Irish Geography
Vol. 56, No. 2 May 2023
DOI: xxxxxxx

Geographical Society of Ireland
An Cumann Tíreolaíochta na hÉireann

Profiling efforts to establish voluntary stewardship in a river catchment

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Received: February 28 2024 *Accepted: June 5 2024.*

Abstract: River water quality in Ireland is in decline. The Maigue River in County Limerick exemplifies this decline with degrading chemical and ecological water quality. The most significant pressures are agriculture, and to a lesser extent, hydromorphology, and discharges from urban and domestic wastewater systems. Because human activity is a main source of pressure on riverine systems and natural habitats, improving water quality rests partly on increasing local community interest, involvement, and cooperation in water and catchment management initiatives. This study profiles efforts made to foster engagement with residents of the Maigue River catchment where a devastating pollution event in 2014 precipitated the formation of a community water group that increased public involvement in initiatives focused on river water quality and biodiversity. Most of these initiatives would not have been possible without the individual attributes of local participants, an organisational structure (Maigue Rivers Trust), a champion (Project Officer), and supporting funds, training, and resources. These bottom-up efforts demonstrate that voluntary engagement supported by core funding helped further the public participation aims of conservation legislation (Water Framework Directive and River Basin Management Plans) and expanded catchment stewardship. However, future sustainability, with meaningful improvements in water quality, requires time, a functioning structure, and adequate resources, as part of a coherent integrated catchment management approach, if trusting relationships with local communities are to be developed and maintained.

Keywords *Water quality, community engagement, citizen science, catchment management, Rivers Trust*

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Introduction

Rivers are natural resources that are at risk of pollution, over-exploitation, and unsustainable use. Good quality fresh water is essential for life and human health, yet nationally, and locally in Ireland, river water quality is in decline (EPA 2022). The EU Water Framework Directive (WFD) mandates that Member States utilise their River Basin Management Plans (RBMPs) and Programmes of Measures (PoMs) to safeguard and, when necessary, restore water bodies to attain good status (chemical and ecological) and prevent any deterioration. Integrated catchment management (ICM) is the nationally and internationally recommended approach to ensure good water quality and meet the objectives set out by the WFD. ICM is the approach prescribed nationally and internationally to best achieve good water quality and the Water Framework Directive (WFD) objectives (Daly *et al.,* 2016). ICM focuses on a river basin scale to include the complex hydrological and ecological interactions as well as the political, socio-economic, and cultural influences that impact on water quality. Water management, with stakeholder and community engagement is compromised in Ireland as there is no coherent national water/ICM-focused community engagement framework or policy (Rolston *et al*., 2017; O Cinnéide *et al.,* 2021).

There are generally four groups involved in catchment management: stakeholder regulators; professional stakeholder organisations; local stakeholder organisations; and members of the public (Orr *et al.,* 2007). The first two take a 'top-down' approach in implementing frameworks, directives and regulations from the European Union habitat and water protection laws, whereas the latter two take a 'bottom-up' community-based approach to natural resource management (Dublin Statement, 1992). Strictly top-down approaches often lead to poor outcomes in terms of water resource management, and only a genuine integration of both the top-down and bottom-up approaches has the potential to achieve the goals of ICM and the objectives of the WFD (Giordano and Shah, 2014; Ballinger *et al.,* 2016). Advocates of social learning or 'learning together to manage together' emphasises collaboration between the different stakeholders, starting at the earliest possible moment in the process (Mostert *et al.,* 2008).

Implementation of the WFD has proved challenging in the Republic of Ireland in terms of engaging active, meaningful public participation and has been questioned particularly in relation to inclusiveness and representativeness (Antwi *et al.,* 2021; Irvine and O'Brien, 2009). There was a low response rate to public consultations in the first RBMP cycle (2009-2015), and according to Irvine and O'Brien (2009), potential reasons included inadequate mechanisms and resources for the process, and ultimately scepticism at the value and authenticity of the exercise.

The second RBMP cycle (2018-2021) saw the emergence of new governance structures (policy, technical and participatory) focusing on increased communication, stakeholder engagement and public participation (Rolston *et al.,* 2017; Antwi *et al*., 2021). At national level, the Water Policy Advisory Committee provides high-level policy direction and oversight of the implementation of the RBMP, while the EPA provide technical implementation and reporting. As part of this new structure, the Local Authority

Waters Programme (LAWPRO) was established in 2016, tasked with coordinating public participation at regional and local levels (O Cinnéide *et al*., 2021). LAWPRO works with a wide range of groups across the capacity spectrum including individuals, informal and formal (e.g. Tidy Towns) community groups and established catchment focused River Trusts and Associations. A second element of LAWPRO, the Catchment Assessment Team, focuses on measures to improve water quality in 189 priority areas (LAWPRO, 2021). Additionally, the establishment of a Community Water Development Fund (CWDF) has provided important financial support for communities to become active in water quality protection (Osawe *et al.*, 2023). A number of community-led Rivers Trusts (a UK model), also emerged during the second RBMP cycle, and as of 2019 17 trusts were established across the island of Ireland (EPA Catchments, 2019). A partnership agreement was signed between the Rivers Trust and LAWPRO, and an All-Ireland Rivers Trust Director was appointed (O Cinnéide *et al.,* 2021).

