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## Community-funded behavioural change initiatives: Water quality in Ireland

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### ABSTRACT

Mitigating the deterioration in water quality is contingent on changing human behaviours. Community-based behavioural change initiatives are one approach to changing people's actions, which is distinct from many behavioural change programmes that target the actions of individuals. This paper examines a behavioural change initiative aiming to foster proactive community engagement in the management and protection of water catchments in Ireland. The initiative comprises a grant scheme for community groups to undertake a variety of activities to support improvements in water quality, ranging from education and awareness activities to physical interventions. The analysis finds that higher grant awards and a greater number of grant applications are positively associated with either a higher likelihood of engagement with public and private sector stakeholders or participation in the State's River Basin Management Plan process on improving water quality. While this demonstrates some success for the grant scheme, questions remain unanswered with respect to the efficacy of schemes like this. With limited quantitative data available both on the precise nature of interventions applied and measured target outcomes, it was not possible to discern what community group or project attributes are critical to the success of the grant scheme. This deficiency means that effectively replicating or scaling up successful projects like this will be practically challenging.

### 1. Introduction

Countries all over the world are facing difficult challenges, prominent among them are the problems posed by the degradation of freshwater resources (Whitehead et al., 2019; Darwall et al., 2018; Head and Alford, 2015; Kummu et al., 2011). For example, there is a reported 64–71% loss of global wetlands since 1900 (Davidson, 2014). Within the European Union (EU) the depletion of the freshwater ecosystem has also been a matter of concern leading to the implementation of legislative measures such as the EU Water Framework Directive 2000/60/EC (WFD) as a response to mitigating this trend (Rouillard et al., 2018). At the country level, in Ireland just over 47% of surface water bodies are assessed to be in moderate, poor, or bad ecological status, as defined by the WFD (O'Boyle et al., 2019). The decline in the quality of freshwater resources poses a significant threat to ensuring access to safe and high-quality water, as well as

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the sustenance of freshwater resources for future generations.

At the regional level, governments have instituted many measures to protect freshwater resources, including the WFD in the EU, but there is compelling evidence that in addition to legislative measures, policy initiatives to increase participation and engagement among the public, particularly at the community level, are necessary to protect and manage water resources (Axon, 2016; Reed, 2008). However, relatively little is known about what constitutes effective community engagement that yields positive local water management outcomes (e.g., behavioural change that supports water quality improvement) with most empirical research focusing on measures to raise awareness or knowledge of water quality issues rather than investigate behavioural change (Diamantini et al., 2018; Frederiks et al., 2016). This is important because interventions that are aimed solely at raising awareness or increasing knowledge of environmental issues have been less effective in leading people to undertake pro-environmental actions or to behave in more environmentally sustainable ways (Yeomans and Herberich, 2014; Barr, 2003; Cameron et al., 1998; McKenzie-Mohr et al., 1995; Finger, 1994). Furthermore, awareness and knowledge interventions are mainly framed at the individual rather than at the community level (Yeomans and Herberich, 2014; Axon, 2017). The knowledge gap of how to effectively engage communities to facilitate behavioural change towards more environmentally conscious behaviours is detrimental in two major ways. First, it makes it difficult to predict (and if necessary, replicate) specific engagement actions or activities at the community level that can foster behavioural change towards sustainable living. Second, there is little insight into how to scale programmes or initiatives to achieve wider sustainable impacts. Moreover, while there are many studies that examine schemes aimed at improving the environment either at the individual or community levels, few studies have empirically evaluated the impact of these schemes. Where available, most assessments appear unclear on what metrics are used to measure impact. At the same time, a review of the current literature suggests a lack of clarity on the factors that are associated with schemes that have worked or otherwise (Heiskanen et al., 2010; Feola and Nunes, 2014).

Whether related to water quality or other environmental issues such as climate change, the policy objective (e.g., protecting water quality) is usually somewhat removed from the subject of policy levers (e.g., community behaviours). The policy lever may encourage a change in community behaviours, which in turn may subsequently yield the desired policy outcome. Success in changing community behaviours may not immediately deliver the desired environmental policy outcome due to long lead times before environmental impacts are anticipated or if the environmental outcome is not solely dependent on the community's behaviour. Collecting behaviour change metrics may offer early insight into whether the ultimate policy objective might be achieved in the future. For example, if the metric measuring the extent of change in behaviour is negligible there is no need to investigate whether there is a subsequent causal environmental improvement. A difficulty in devising suitable metrics, especially in the case of water quality, is generally that changing behaviour in the community is not related to the behaviour of a single individual thereby necessitating the application of a suite of potential interventions some of which can be substituted for each other, while others may be mutually complementary. Multiple potential interventions could be singularly mapped into multiple metrics, which has the associated risk that policy practitioners focus on the metric that is moving in the 'right' direction rather than apply a more extensive metric of change. The first objective of this paper is to outline a simple method to develop a single-encompassing metric that can be used to evaluate the success of behavioural change initiatives. A second objective is to evaluate the effectiveness of an initiative to foster community engagement that supports environmental management at the community level while using the designed metric to understand characteristics that drive the desired outcomes.

We use a case study of a behavioural change initiative aiming to foster proactive community engagement in the management and protection of water catchments in Ireland. While certain sectors (e.g., agriculture) or activities (e.g., wastewater treatment) are attributed as primary pressures on water quality (O'Boyle et al., 2019), these activities occur within communities and community action and concern related to water quality can foster and prioritise remedial action. To this end, the government is supporting initiatives at the local level to foster behaviour change efforts at improving water quality levels through targeted community-based interventions to increase awareness and implement projects at the catchment level. Knowing whether behavioural change initiatives are successful is important but understanding what aspects of the initiatives are critical for success is equally important. To effectively replicate and scale-up initiatives requires an understanding of the critical factors either within the scheme design or among its participants that are associated with the desired behavioural outcomes.

