linnane, S., Getty, D., & Rolston, A. (2021). River Basin Management Planning in the Republic of Ireland: Past, Present and the Future. *Water 2021, Vol. 13, Page 2074*, *13*(15), 2074. https://doi.org/10.3390/W13152074
4. Antwi, S. H., Rolston, A., Linnane, S., & Getty, D. (2022). Communicating water availability to improve awareness and implementation of water conservation: A study of the 2018 and 2020 drought events in the Republic of Ireland. *Science of The Total Environment*, *807*, 150865. https://doi.org/10.1016/j.scitotenv.2021.150865

Work in Progress

- Antwi, S.H, Getty, D, Linnane, S, Rolston, A, Róisín, S. (2022). Water Demand and Usage trends among Group Water Schemes in the Republic of Ireland: Implication for Water Conservation. *IWA Aqua (Under Review).*
- Antwi, S.H, Getty, D, Linnane, S, Rolston A (2022). Willingness of consumers to pay for water services: A case study of Group Water Schemes. *Technology in Society (Under Review).*

Policy Brief

Antwi, S. H., Rolston, A., Linnane, S., & Getty, D. *(2021).* Communicating water availability to improve awareness and implementation of water conservation in the Republic of Ireland
Commissioned by An Fóram Uisce | The Water Forum (2021).

Technical Report

Survey analysis on drinking water demand trends and consumer attitudes to water conservation in Ireland's GWS sector. Commissioned by the National Federation of Group Water Schemes (2020).

Conference presentations related to this research

1. "The implication of communication on consumers' willingness to pay for water services in the Republic of Ireland" Virtual Poster Presentation delivered at the 3rd IAHR Young Professionals Congress, organized by The International Association for Hydro-Environment Engineering and Research (IAHR), 28th November 2022 - 2nd December 2022.
2. "Communicating Water Availability to Improve Water Conservation" Poster Presentation delivered at Chapman Conference on Solving Water Availability Challenges through an Interdisciplinary Framework, hosted by the American Geophysical Union, at Colorado School of Mines, USA, 12th -16th September 2022.
3. "Water Governance Reforms in the Republic of Ireland: A historical perspective toward Sustainable Water Future" Oral Presentation delivered at ENVIRON 2022 Conference: 32nd Irish Environmental Researchers Colloquium, hosted by Ulster University, Northern Ireland, June 20th-22nd 2022.
4. "Communicating Water Availability to Improve water Conservation" Poster Presentation delivered at The Netherlands Centre for River Studies Conference 2022, hosted by The Netherlands Centre for River studies (NCR) at TU Delft, Rotterdam 13th-14th April 2022.
5. "Communicating Water Availability to Improve Water Conservation" Oral Presentation delivered at Water Summit for Global Development 2022 hosted by TU Delft, Rotterdam, Netherlands, 15th March 2022.
6. Potsdam Summer School on Water: Our Global Common Good – The Hydrosphere across Land and Sea jointly organized by the Institute for Advanced Sustainability Studies (IASS), and the University of Potsdam, Germany. July 9th-20th 202.
7. "Water Management and the Sustainable Development Goals in the Republic of Ireland: Perspective and knowledge of Stakeholders" Presentation delivered at Delft International Conference On Socio-hydrology hosted by TU Delft, Rotterdam, Netherlands, September 6th-8th 2021.
8. "Socio-Economic Assessment of Water Governance and Management Legislations in Ireland," Poster Presentation delivered at ENVIRON 2020 Conference: 30th Irish Environmental Researchers Colloquium - Jointly hosted by ESAI & DCU Water Institute, Ireland, October 20th - 22nd, 2020.
9. "Climate Change Justice: The role of the Youth". Virtual Presentation at Global African Congress Annual Congress, UK, June 5th 2021.
10. "Climate Change and Migration". Virtual Presentation delivered at St. Francis' College, Hertfordshire, UK, June 15th 2021.
11. "The Impact of COVID-19 on Energy and Water Access: An African Perspective". Virtual Presentation delivered at Leaders of African Technology and Renewable Energy Hangout. Hosted virtually by Leaders of Africa, USA, January 26th 2021.

ABSTRACT

The recent restructuring of water governance in the Republic of Ireland has attempted to facilitate a more integrated national approach to managing Ireland's water resources. Changes include the establishment of Uisce Éireann, the introduction and subsequent repeal of charges for water and wastewater services, and alteration in governance processes through the second River Basin Management Plan, in addition to the Group Water Scheme's (GWS) role in water supply and management in Rural Ireland. These changes have become necessary due to a variety of factors, including demographic growth, legislative instruments, agricultural activities, and land-use changes. In addition, climate change has become a catalyst for continuous variations in the hydrological cycle, leading to extreme meteorological and agricultural droughts that ultimately affect water availability. To investigate the impacts of these changes on water resource management, this research uses a descriptive, concurrent mixed-method approach and research lenses to examine the historical antecedents, current state, and future prospects of water governance and management practices in the Republic of Ireland. This research is the first-known assessment of changes in water governance and practices in water-rich Ireland over the last seven decades, highlighting significant events and preparedness for future challenges. The research findings contribute to the broader knowledge of water governance and management by addressing identified gaps and making recommendations for improvement. The findings have implications not only for the Republic of Ireland but also for other countries striving for a sustainable water future.


Twitter
Hosepipe
Pollution
Adaptation
Newspaper
Future
Demand
Rural Era
WFD
NWRP
Strategy
Scarcity
Facebook
An Fóram Uisce
Mitigation
Supply
Equity
Access
Legislation
Landuse
Socio- Economic
Analysis
Practice
Perception
Quality
Practice
Twitter
Votes
Nitrate
Trust
Media
GWS
Adaptation
Case Study
Demographic
Management
Access
Adaptation
Farming
Elections
Quality
WPAC
Engagement
Political
Engagement
Media
Catchment
RBMP
Newspaper
ASSAP
Governance
GWS
Rural Era
Adaptation
EPA
Resilience
Policy
Catchment
Biodiversity
Landuse
Awareness
RBMP
LAWPRO
GWS
Management
WFD
WPAC
Schemes
Perception
Compliance
Nitrate
Strategy
Case Study
Political
Sustainability
Charges
Sentiments
Drought
Climate Change
EPA
Farmers
Equity
Policy
RBMP
Trust
Conservation
Vulnerability
IWRM
EU
Quality
IWRM
Supply
Farmers
Farming
Votes
Governance
Implication
Media
Votes
Nitrate
Evolutions
Votes
ASSAP
RBMP
Elections
Interviews
WFD
ASSAP
Demand
Equity
Leakages
Future
EPA
Political
Charges
Equity
Awareness
Interviews
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Externalities
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Practice
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EU
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NWRP
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Evolutions
Strategy
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Compliance
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Reactive attempts
Policy
Round Theory
Emission
IWRM
Access
Integration Era
Stakeholders
Phosphorus
Adaptation
Analysis
Three-tier structure
Literature Review
IWRM
Agriculture
GWS
Rainfall
Legislation
Infrastructure
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Supply
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