An Fóram Uisce (The Water Forum) was established in 2018 as a statutory body that represents and bridges stakeholders in water-related matters and policy. The Forum interacts directly with various stakeholder bodies across the local, regional and national tiers of governance of Ireland's RBMP. An Fóram Uisce is composed of 26 stakeholder members from 16 different sectors (e.g. Sustainable Water Network, Irish Farmers Association, Rivers Trust). An Fóram Uisce advises the Minister on national water policy and management.

A wide range of people and entities now populate the landscape of community engagement with water in Ireland including LAWPRO community water officers, catchment management associations, Rivers Trusts, informal community groups (Weiner *et al.,* 2022). Additionally, non-governmental organisations (NGOs) and European Innovation Partnership (EIP) projects are actively pursuing water restoration goals. Supports are available to volunteer groups via local development companies, the Sustainable Water Network (SWAN), the I-Catch training network and the Rivers Trust Network Support Service, thus making for an increasingly busy landscape of local water governance and engagement.

Maximising the potential of local knowledge and data collection with citizen science is an increasingly popular tool for capacity-building, increasing public engagement, and bridging society, science and policy efforts (Richter *et al.*, 2018; Haklay, 2015). Citizen science is a form of public participation that engages non-scientist volunteers in collaborative scientific investigations, thereby providing professional researchers with access to localised data at extensive spatial and temporal scales that would otherwise be impossible or prohibitively expensive to obtain (Dickinson *et al.*, 2012). For example, researchers can learn of the presence of rare or invasive species, gaps, patterns, relationships, and trends in climate, habitats, or ecosystems (Bonney *et al.*, 2009; Williamson *et al.*, 2016). There are generally three citizen science models: those designed by scientists where trained volunteers collect data, collaborative projects that are designed and refined by volunteers, and co-created projects that involve volunteers at all stages (Bonney *et al.*, 2009; Tweddle *et al.*, 2012). In terms of geographic scale, these

can vary depending on whether they are broadscale and purely computer-based versus those that require active data collection at local or community scale, such as sampling and identifying aquatic macroinvertebrates or collecting water samples for laboratory analysis. This will also depend on the goal of the project and on the data gap that needs to be filled, whether it is catchment-based, national, global, or related to a particular community or river. A range of citizen science initiatives for water are summarised in Weiner *et al.* (2022) and Kelly-Quinn *et al.* (2022), spanning from gamified digital data collection to person-led field-based efforts.

This paper profiles the efforts made to establish a river community group and foster public engagement with a river catchment at risk of further degradation. Consideration was given to legislative recommendations, as well as the aspirations of the local community in the context of ICM. The paper also seeks to evaluate how far this engagement has furthered the public participation aims of the WFD, the RBMP and conservation legislation. Key questions asked are: 1. Where do community-level aspirations fit within an ICM model? 2. Can citizen science data collection fulfil community-based ICM aspirations? and 3. Who provides expert guidance to communities?

Methods

The Maigue Catchment

The Maigue River catchment has a land area of 1122 km^2 and encompasses 1296.7 km of river channel with six main sub-catchments including the Loobagh, Morningstar, Drumcomogue/Camogue, Clonshire/Grenagh, and Barnakyle as well as the Maigue itself (Figure 1). The third cycle of the RBMP (2022 to 2027) characterised the catchment waterbody (45 rivers) status as follows: 34% poor, 43% moderate, 23% good, and 0% high (epawebapp.epa.ie/qvalue**)**. Degraded water quality is primarily associated with nutrient overload caused by agricultural pollution and, to a lesser extent, channel modifications, urban wastewater discharge and leaks from poorly-maintained rural septic tanks.

Community Engagement

A pollution event occurred in the Maigue catchment in 2014 when 70,000 gallons of slurry leaked into a headwater river and resulted in an extensive fish kill over several kilometres. This catastrophic event was the catalyst for the establishment of a community water group. The Maigue Rivers Trust (MRT) is a registered charity and includes a range of voluntary directors representing a range of social, economic and environmental interests (education, community, finance, amenity, business, research, farming, angling, and conservation) to help protect and enhance the rivers of the Maigue catchment. Since its launch in 2016, the MRT has endeavoured to foster and increase community interest and engagement with the catchment rivers and streams. The range of MRT activities and events were collated according to the date of occurrence, and the number of attendees, and were classified according to the type of engagement (participation, communication, consultation, and research) (Table 1).