The remainder of the paper is organised as follows: the next section provides the theoretical framework for the study as well as a review of the empirical literature on water management issues and community engagement. Section 3 describes the methodology employed including the background of the case study, data, design of the success metric and the analytical methods used in the study. While sections 4 and 5 present the results and discussions of the main findings of the research, respectively. Section 6 concludes by summarising key findings and their implications for policies.

## 2. Theoretical framework and literature review

### 2.1. Theoretical framework

The three most common theoretical frameworks underpinning the rationale of behavioural change research are the Trans-theoretical Model, Social Cognitive Theory, and the Theory of Planned Behaviour (Darnton, 2008). The Transtheoretical Model segments the target audience and tailors interventions to various sub-groups (Prochaska and Velicer, 1997). Social Cognitive Theory centres around learning from others and using positive and negative reinforcement of behaviour (Bandura, 1991). The Theory of Planned Behaviour posits that behaviours are determined by intentions, which are predicted by attitudes, subjective norms and perceived behavioural control (Ajzen, 1991). Engaging communities to foster more environmentally sustainable behaviours isn't exclusive to one theoretical framework. For example, involving community leaders as role models or reinforcing positive behaviours

draws on Social Cognitive Theory, whereas seeking to establish new community norms draws on the Theory of Planned Behaviour. Several classifications of behavioural change interventions have been proposed (Kok et al., 2016; Poortinga and Whitaker, 2018; Wallen and Daut, 2018; Rajapaksa et al., 2019). Wallen and Daut's classification includes (1) education and awareness, (2) outreach and relationship building, (3) social influence, (4) nudges and behavioural insights and (5) incentives. Grilli and Curtis (2021) find that all five approaches can be effective but with efficacy differing depending on context. In general, the impact of information-only approaches on environmental-conscious behaviours is small whereas social influence approaches are generally more successful. Outreach and relationship-building approaches are generally quite effective but less commonly used as they are resource intensive. The case study outlined below falls into this category. While nudges are a useful tool for encouraging individual behavioural change, the opportunities for application are limited to situations where the context of choices facing individuals can be controlled.

Raising awareness or educating people by providing more information is a commonly utilised behavioural change intervention based on well-established psychological theories such as the information- or knowledge-deficit model (Owens, 2000). While popular, focusing solely on education and awareness raising are often not sufficient means to stimulate behaviour change but is usually a component of all other approaches because some information is always provided (Grilli and Curtis, 2021; Yeomans and Herberich, 2014; Barr, 2003). One perspective is that interventions to influence behavioural changes are most effective when they are carried out at the community level and involve direct personal engagement with people, so-called 'social marketing' (Ockwell et al., 2009; McKenzie-Mohr, 2011; Axon, 2020). As McKenzie-Mohr (2011, pg.22) argues, to stimulate new sustainable practices efforts must be concentrated on facilitating "individuals to engage in behaviours that, collectively is sustainable, and design programs accordingly". Moreover, managing common pool resources, such as water, for example, requires action at a community or catchment level. Thus, community-led, participatory approaches such as the community-based social marketing (CBSM) approach advocated by McKenzie-Mohr (2011) have gained wide acceptance among practitioners and scientists. This approach falls within Wallen and Daut's (2018) outreach and relationship-building classification involving the implementation of different project interventions - an example of which is the basis for this study.

## 2.2. Empirical studies

Studies examining community engagement and behavioural change intervention in environmental management are almost as numerous as the number of schemes/interventions but relatively few studies evaluate the impact of these schemes. The case study outlined later is within the context of increasing the general public's participation in water resource management, i.e., River Basin Management Planning, and encouraging behaviours sympathetic to improving water quality, which generally falls within Wallen and Daut's (2018) outreach and relationship building (ORB) category of interventions. Consequently, we focus on literature using outreach and relationship interventions in what follows.

Many studies follow a qualitative approach, some of which are grounded on a model termed the 'Behaviour Change Wheel' developed by Michie et al. (2011). For instance, Axon et al. (2018) employs a qualitative scoping method to identify and characterise several individual- and community-based energy-related behaviour change case study interventions. The analysis concludes that the interventions examined have mixed success but this may reflect a broad policy/intervention focus among the various case studies analysed. The study by Axon et al. (2018) and similar ones by Espinosa and Walker (2013) and Trier and Maiboroda (2009) based on changing behaviours in communities suggest that substantial resources and community liaisons are necessary for a successful intervention and that success is more likely where the sense of belonging to the community is strong.

Axon (2016) also used a qualitative methodological approach to evaluate an intervention designed to engage the public on sustainable carbon reduction strategies. The research finds that the elements of social, economic and environmental context must be taken into consideration when designing and implementing interventions aimed at fostering behavioural changes. Also in the qualitative sphere, Doyle and Davies (2013) use a participatory approach based on Social Practice Theory (Hargreaves, 2011) to evaluate an intervention aimed at supporting the adoption of sustainable home heating practices. The study employs visioning and transition workshops in an iterative process involving several focus group discussions to elicit information for the evaluation of the success of the intervention.

In a review study, Grilli and Curtis (2021) note that studies on outreach and relationship interventions tend to prioritise the engagement process rather than undertake quantitative assessments of the impact of the intervention. They conclude that successful ORB interventions are usually resource-intensive and are more likely to be effective where there is a strong community spirit. Morris et al. (2018) is one example of a quantitative analysis, which comprises an assessment of a community-based initiative aimed at supporting the development of sustainable communities. They employ a mix of quantitative and qualitative methods involving a questionnaire survey and semi-structured interviews and conclude that the intervention is relatively unsuccessful across the metrics of awareness, the potential for adoption, and sustainability. In a meta-analysis study assessing whether social norm interventions achieve pro-environmental behaviours, Farrow et al. (2017) find that these interventions are effective at inducing significant changes in behaviour. Farrow et al. also note that a substantial knowledge gap still exists with respect to these tools, particularly related to the influence of moderating variables and the heterogeneity of their impact on behaviours.