The Department for Housing, Planning and Local Government provided the first core funds (100% in year 1, 66% in year 2; 33% in year 3) for staffing volunteer-led community water groups in 2019. This initiative was titled the Resilience Pilot Project and focused on just two Rivers Trusts in Ireland (Inishowen, Donegal and Maigue, Limerick). The appointments began in 2020 and the intention of the initiative was to support active community-based groups to achieve sustainability as water quality actors and inform future community engagement initiatives.

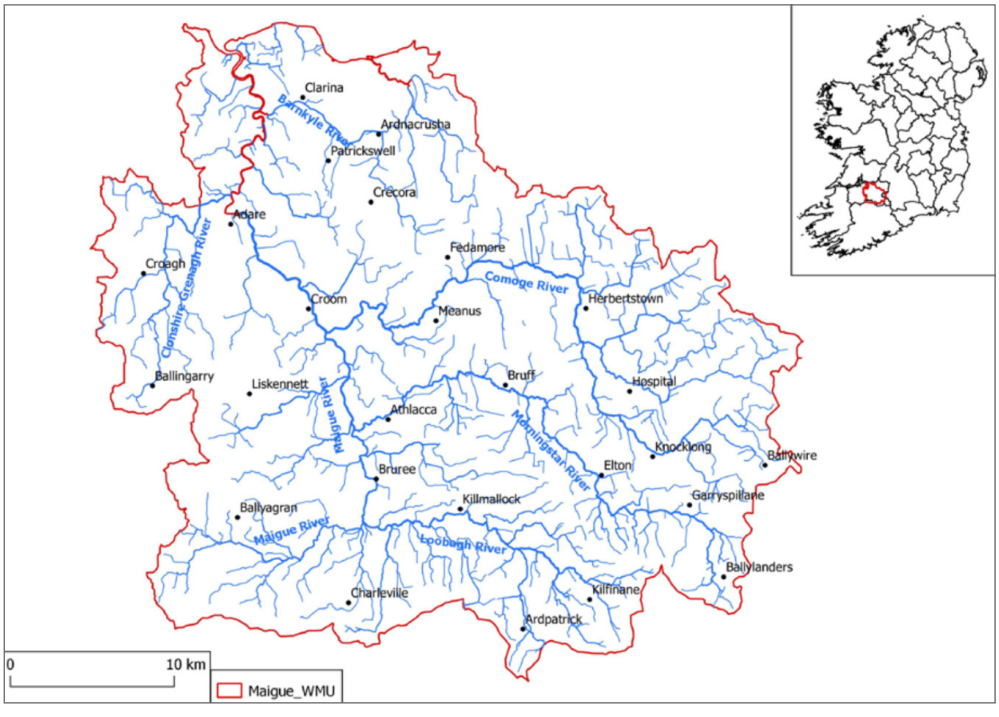

Figure 1: Location of Maigue catchment with river network and towns.

A range of River Trust public membership models were examined by the MRT. First a network model was explored for sectoral interests (e.g., education, farming, recreation) with consideration of member group nomination and rotation procedures. Other membership models with various categories (e.g., community groups, businesses, individual supporters, volunteers) were also examined for a range of UK rivers trusts (West Country, Wye and Usk). Benefits of membership models can include educational and training opportunities, insurance cover during organised events, and voting rights with nominal membership fees for full and associate members. In the end, no membership model was adopted. A simple expression of interest section was added to the MRT website page, while the appointment of a project officer subsequently afforded opportunities for individual engagement and recruitment.

Volunteers and Citizen Science

When MRT directors reviewed Rivers Trust membership models, it was noticeable that citizen science initiatives featured prominently. Citizen science was subsequently adopted to stimulate connections and interest in the river and potential volunteers and members of the MRT. A collaboration between the MRT and an EPA and Mary Immaculate College funded postgraduate project explored the potential of utilising citizen science in the Maigue river catchment. The project, entitled Citizen Science Investigations – River Environmental Stewardship (CSI-Rivers), included a catchment-wide social survey that was intended to collect data on the concerns, perceptions and opinions of the catchment residents, as well as to stimulate potential interest in river observation and monitoring (Weiner, 2024).

Table 1: Public participation, communication, and consultation categories

Participation	Communication	Consultation	Research
Fun Activity Citizen Science Field Sampling Training Demonstrations	Public talks Newsletters Promotion Material Education Material Social Media Public Meetings	Public Consultation Collaboration Funding Applications Individual/landowner meetings	Field surveys Research Reports Placement Students Works

In addition to the array of MRT public outreach activities, a range of citizen science initiatives were trialled in the Maigue River catchment, to stimulate interest in the catchment rivers and gather data on the potential for Maigue citizen stewards. The Small Streams Risk Score (SSRS), Small Stream Impact Score (SSIS), and Citizen Science Stream Index (CSSI), were used to evaluate river biology, while the Freshwater Watch (FWW) focused on chemistry and physical parameters. The SSRS was developed in 2006 by the Environmental Protection Agency (EPA) and the Western River Basin District (WRBD). The system helps detect significant sources of diffuse waterbody pollutants by measuring the abundance of sensitive taxa of aquatic macroinvertebrates to determine the water quality in river tributaries (McGarrigle, 2014). Volunteers are trained to collect specialist data using approved, standardised methods. The SSIS was developed in 2020 by University College Dublin in collaboration with the EPA and LAWPRO and is also an approved method of measuring water quality using macroinvertebrates in small streams (Kelly-Quinn *et al.*, 2022). The CSSI, also known as the traffic light system, was developed by practitioners and researchers in University College Cork, and is promoted by LAWPRO and supported by the EPA (https://lawaters.ie/citizen-science/). The CSSI is suitable for beginners as it simplifies macroinvertebrate identification to recording the absence or presence of six key macroinvertebrate taxa (flat mayfly nymph, stonefly nymph, green caddisfly larvae, leeches, snails, and blood worms) (McSorley, 2022). FWW, developed by Earthwatch Europe (www.freshwaterwatch.org), includes a monitoring kit supported

by a web portal and mobile phone application to record and analyse water quality data (e.g., nitrates, phosphates, turbidity, and colour) from lakes, rivers, and streams. Citizen scientists take water samples from the river, analyse the data themselves, and record the measured results based on a colour range.

Results

Communication and Participation

Most of the Maigue Rivers Trust activities since 2016 have centred around creating opportunities for public participation and communicating its work. These outreach activities have included in-person and online meetings, public talks, demonstrations, training, kayaking events, workshops, festivals, and media, social media campaigns and data gathering. There were 37 funding applications (for example, LEADER, Limerick City and County Council, Environmental Partnership Fund, CWDF) (Figure 2), of which there was a 60% success rate. The predominant activities included funding applications, project officer meetings with individual landowners, businesses and interested individuals, and public talks to a range of community groups (e.g., IFA, ICMSA, Tidy Towns, angling clubs). Also, research reports and annual newsletters were produced.

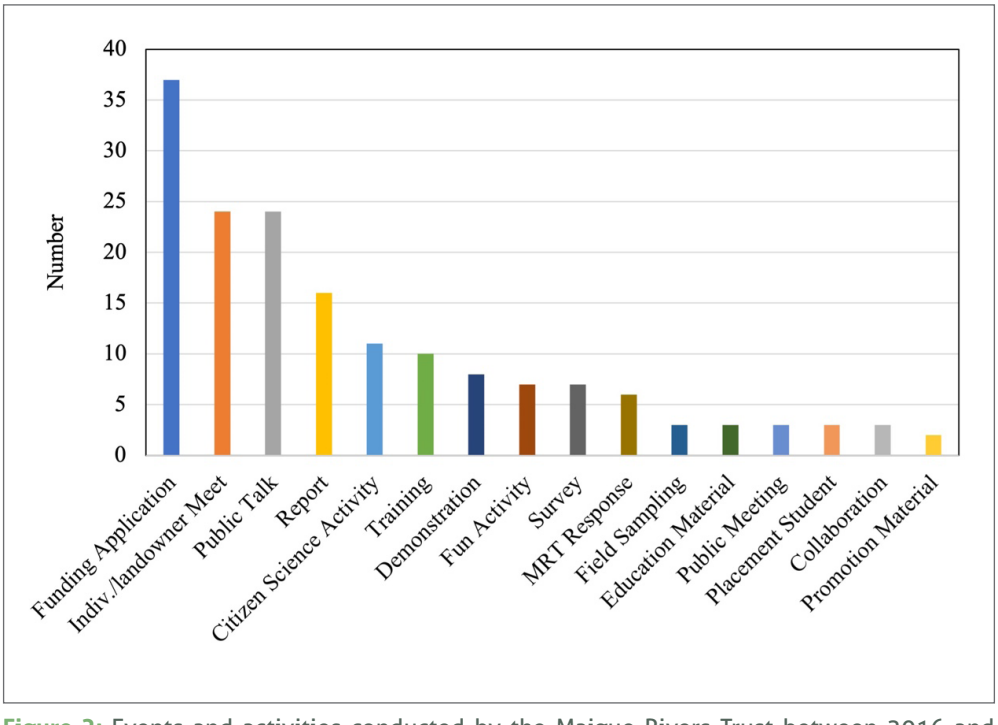

Figure 2: Events and activities conducted by the Maigue Rivers Trust between 2016 and 2022.