Grilli and Curtis (2021) note that where ORB quantitative assessments are undertaken, they predominantly use a 'before-after' approach where the intervention is assigned to the entire target population and its effectiveness is assessed by comparing the outcome of interest before and after the intervention. This approach generally reflects the fact that interventions are implemented at the community level and require the involvement of all members precluding the establishment of a control group. For example, studies by Espinosa and Walker (2013) and Axon et al. (2018) focus on communities within single villages. The challenge for issues such as water quality and climate change is that there isn't a single 'community' and the spatial dimension is much greater. Therefore, in this case, it

can relate to entire river catchments.

In reviewing these studies assessing behavioural change interventions, it is apparent that the metrics or indicators for identifying impact (success or otherwise) are unclear, vague or largely ambiguous. This is partly attributable to the qualitative nature of the different methods adopted for analyses but also applies in quantitative studies where success metrics can be quite narrow in definition. It is also notable that empirical studies are relatively few in number. With few exceptions (e.g., [Espinosa and Walker, 2013](#); [Axon et al., 2018](#); [Trier and Maiboroda, 2009](#)), most assessments focus on interventions conducted at the individual or household level. This study targeting community-level interventions accounts for the complexity of behavioural change interventions by using a combination of indicators to measure how different actions embedded in various interventions are supporting environmental sustainability. Specifically, our metric, using a composite index weighted by expert opinion related to the relative impact of each intervention provides a more balanced measure of behaviour change interventions. We also assess the factors associated with different interventions that can support behavioural change towards improving water quality, attempting to bridge a knowledge gap highlighted by [Farrow et al. \(2017\)](#).

### 3. Material and methods

#### 3.1. Background

The WFD is grounded on the idea that to achieve environmental sustainability, public engagement in environmental decision-making at different levels is necessary ([Rollason et al., 2018](#); [Reed, 2008](#)). One recommendation from a recent report on water governance in Ireland suggests the need to prioritise strengthening the capacity of water governance facilitators (e.g., local authorities) to engage local communities to facilitate behavioural and attitudinal change in relation to the management of water resources ([Boyle et al., 2021](#)). The Community Water Development Fund (CWDF) is one initiative to achieve this objective.

The Local Authority Waters Programme (LAWPRO), which collaborates with stakeholders to identify and resolve water quality problems in Ireland, administers the CWDF. Community engagement is the cornerstone of LAWPRO's work, combining local and expert knowledge, for a better understanding of what is happening in a local catchment and to develop community engagement in water quality management. The CWDF disburses small grants to community groups to fund a range of water-related interventions such as the design and implementation of habitat enhancement projects, public workshops etc., to encourage community members to make behavioural changes that support the management of water resources to ultimately protect and improve water quality. The CWDF is based on the premise that when provided with the necessary support, communities can play a pivotal role in the protection and management of water resources, biodiversity and the overall environment. As indicated earlier, environmentally-conscious choices are mediated by a combination of attitude, beliefs, social norms, knowledge-deficit as well as the specific environmental context, thus, the CWDF's interventions are aimed at mediating these challenges through an 'outreach and relationship building' approach. The broad categories of interventions supported by the CWDF include:

- Education and awareness interventions - information dissemination, signage, public events, etc.
- Physical interventions - Habitat/biodiversity restoration; riparian biodiversity work, etc.
- Partnership/collaboration - collaboration between community groups, public bodies, and local partners on water management issues.

LAWPRO accepts applications from community groups for CWDF grants once per year and has operated the fund since 2018.

#### 3.2. Data

##### 3.2.1. Survey design

The data for this study come from a survey of 330 community groups that applied to the CWDF for project funding. The survey was designed with assistance from LAWPRO and administered online in the spring of 2022. The invitations to participate in the survey were sent directly by LAWPRO to available email contacts within community groups that had previously applied for funding from the CWDF. The survey elicited information both on applicants and the projects for which they sought funding and the questionnaire comprises 34 questions divided into five sections. The first section covered questions related to the general description of the group such as the main activity of the group, membership composition, location etc. The second section captured information relating to the group application process for the CWDF including the year(s) of application and the level of grant aid applied for. The third section elicited information on the activities that the group undertook to promote their interventions, raise awareness of water quality, and educate the community on water quality issues. The fourth section contains questions that seek information in relation to physical interventions implemented to achieve ecological improvements of a waterbody. The final section asked participants about any kind of partnerships or collaborations that the group may have had with other organisations or groups that directly or indirectly supports community water quality improvement efforts. The dataset for analysis comprises 272 project grant applications across 174 community groups. Administrative data on all project applications were also available but did not contain detailed information on the grant applicants, similar to that collected in sections one, three and five of the survey.

##### 3.2.2. Survey respondents

Some descriptive statistics of the respondent groups are reported in [Table 1](#). The majority of the community groups were

established since 1990 (over 70%) with 38% established since 2010. Over half of the community groups (54%) have in excess of 20 active members, while the groups are broadly dispersed around the country.

Across the 4 years of the grant scheme, the average grant funding received per organisation is 3,985, ranging from 300 to in excess of 28,000. Among respondents across the four years of the scheme, there was a 94% success rate in grant applications. Across all grant applications over the four years, the average success rate was 74%. The distribution of the number of times groups applied and received funding (repeat applications) is presented in Fig. 1. A majority of groups successfully applied for funding on just one occasion, and only 17% of the respondent groups received funding in at least 3 of the 4 years of the grant scheme.

Table 2 shows the breakdown of group types by primary activity or motivation of the group. The group categories comprise resident associations, tourism or heritage groups, as well as ‘Tidy Town’ groups that aim to improve their local environment and make their area a better place to live, work and visit. Environmental groups comprise river trusts or catchment associations, as well as environmental/biodiversity groups. The Other category comprises groups involved in social enterprise or festival/event groups. Just over half of the groups cited environmental protection or water quality initiatives as the primary activity of the group with the balance primarily focused on either community development or sports/social activities. Tidy towns/Tourism groups are the largest respondent category and might nominally be viewed as being primarily concerned about economic and social development. From the survey responses, that is clearly not the case with environmental protection being the primary motivation among roughly 2 in 5 Tidy towns/Tourism groups.