The number of Maigue Rivers Trust events and activities increased every year between 2016 and 2022 (Figure 3), except during 2020 due to the impact of COVID-19. The number of activities tripled following the appointment of a project officer in 2019.

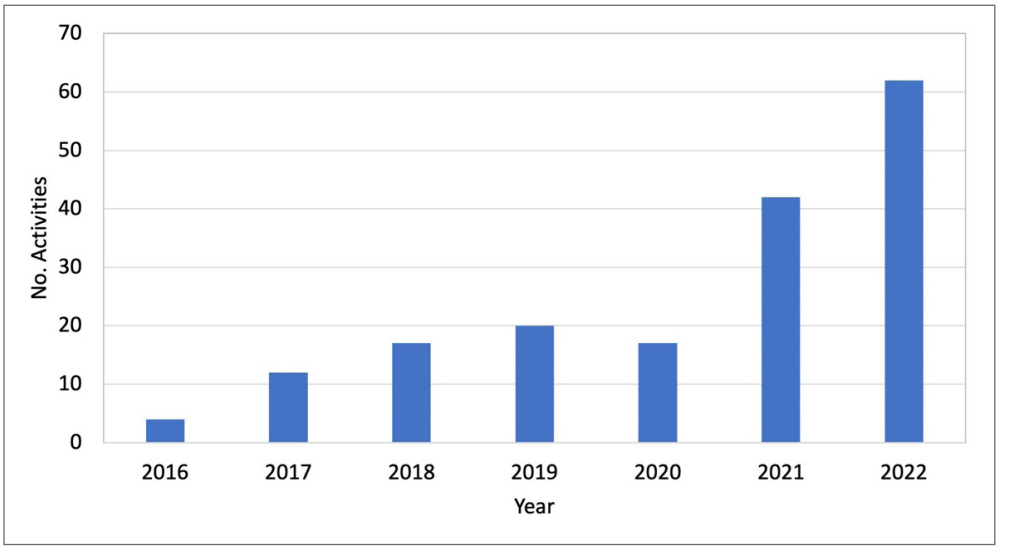

Figure 3: Number of Maigue Rivers Trust events and activities between 2016 and 2022.

A range of efforts to identify and recruit potential catchment volunteers included social media campaigns, website appeals and enlistment of individuals at public events and activities. Efforts were made to interest individuals in the health of rivers as well as river and riparian zone biodiversity at public talks, demonstrations, fun activities, and public meetings. The demonstration events were organised across the catchment from 2019 and reached approximately 1,800 people. Each event and activity highlighted public safety and strict biosecurity measures were put in place as an awareness raising and educational opportunity. Alien invasive species Giant Hogweed (*Heracleum mantegazzianum*) and crayfish plague (*Aphanomyces astaci*) are present in the Maigue catchment and river and talks, and demonstrations focused on best practice and how to avoid contact with these hazardous alien invasive species.

Citizen Science

Training in the SSRS was organised for two groups of eight and ten anglers in 2017 and 2018. Five people attended the SSIS 'Train the Trainer' training in 2020. In 2021 training for the CSSI was put in place in 2021 with just six individuals participating. These three freshwater monitoring systems require in-stream kick sampling for macroinvertebrate identification. Multiple macroinvertebrate demonstrations took place across the catchment generating public interest on the day, but rarely resulting in expressions of interest for longer term volunteering. Just three individuals provided kick sample results by measuring macroinvertebrates using the CSSI. A focus group found that a number

of the volunteers were reluctant to get into the river to conduct kick sampling and preferred to take water samples from the riverbank or a bridge. Low confidence levels in macroinvertebrate identification, even with the simplified CSSI system, was another barrier to collecting data for some of the volunteers.

The citizen science project, Freshwater Watch (FWW) measuring nitrate and phosphate levels, was introduced into the Maigue River Catchment in 2021 and proved to be the most accessible and popular with volunteer engagement. A joint event with a Tidy Towns group was organised to recruit citizen scientists to monitor freshwater sites regularly within the catchment. Word of mouth and social media led to individuals and a youth group approaching the MRT to get involved, and a few individuals signed up at organised events. Expressions of interest were received from approximately 36 individuals. As a first step (in May 2021) online training was provided with 11 individuals participating.

The volunteers were asked to commit to taking water quality readings either monthly, quarterly, or intermittently. The MRT was particularly interested in obtaining samples from some of the smaller streams for which the EPA had not assigned a status. The MRT was mindful that obtaining a wide spatial coverage was important, but it was also beneficial to recruit volunteers with differing levels of time commitment within the same regions. Intermittent records helped provide baseline values while monthly readings would help determine trends over time, if that level of volunteer commitment was possible. The volunteers were also encouraged to take readings based on events, such as before and after rainstorms, clean-ups, or flood works.