### 3.3. Empirical method

In this section, we provide a description of the design of the outcome metrics and the statistical techniques adopted for the study.

#### 3.3.1. Composite index metric

Community interventions initiated to foster behavioural change towards actions that support environmental improvement cannot be easily assessed with a single-dimensional indicator. This is because of the multitude of potential behavioural outcomes and the complexity of their association with environmental outcomes, such as water quality metrics. This is the basis upon which the ‘behavioural change wheel’ developed by Michie et al. is framed. A single measure is unlikely to adequately capture all efforts to encourage changes in behaviour leading to improvements in water quality. Therefore, we apply a multi-dimensional approach to measure the association between the type of interventions initiated and the propensity to engage with relevant stakeholders on the likelihood for community groups/members to change behaviour that targets water quality improvement. Specifically, we group interventions into three categories depending on the extent to which such interventions are capable of promoting water quality improvement. That is, our outcome metric is a composite index of interventions relating to *education/awareness*, *physical intervention* and *partnership/collaboration*. The first category comprises activities such as the distribution of information leaflets, erecting signage, and holding public events, as outlined in Table 3. Physical interventions include works that affect the natural environment, whereas partnership/collaboration interventions include initiatives with a range of other stakeholders. Composite indices have been used in several areas to measure outcomes, for example in agricultural innovation (Läpple et al., 2015), public health interventions (Sadler et al., 2019), and sustainability of energy supply (Balode et al., 2021).

To create the composite index, a weighted sum of the count of proposed activities specified in the grant application is calculated.

**Table 1**  
Group characteristics from the survey.

Group characteristics	% (n = 174)
Year group was established:	
Before 1970	16.2
1970–1990	13.3
1991–2010	32.4
After 2010	38.1
Group membership size:	
Small (1–9 members)	2.3
Medium (10–20 members)	43.7
Large (21+ members)	54.0
Year of application:	
2018	14.3
2019	21.0
2020	26.5
2021	38.2
Region:	
Border	17.9
Midlands & East	26.0
South East	17.9
South West	23.7
West	14.5
Grant offered	3985.1 (4649.1) <sup>a</sup>

<sup>a</sup> Mean value and Standard Deviation in parenthesis.

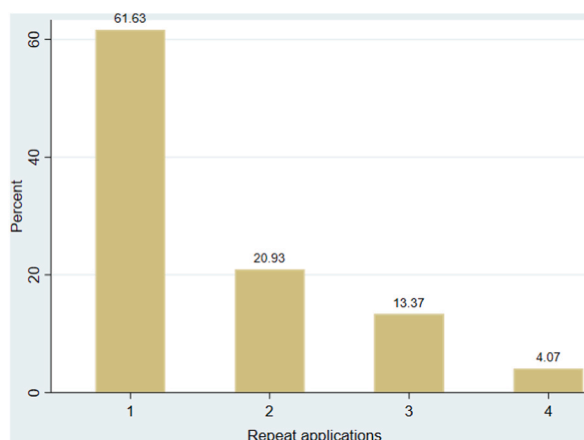


Fig. 1. Number of times groups applied and received funding (n=174).

Table 2

Group type by primary activity (N = 174).

Group Type	Group's primary activity			Total
	Environmental	Community	Sports &	
	Protection	Development	Social	
Tidy towns/Tourism	20%	34%	0%	53%
Environmental Group	24%	2%	0%	25%
Angling Club	4%	0%	3%	7%
Other	6%	3%	6%	14%
Total	53%	38%	9%	100%

Table 3

Selected community actions for interventions to improve water quality.

Education/awareness	Physical interventions	Partnership/Collaboration
Leaflets/flyers (5.0–[6.5]–8.0)	Fencing (5.0–[7.5]–9.0)	Landowners (2.0–[2.7]–3.0)
Newspaper/radio media(5.0–[7.0]–9.0)	Drainage (2.0–[6.0]–10.0)	Local authority (2.0–[2.8]–3.0)
Erected physical signs(5.0–[6.7]–8.0)	Habitat enhancement (8.0–[9.5]–10.0)	State agencies (e.g. EPA) (3.0–[3.0]–3.0)
Workshops/events/tours (7.0–[8.7]–10.0)	Barrier removal (8.0–[9.0]–10.0)	Funding organisations (2.0–[2.7]–3.0)
Water quality/biodiversity training (7.0–[8.8]–10.0)	Nature-based solutions(8.0–[9.2]–10.0)	Others (e.g. Group Water Scheme) (2.0–[2.7]–3.0)
Organised biodiversity events(5.0–[7.3]–9.0)		
Communities Special Awards (6.0–[7.2]–9.0)		

Note: Figures presented represent scores from the experts (LAWPRO's Community Officers) in format (minimum–[average]–maximum).

The weights are based on the expert opinion of the relative importance or possible impact of each activity in ultimately encouraging community engagement and supporting water quality improvement in Ireland. The experts are LAWPRO staff with responsibility for water catchment management and CWDF grant administration. The experts weighed the different categories of potential interventions in terms of their efficacy in directly or indirectly influencing water quality improvement. The weights used range from 1 to 10 for the physical intervention or awareness interventions, with 10 being the activity most likely to support water quality improvement or nudge behaviour towards that, based on their experiences of water catchments' management. While weights range from 1 to 3 for the engagement (partnership/collaboration) category - 3 being an engagement most likely to support water quality improvement. The averages of the scores based on the experts' opinions are reported in Table 3. The three intervention categories of *education/awareness*, *physical intervention* and *partnership/collaboration* are summed to derive an overall composite index of grant application interventions. In the empirical model, the primary explanatory variables are the level of grant awards and the number of repeat applications. Other control variables include the nature/type of organisation/groups, the primary aim/motivation of the group/organisation, the membership size, and group members' commitment measured as the number of hours members commit to the group's activities. Our engagement indicator is related to engagement with other community groups and official government agencies and is categorised across project planning activities (e.g., seeking consent, etc.) and implementation activities.