Volunteer scientists were predominantly male (70%) and almost half are associated with farming. Volunteers submitted data monthly (13%), quarterly (26%), or intermittently (26%) over the two years. Some citizen scientists (39%) maintained continuous sampling, and regularly took monthly, quarterly or seasonal readings at the same river or stream location. Other citizen scientists sampled randomly throughout the catchment. The river and stream locations sampled between 2021 and 2022 in the Maigue catchment included the Maigue itself and the key tributaries, the Morningstar, Loobagh, Grennagh/Clonshire, Camoge, and the Barnakyle (Figure 1). Additional samples were collected south of the Maigue in Ruppulagh from the River Sheep, a tributary of the Funshion subcatchment and the Blackwater catchment.

A total of 70 volunteer samples and 206 measurements (for nitrates and phosphates) were recorded for the Maigue between 2021 and 2022 (Figure 4). Between 2021 and 2022, there was an increase in the number of sites achieving low nitrate readings (<0.5 mg/l) and a reduction of sites with nitrate levels between 0.5 and 2 mg/l. However, the results also showed higher levels of nitrates (between 2 and 5 mg/l) in seven of the sites in 2022. Similarly for phosphates, there was an increase in the number of low phosphate measurements (<0.02 mg/l) between 2021 and 2022, and a concomitant decline in higher levels (0.02-0.2 mg/l) recorded. However, phosphate levels at the highest range (between 0.5 and 1 mg/l) were recorded at several sites in 2022.

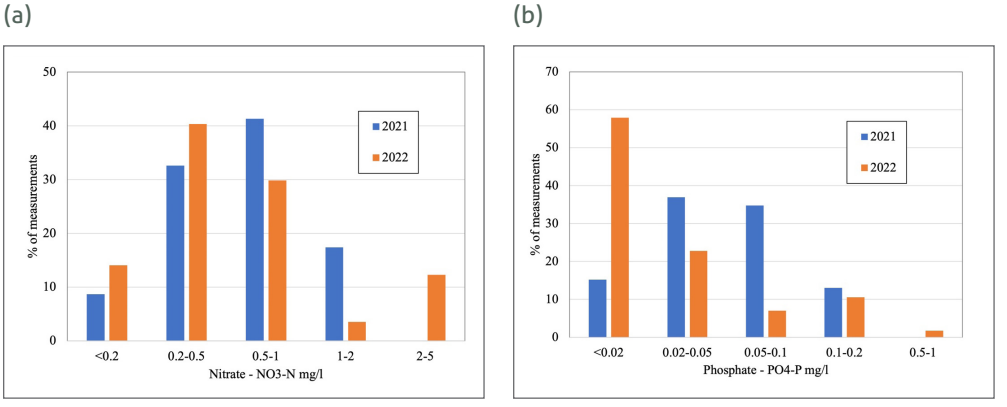

Figure 4. FWW Nitrate (a) and Phosphate (b) levels in the Maigue River Catchment 2021 and 2022.

While the citizen science nutrient testing kits were valuable in terms of the level of interest generated among volunteers, the value of the results can be questioned. The level of accuracy for low nitrate readings is weak. Nearly a quarter of the volunteers had difficulties at some point using the Freshwater Watch App, and some preferred not to use the App so they submitted their records to the MRT project officer on paper.

Discussion

The paper aimed to assess the extent to which MRTs community engagement efforts have advanced the public participation goals of the WFD, RBMP, and conservation legislation. Key questions such as the place of community-level aspirations within an ICM model, the potential of citizen science data collection to meet community-based ICM goals, and the sources of expert guidance for communities are addressed in this discussion.

Community level aspirations and the ICM model

The rationale for the establishment of the MRT was to provide a structure to involve local communities in meaningful participation in stewardship and management of the Maigue river (maigueriverstrust.ie). This effort complies with the principles of ICM, the WFD and social learning (Mostert *et al.,* 2008; Daly *et al.,* 2016; Rolston *et al.,* 2017), incorporating what legislation requires (i.e., from the top-down) with the aspirations of the community (i.e., from the bottom-up), with co-development, cooperation, pooling of resources and expertise and, importantly, building trust.

The MRT was established to conserve, protect, and rehabilitate the rivers, streams, and watercourses, of the Maigue catchment, and the group evolved contemporaneously with LAWPRO and Rivers Trust in Ireland. MRT developed in three phases from an informal group responding to a pollution incident, to the formation of an initial core volunteer group aided by Limerick City and County Council staff, and ultimately, to a

formal charity, with a dedicated project officer. The visibility of the Maigue Rivers Trust has expanded locally and nationally each year since its official launch in 2016, and huge gains were achieved across the catchment in terms of river-focused events and activities. The project officer position facilitated professionalisation of a voluntary group through formulation of governance and finance structures, and adherence to charities and health and safety legislation, enabling an exponential increase in the visibility, depth, and breadth of public contact.