Table 3 illustrates the heterogeneity of expert opinion on the relative importance of potential interventions in terms of their efficacy in influencing water quality improvement, showing minimum, average, and maximum expert scores by intervention. Substantial differences in expert opinion on environmental topics are not uncommon across the literature (e.g. Motlagh et al., 2020; Nijnik et al.,

2014). Nonetheless, it is useful to further explain how the expert opinion weightings were collated. The experts were surveyed via an online questionnaire that comprised three questions, one for each of the intervention types in Table 3, asking them to rate the relative importance or impact of each of the sub-activities listed. While a 10-point scale is used for both Education/awareness and Physical interventions, as the two questions/scales are discrete, we can only rank the responses within an intervention category but not across the two categories. For Education/awareness interventions the experts ranked training highest (8.8), followed by workshops (8.7), with distributing leaflets/flyers least (6.5). For physical interventions habitat enhancement (9.5), nature-based solutions (9.2), and barrier removal (9.0) were most highly ranked, with fencing (7.5) and drainage (6.0) interventions least favoured. To this end, we cannot compare Education/awareness intervention scores with Physical interventions. For example, suggesting that Fencing (7.5), for instance, is ranked higher or lower than newspaper/radio media (7.0) or workshop (8.7) interventions, respectively, would be inappropriate in this regard.

3.3.2. Empirical model

The most common empirical technique to analyse situations where people make different choices (in this case, interventions undertaken) is a binary choice model, usually a probit or logit specification. This specification is appropriate if the relevant outcome is reduced to a dichotomous choice, i.e., taking on values of 0 and 1 depending on the choice being made or not (Wooldridge, 2010). Logit regression models are used to investigate the binary decision of whether groups engaged with either other stakeholders within river catchments or with the formal river basin management planning process. This distinction is important because deepened engagement with the river basin planning process over time signifies heightened interest and concern to support water quality improvement, which is the main objective of the River Basin Management Plan (RBMP).

In the case of the composite index metric, values are on a continuous scale between 0 and 1. The ordinary least square (OLS) estimator is traditionally used in such circumstances but community groups apply for project funding across several years, so we model the outcome analysis in a panel data econometric framework, where a community group, *i*, applies for CWDF funding in year *t*. In this framework, we estimate a random effect regression model based on a generalised least square (GLS) estimator. Following (Wooldridge, 2010), the model is of the form:

$$Y_{it} = X_{it}\beta + c_i + \varepsilon_{it}, t = 1, 2, \dots, T, \tag{1}$$

where  $Y_{it}$  is the outcome of interest (e.g. composite index metric) for each group *i* at year *t* and  $x_{it}$  is 1 x K vector of observed explanatory and control variables (i.e., the variables indicated earlier such as the level of grant awards and the number of repeat applications, nature/type of groups, groups' primary motivation etc.) and  $\beta$  is the parameter to be estimated.  $c_i$  is the group-specific unobserved random effect and  $\varepsilon_{it}$  are idiosyncratic errors that varies across time and groups.

4. Results

For simplicity, we combine the different intervention types into similar categories, and the average weighted scores of the intervention categories used to compute the composite index are presented in Fig. 2. We then present the results by taking each of the research questions in turn. Specifically, we discuss the results of empirical models examining the association of the CWDF on project engagement with community stakeholders, as well as, the type of projects that community groups pursue as measured by the composite index defined above.

4.1. Has the CWDF improved the level of community engagement related to water protection and management?

One of LAWPRO's core objectives is to develop community engagement in water quality management. At one level this entails engagement and collaboration among stakeholders within river catchments, and at a higher level includes formal engagement with the

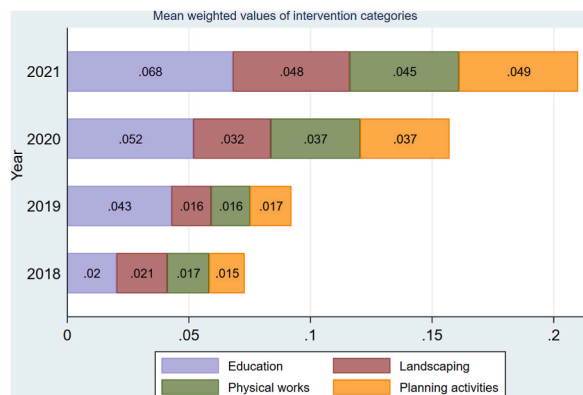


Fig. 2. Average weighted scores of intervention categories and composite indices, by year.

State’s river basin management planning process. We investigate both these issues in turn in the context of the CWDF. The *ex-ante* assumption is that specific types of organisations, such as environmental groups, may have a higher likelihood of engagement with water quality management issues. The research questions are whether groups that are receiving CWDF funding or higher levels of CWDF funding are more likely to engage compared to those with lower or no funding; and whether engagement is associated with particular group attributes.

4.1.1. Engagement with other stakeholders

In this section, we examine the relative odds of groups engaging with other local stakeholders, either NGOs or State agencies, using logit regressions. We distinguish between engagement at the level of planning for a project (e.g., seeking permissions, consultations, etc.) and engagement at the project implementation level (e.g., on-site works, project supervision, etc.). The regression estimates are reported in columns (1) to (4) of Table 4 as marginal effects, which measure the change in the probability of engagement for a (unit) change in the explanatory variables.

The two variables of particular interest are the cumulative grant funding received by a community group and the number of years of grant applications (i.e., 1 to 4). Positive and statistically significant parameter estimates on these variables is consistent with the CWDF improving the level of community engagement in water protection and management. In relation to cumulative grant funding, we find that higher levels of funding are associated with a higher likelihood of engagement with stakeholders both in the planning and implementation of projects. The highest measured impact is planning type consultations with State agencies, which include local government, Environmental Protection Agency, Inland Fisheries Ireland, and the National Parks and Wildlife Service. Each additional 1000 is associated with a 5 percentage point higher likelihood of engagement by the recipient groups. In summary, higher levels of grant awards are associated with a greater likelihood of engagement across stakeholder groups.