MRT successes could be described as greater vertical integration with river basin initiatives and greater horizontal integration with agencies operating at catchment scale (Mostert *et al.,* 2008). However, MRT has yet to establish a membership model and collaborative catchment groups who would help define the aspirations for ICM. Ballinger *et al.,* (2016) provide a guide for managing collaborative ICM in three phases establishment, operating and implementing collaborative groups with recommendations on completing each stage are based on the experiences of IRD Duhallow LIFE. At most, the MRT took the first steps towards a collaborative process (Orr *et al.,* 2007), with an increase in public participation and awareness, but due to limited, and constrained funding opportunities, is only at the early stages of gathering viewpoints, representing interests, and mobilising and developing know-how (AEIDL 1997).

Most of the catchment and water stewardship initiatives would not have been possible without the enthusiasm of participants, an organisational structure (Maigue Rivers Trust), a champion (Project Officer) and supporting structures (core funding and funding awards for training and resources). Resilience Pilot Project core funding on a sliding-scale enabled a comprehensive expansion of activities and facilitated an escalation in meaningful public engagement and reach across catchment communities. Additionally, a Community Water Development Fund seeded many beneficial awareness-raising projects in the Maigue catchment. However, the long-term nature of practical interventions and the short-term award cycle as well as partial funding awards limits the target outcome potential (Osawe *et al.,* 2023).

It was envisaged that corporate funding and membership fees could have provided additional funding. To this end MRT directors undertook business and strategic plan mentoring. While a strategic plan was drafted, the business plan required additional expertise to finalise. The only course of action available within the MRT's capacities was to develop fee paying services but this was only possible with core staff. The lack of a membership model was an additional gap. Corporate Social Responsibility (CSR) funding for non-governmental organisations and charities has never been so relevant, and businesses are increasingly being required, encouraged, lobbied, or are genuinely interested in supporting sustainable practices and initiatives (Burke, 2015). Charitable organisations are encouraged to develop business plans that help attract sponsorship. This can be a very challenging exercise for voluntary groups with limited or no core funding, particularly in the current landscape of competing social interests. The Resilience Project funding concluded after its cycle of three years, prompting a review of the pilot programme conducted by LAWPRO. No results or findings from the review have been

reported thus far. An effective mechanism is required to help bridge the gap between the need for green funding and CSR. Another potential solution is to scale-up the CWDF to provide core funding, a commitment made by the Programme for Government in 2019 (O Cinnéide *et al.,* 2021; Osawe *et al.,* 2023). This would bring elements of sustainability and continuity for community water groups.

Citizen science and community-based ICM aspirations

Policies mandating citizen participation in planning and decision-making for water are now widespread (e.g., Rural Development, WFD, National Biodiversity Action Plans) and there has been a rapid growth in citizen science initiatives internationally and nationally (Kelly-Quinn *et al.,* 2022; Weiner *et al.,* 2022).

The MRT made substantial efforts to foster public engagement and citizen science in the Maigue catchment. It was envisaged that citizen science would provide a meaningful activity to examine water quality and increase stewardship across the catchment (Haklay, 2015). A secondary aim was to fill gaps in EPA monitoring data and determine local pollution sources and pathways, however these aims have had limited success.

There were many challenges associated with attracting and maintaining volunteer engagement in all the water quality monitoring systems introduced by the Maigue River Trust. Demonstration events attracted hundreds of people and were very well received, but only resulted in a handful of volunteer participants. Each expression of interest was followed up by the project officer, promoted and encouraged, but did not always result in an active participant, reflecting the challenges of transforming interest into activism (Clayton *et al.*, 2017).

Trials of citizen science observational techniques for water focused on river biology and water chemistry with the latter proving most popular. Overall, the Freshwater Watch kits helped build connections and increase awareness, and they offered the local residents an opportunity to get involved meaningfully in caring for their river environments. Volunteer-collected data, however, can include volunteer biases, errors, and data variability associated with demographics, ability, experience and commitment (Kosmala *et al.*, 2016). With proper training and a high level of interest, volunteer data can be as reliable as that from professional scientists, although studies show a greater variability from using the Freshwater Watch testing kits due to subjectivity of reading the colorimetric range and limitations in reliability and accuracy particularly with low nutrient concentration levels (Quinlivan *et al.,* 2020). After two years of operation in the Maigue catchment a relatively modest number of volunteers (23) were recruited; 86.6% of the volunteers utilised the kits and submitted data, a further 13.3% were interested enough to take kits and learn how to use them, however they did not operationalise them and submit data. Additional challenges were experienced with technological capabilities, data analysis to provide meaningful results, and feedback to the researchers, volunteers and water resource managers (Newman *et al.,* 2011). These challenges were surmountable only with the support of a project officer, who was necessary to help motivate and maintain volunteer interest and remind them to take readings and also that

their records are valuable (Geoghegan *et al.,* 2016; Haklay, 2015).