The estimated coefficients on the number of years of grant applications are all statistically insignificant. This means that the level of engagement does not change as groups re-engage with the CWDF grant. Overall, engagement is associated with the level of grant funding rather than the number of grant applications.

Several additional variables were included in the regression to control for different characteristics of the groups such as main group activity, year of establishment, membership size and amount of time dedicated to group activities. Surprisingly, we find no significant parameter estimates associated with these characteristics, meaning that group attributes appear not to play a role in explaining the probability of engagement.

4.1.2. Engagement with the river basin management planning process

In this section, we examine whether there is an association between CWDF and levels of engagement with the State’s River Basin Management Plan (RBMP) process. Where the previous section included engagement with State agencies, the distinction made here is that engagement with the river basin management planning process through consultations or submissions could be considered a higher level of engagement that potentially signals a community group’s sense of ownership of water quality. Column (5) of Table 4 reports the logit regression of engagement with the RBMP process. The results here contrast with those described above. Higher levels of grant awards are not associated with a greater likelihood of engagement but engagement with the RBMP does increase with the number of years of grant applications to the CWDF. The likelihood of engagement with the RBMP is 18 percentage points higher among groups with two years of grant applications to the CWDF compared to groups with just one CWDF application. For groups with CWDF applications across all 4 years, the likelihood of engagement is 46 percentage points higher than groups with just one CWDF application.

4.2. Has the scope of project interventions increased over time?

In the last section, the unit of analysis was the community group or grant applicant. In this section, the unit of analysis is at the individual grant application level. Each grant application can cover three types of interventions, which are education and awareness raising, physical interventions related to water bodies, and partnership/collaboration interventions designed to improve water quality. Within each of these categories, multiple types of activities are feasible. In section 3.3.1 we described our approach to constructing a

**Table 4**  
Logit (Marginal Effect) model for indicators of engagement.

Variables	(1)	(2)	(3)	(4)	(5)
	<i>Community groups</i>		<i>Official agencies</i>		<i>River Basin Management</i>
	Planning	Implementation	Planning	Implementation	
Cumulative grant ('000)	0.039*** (0.014)	0.021* (0.012)	0.052*** (0.018)	0.019** (0.009)	0.0001 (0.010)
Repeat applications (Base = 1)					
Repeat = 2	-0.008 (0.101)	0.088 (0.102)	-0.037 (0.097)	0.064 (0.099)	0.188* (0.103)
Repeat = 3	-0.080 (0.136)	0.069 (0.139)	-0.020 (0.140)	0.116 (0.132)	0.375*** (0.130)
Repeat = 4	-0.090 (0.204)	-0.099 (0.198)	-0.174 (0.209)	0.015 (0.175)	0.466** (0.189)
Other controls	Yes	Yes	Yes	Yes	Yes
Observations	170	168	170	170	167

Standard errors in parentheses. \*\*\*p<0.01, \*\*p<0.05, \*p<0.1.



composite metric of project interventions. This metric measures the number of interventions and is not able to distinguish on quality of interventions, as that would have required the collection of more qualitative data that was not feasible within the administered survey.

Fig. 3 presents the kernel density of the composite index across years, which is a non-parametric estimate of the probability density of the composite index variable. In estimating the probability density of the composite index for each year, comparisons of the population of grant applications, as represented by the composite index, can be undertaken including evaluating if there is a substantive change in composition of grant applications across years. The densities for the latter three years of the CWDF are broadly similar, with the peak density shifting slightly to the right with each year of application. This suggests the mean value of the composite index is increasing with each year, reflecting grant applications with greater depth of activities. The kernel density for 2018 is slightly different compared to the other years. In 2018, which was the first year of the CWDF, there are substantially few grant applications with high composite index scores. Mean values for composite index, including sub-indices, are reported in Table 5, which shows the mean composite index scores increases each year from 2018 to 2021. The reported  $\chi^2$  tests for equality of means across the 4 years confirm that mean values for the combined index are statistically different. The increasing mean value is indicative that the composition of grant applications as measured by the composite index has improved over time, particularly in terms of the number of interventions per grant application. In the case of education/awareness and partnership/collaboration interventions, the mean score of the sub-indices also increases with time and the  $\chi^2$  tests for equality of means across the 4 years are also statistically significant, rejecting a null hypothesis that they are equal. In the case of physical interventions, the mean composite index scores are not statistically different, implying that the mean number of physical interventions per grant application has not changed across the four years.

#### 4.3. How do grant applications vary by applicant type?

*Ex-ante* one would expect that the nature of grant applications varies by community group characteristics. For example, applications by angling clubs, community development groups, or catchment associations might focus on different types of interventions depending on the group's priorities. It is instructive to see how the composite index of interventions within a grant application varies by applicant attributes such as group type, size, or motivation. Undertaking this analysis would indicate if specific group attributes are likely to be associated with particular types of interventions, which is information that could be used to prioritise funding. Such information would also bridge the knowledge gap identified by Farrow et al. (2017). While the CWDF received 595 applications across 4 years, from which we have some administrative data, as reported in Table 5, we rely on the survey data for information on group attributes so this analysis is based on the survey sample of 264 separate project grant applications. We have no means to quantitatively assess whether the survey sample is representative of the population of groups that have applied for CWDF funding but when we compare the kernel densities of the composite index for all project applications with those for the survey sample there are no substantive differences. The shapes of the distributions for the survey sample versus all project applications broadly overlap, albeit the survey samples have slightly higher index values. See Fig. 4a for project applications in 2018 and 2019 and in Fig. 4b for applications in 2020 and 2021. The combined index is the only data common to both the sample and population and based on the kernel plots there is no evidence to suggest that the survey sample is not representative of the population of applicants.

To examine how grant applications vary by applicant type, the composite index scores were regressed, using the model described in section 3.3.2, on a series of variables describing applicant groups' attributes, including group type, main activity, and size, among others. The model estimates are not reported, as there were no statistically significant associations between the groups' attributes and the composite index. Although a null result, what it does suggest is that based on the quantitative data available on project interventions, the composition of grant applications neither varies by type of applicant group nor their attributes. Given the diversity of applicant groups and the wide spectrum of potential interventions, this finding was unexpected and is examined more in the Discussion section.

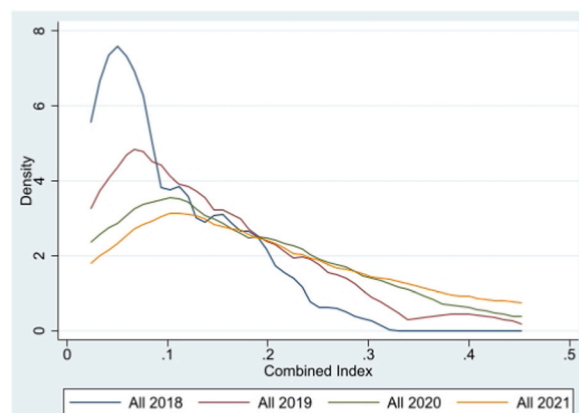


Fig. 3. Kernel density of Composite Index, by year.

**Table 5**  
Distribution of measurement composite metric scores over time (2018–2021).

Intervention indices	Mean index values								$\chi^2$ test <sup>a</sup>
	2018	N	2019	N	2020	N	2021	N	
Education and awareness	0.048 (0.017)	75	0.073 (0.042)	82	0.074 (0.041)	120	0.082 (0.048)	165	96.46***
Physical intervention	0.122 (0.051)	22	0.151 (0.059)	24	0.15 (0.053)	50	0.142 (0.057)	97	4.86
Partnership/Collaboration	0.113 (0.034)	27	0.159 (0.064)	31	0.161 (0.074)	57	0.163 (0.084)	88	32.05***
Composite index	0.096 (0.065)	97	0.143 (0.103)	102	0.181 (0.137)	141	0.213 (0.155)	195	100.12***

Note: Standard deviation (SD) in parentheses.

\*\*\*p<0.01, \*\*p<0.05, \*p<0.1.

<sup>a</sup> Multivariate test of equality of means.

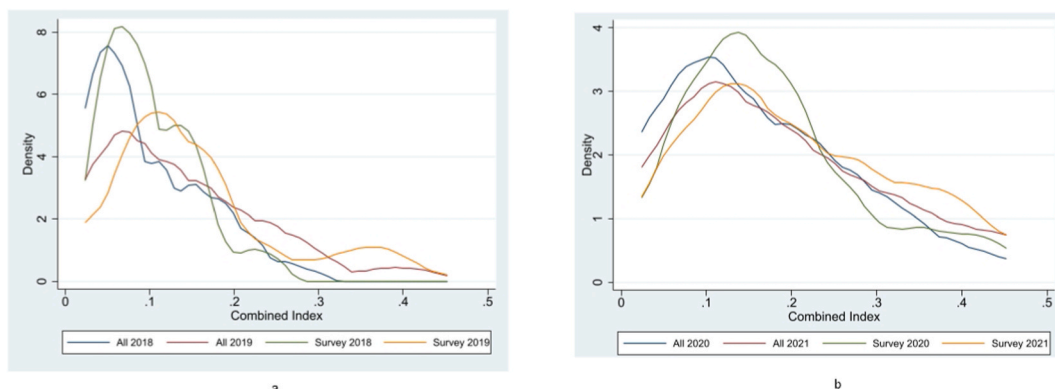


Fig. 4. Kernel density of Combined Index, survey versus population.

### 5. Discussion

From the data in Table 5, there are disproportionately more education and awareness interventions seeking CWDF funding than physical interventions or partnership/collaboration activities, though many applications comprise all three interventions. This is consistent with behavioural change initiatives elsewhere and may reflect the relative ease of implementation and also that education/awareness activities are a necessary component of other intervention categories (Grilli and Curtis, 2021). From the literature, we know that the most basic education and awareness interventions, such as the provision of information only, have little behavioural impact whereas interventions containing tailored information or combining with public pledges to change behaviours are more successful (Yeomans and Herberich, 2014; Lokhorst et al., 2010). While education and awareness interventions have been largely favoured to motivate behaviour change among CWDF applicants, the proportion of other intervention types has increased over time. This may reflect a growing recognition of the relative importance of other intervention types rather than a focus on knowledge provision to promote behavioural change.

On the basic question of whether the CWDF is successful in changing behaviours, the answer is a nuanced one. There is clear evidence from the analysis that community groups funded under the CWDF are more likely to engage with public and private sector stakeholders, as well as with the river basin management planning process. This is an indication of the success of the CWDF in terms of the ability of the fund to support community engagement towards water quality improvement efforts. These engagements are likely to lead to greater community ownership of water-related issues, and possibly to a change in behaviours positively impacting water quality. While this present study is not directly linked to behaviour change as more research may be needed to decipher this, however, several other studies find that community interventions at the catchment level represent value-for-money in terms of supporting behaviour change among farmers towards water quality improvement, with analyses conducted within the Great Barrier Reef (GBR) lagoon in Australia, notable examples. For example, Eberhard et al. (2021) and Willis et al. (2017) show that different intervention typologies are associated with increased farmers’ knowledge, skills, and awareness; intention to change, as well as a willingness to do something differently as a result of engaging with intervention programs.