The main value in the Freshwater Watch records was the establishment of a core group of intermittent and systematic environmental stewards, and an expansion of the range of monitoring points across the catchment. However, citizen sciences efforts to-date could be critiqued as they are not integrated with any strategic catchment management plan, and thus does not comply with ICM aspirations (Giordano and Shah 2014). A key question centres on how the output from volunteer monitoring can be employed to effect real change and how these efforts can be sustained. To generate resilience and future sustainability, for meaningful improvements to water quality, upscaling, and replication of initiatives across the catchment and longer-term progress tracking is necessary (Osawe *et al.*, 2023). Thus, any significant water quality project is a long-term engagement and needs the support of a dedicated champion. To cope with the potential disadvantages and weaknesses of citizen science initiatives and to increase the reliability of the data, scientists and managers may need to lower the expectations for the type of data they require or find means to calibrate and validate the data (Alender, 2016; Conrad and Hinchley, 2011). The alternative is to simply accept that its main use is as a tool to increase public engagement in river stewardship.

Guidance for communities/Oversight

The WFD advocates for information supply, consultation, and active involvement. New governance structures for water management in Ireland have been a welcomed development to help further the overarching aim of the WFD and ICM, especially through addressing gaps in public participation (Daly *et al.,* 2016) and efforts to increase stakeholder input to policy development by An Fóram Uisce. However, with these new structures, the landscape of water-players has become somewhat complex, especially for community-led bottom-up efforts. Numerous entities and varying degrees of responsibility can create fragmented and siloed groups (Rollason *et al.,* 2018; Antwi *et al.,* 2021).

The experiences (successes and failures) of the MRT have occurred within contexts of dominant vertical regulatory drivers, and more recent horizontal collaborative efforts (Daly *et al.,* 2016; Rollason *et al.,* 2018). To fulfil the aims of ICM, communities need to collaborate effectively with a range of stakeholders at the local catchment level (e.g., IFI, OPW, NPWS, EPA, Local Authorities). While the MRT has developed such collaborations, the continued top-down regulatory imperative restricts integration between agencies and catchment communities. Local community participation is often limited to consultation and representation in catchment interventions (e.g., priority areas for action), with broadscale objectives and tight funding supports (O Cinnéide *et al.,* 2021).

Expert guidance can help communities to participate in the development and implementation of an agreed vision of sustainable land and water use for their catchment (Ballinger *et al.,* 2014). But who will provide this guidance or oversight – An Fóram Uisce, LAWPRO, Rivers Trusts or Local Authorities? While there have been clear efforts to bridge society and science through policy and governance structures, the complex landscape and multiple players contributes to the continued top-down/bottom-up challenges. The

traditional view that top-down management see public participation as a barrier to the delivery of management objectives is still evident (Rollason *et al.,* 2018), and this results in practices that exclude communities and participatory involvement at local level.

LAWPRO's dual scientific and community roles appear to be very compatible and synergistic. However, Community Water Officers (CWO) are responsible for impossibly large regions. This highlights the necessity for local community champions to fill geographical gaps and provide much-needed people-level interactions, to effectively overlap with the role of CWOs. There is room for community engagement expansion and appetite for more consistent and sustainable contributions to the river basin management planning process (Antwi *et al.,* 2021; O Cinnéide *et al.,* 2021).

In conclusion, bottom-up voluntary efforts supported by core funding has contributed to significant gains in terms of visibility, trust, recognition, and community education and engagement, but modest gains in terms of volunteer water quality monitoring in the Maigue catchment. The work of the MRT has furthered the public participation aims of conservation legislation, the WFD, and River Basin Management Plans. Positive factors have included the creation of a robust charitable framework with the potential for capacity building. However, meaningful and effective participation within ICM requires time and a functioning and a resourced structure to develop trusting relationships with local communities if the aim of sustainable public participation in water quality improvements is to be achieved. While the mechanisms and resources for public participation has greatly improved, there are clearly synergies and further supports necessary to extend the effectiveness of the process and achieve sustainability for community groups as water quality actors.

Acknowledgements

The authors are very grateful to the citizen scientist volunteers who dedicated their time, as well as to the funding provided by Environmental Protection Agency and Mary Immaculate College that made this research possible, and the funding that made the Maigue Rivers Trust events possible.

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