In both the econometric analyses on community group engagement with stakeholders and the RBMP process in section 4.1, and on grant applications by applicant type in section 4.3 no substantial statistical relationships were identified between the dependent variables in question and a broad range of community group attribute variables. Given the diversity of applicant groups and the wide spectrum of potential interventions, this is an unexpected finding. It would be unreasonable to assume that all groups are similar and equally capable of delivering effective community interventions, yet the analysis does not provide any evidence otherwise. Without questioning the merits of any grant recipient or the quality of individual projects, there are no quantitative metrics available that can rank or rate the quality of individual projects. While grants are assessed based on detailed applications, without a quantitative ranking it is difficult to undertake statistical analyses and draw insights across all applications. The composite index computed in this paper is a

measure of the count of interventions weighted by the relative importance of each activity provided by LAWPRO. Within this weighting, physical interventions had the highest rating, followed by public workshops and water-related training events but there is not a strong weighting towards particular types of intervention. Across 14 types of interventions, the mean ranking on a 10-point scale was 7.1 with a standard deviation of 1.1, which provides a relatively uniform weighting. This weighting, essentially a weighted count of interventions rather than a measure of the scope of interventions, means that it is difficult to quantitatively distinguish between the quality of projects across grant applications. The CWDF should consider a more focused approach, possibly identifying desired or high-priority interventions, rather than responding to proposals from the community that may be less effective. The ultimate goal of the CWDF should be more explicit. One possible approach is to guide community groups to undertake proven interventions, possibly matched with applicant groups' expertise and capabilities.

A more comprehensive evaluation of the efficacy of the CWDF would entail comparing the impact of CWDF funding on metrics of delivered outcomes. The composite index calculated earlier is a measure of proposed outcomes, i.e. at the grant application stage, though echoing the previous point it provides an insufficient measure of the scope of proposed projects. A retrospective measure of outputs is paramount to proper assessment. Grilli and Curtis' (2021) recommendations for a behaviour change programme are relevant here but two are particularly pertinent in this instance. The first is to "carefully select the behaviour to change". Not all behaviours are equally important and in the context of CWDF, it should be clearer which interventions are considered most beneficial. The analysis earlier demonstrated that the CWDF is achieving success in increased engagement with stakeholders and the RBMP process. However, with available data, it is not possible to say which types of interventions are most critical in this regard. Grilli and Curtis' second recommendation of relevance is to "define the measure of success and measurement methods". Implementing such guidance in the context of community engagement with water quality issues is not trivial both in determining what success means and then how to practically measure it, as much of what constitutes ORB interventions, as well as, the desired behavioural outcomes are generally more qualitative in nature and not conducive to simple quantitative metrics. Nonetheless, without some specified measure of success and progress tracking, it will be difficult to argue how the CWDF is making meaningful change and that associated public expenditures represent value for money. A condition of grant funding should include reporting on outcomes. With CWDF-prioritised interventions, as proposed earlier, developing relatively simple indicative metrics of project outcomes, uniform across projects, should be feasible.

This research failed to provide new insights on the influence of moderating variables and the heterogeneity of their impact on ORB behaviours, particularly relating to community group attributes, a persistent research gap identified by Farrow et al. (2017). Some insights of this nature will already be known to the administrators of the CWDF in terms of personal intuition related to the dynamism of specific community groups or their capacity to deliver projects. Such knowledge will be likely gleaned via personal relationships rather than through a systematic process. In the absence of systematic data collection for funded projects, it is impossible to comprehensively understand what are the critical success factors both within projects and community groups. That information is critical to earmark funding to projects and groups with a higher likelihood of success. The same information can be beneficial in devising which types of groups need additional support and training to develop their internal capacity to lead viable behaviour change projects within their communities. Future programmes should incorporate these salient issues that are germane to providing robust evidence of the effectiveness of community-funded programmes. This means that the evaluation of such programmes and associated data collection is designed and executed in parallel with the implementation of the programmes themselves. In addition, based on these results and following similar findings from other related community interventions such as those involving the GBR lagoon, future research could incorporate both qualitative and quantitative research and analytical methods combining systematic evaluation data as well as qualitative data. This is consistent with Michie et al.'s argument that behaviour change interventions are more effective when interventions are effectively characterised, requiring different intervention approaches that are then linked to a targeted behaviour change objective.

## 6. Conclusion

Most water pollution is ultimately caused by human behaviours, where if behaviours were modified, environmental pressure could be substantially reduced. Behaviour change strategies are often framed at the individual level, but recent evidence suggests that initiatives to influence behavioural change are most effective when they are implemented at the community level, which involves building relationships with the relevant stakeholders (McKenzie-Mohr, 2011; Axon, 2020).

In this paper, we assess the factors associated with different community-based interventions that can support behavioural change with the intention of improving water quality. We apply a multi-dimensional assessment of interventions using a case study of a community-based grant funding scheme. Results show that while education and awareness interventions are the most favoured methods utilised to motivate behavioural change the use of other intervention types involving partnership and collaboration has increased over time reflecting the growing importance of building relationships and encouraging the direct involvement of relevant stakeholders as an important lever to achieve desired environmental management outcomes.

There is clear evidence that CWDF funding is associated with better public engagement on water management issues. Higher levels of CWDF funding, or repeat grants, are associated with either a higher likelihood of engagement with public and private sector stakeholders or participation in the river basin management planning process. This is evidence that the CWDF can be successful in engaging communities to become involved in the protection and management of their local water resources. However, there are also challenges for the CWDF. The empirical analysis was unable to provide any insights into which aspects of either the community groups themselves or their funded projects are most important in successfully engaging communities to become active in water quality protection issues. Notwithstanding that the CWDF is funding many beneficial projects, without clearly specified measures of success and progress tracking, it is difficult to see how successful projects can be easily scaled-up and replicated elsewhere. While communities

may have a variety of local objectives for their projects, the CWDF should have a clear priority of objectives in the context of the WFD and RBMP, including explicit targets in terms of outcomes it wishes to achieve. To support the delivery of these outcomes, progress tracking is essential, including collecting data both on the activities undertaken and outcome metrics, which should be a condition of grant funding.

### Credit author statement

**Osayanmon Wellington Osawe:** Conceptualization, Formal analysis, Writing – original draft, Visualization, Writing – review & editing, Project administration. **Gianluca Grilli:** Conceptualization, Supervision, Project administration. **John Curtis:** Conceptualization, Formal analysis, Writing – review & editing, Supervision, Project administration, Funding acquisition.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Data availability

The authors do not have permission to share data.

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