Focus Article

Governance issues in developing and implementing offsets for water management benefits: Can preliminary evaluation guide implementation effectiveness?

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This article explores governance issues in developing innovative pollutant offset programs by focusing on a case study being piloted at the Gisborne Recycled Water Plant in Jackson Creek, a rural subcatchment of the Maribyrnong River north of Melbourne, Australia. The article offers preliminary lessons from the ongoing design and anticipated challenges facing this innovative program based on reflections from the literature and project progress to-date. This case exemplifies a form of adaptive governance—an approach well suited to achieving broad sustainability objectives—and for which an early assessment is both appropriate and opportune. Adaptive governance is characterized by governmental collaboration with civil society groups, social learning through public participation, and experimentation leading to more flexible policy outcomes. Early assessment affords the possibility of midcourse corrections, drawing on experience acquired elsewhere. We contend that the approach being developed in Victoria through this pilot program has implications beyond the use of recycled wastewater for achieving various social objectives. It may also contribute to the development of an expansive water quality offset framework applicable to point source discharges, nonpoint source pollution, and sewerage overspills. Moreover, the approach can be applied to design of offset systems elsewhere—with appropriate economic savings and effective application to multiple water quality challenges if potential problems are discerned early.

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INTRODUCTION

Water quality trading and offset programs are promising approaches to mitigate impacts of pollutants in receiving water bodies. The underlying concept is a credit-based system wherein a discharger earns 'credit' by measurably reducing a pollutant in discharged effluent. The credit can be traded with other dischargers, or applied toward another pollutant by the same discharger. Trading schemes can range from multiparty trading markets[1] to more holistic, multiobjective approaches having as their goal the reduction of total pollutants at lower cost to society

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coupled with the generation of other social benefits (e.g., improved instream flow).[2]

The Jackson Creek Pilot Project in Victoria is intended to explore a trade-off among dissimilar pollutants with different environmental impacts. The goal of this experiment is to develop a systematic approach to measure *net positive environmental benefits*[3] while also evaluating the effectiveness of a series of dissimilar trade-offs revolving around the 'triple bottom line' (TBL)—a sustainable development principle that aims to integrate social, economic, and environmental objectives. In this experiment, offsets must be cost effective and incorporate stakeholder and community participation in the decision-making process to ensure that local values and interests inform final offset framework design.[4,5]

While water quality trading and offsets have existed for decades, and several agencies and other entities have provided financial and technical support for their implementation,[6] their practical success has thus far been limited.[7] Among other reasons, traditional water pollution governance systems limit the application and adoption of these schemes due to regulatory roadblocks or severe restrictions on offsets. We contend that adaptive governance, characterized by bottom-up, multi-actor collaboration, policy learning mechanisms, and flexibility in managing resources under uncertain and dynamic social and environmental conditions,[8–10] can enhance their success. This is because such schemes may better allow for integration of societal values in the offset development process as well as more effective elicitation of non-market considerations in their design. Although Western Water, the principal entity responsible for the Jackson Creek Pilot project, has not explicitly embraced adaptive governance in its offset program, the concept provides a useful framework to assess challenges to the policy's versatility, flexibility, and inclusiveness.

The goal of this investigation is to use the Jackson Creek pilot study to explore the role of adaptive governance in the early development of a water quality offset scheme—and its role in fostering publicly acceptable, ecologically sound outcomes. Western Water is exploring an offset scheme to trade point source effluent discharge from the Gisborne Water Recycling Plant (WRP) with diffuse pollution from urban and agricultural discharge. The success of this approach, we believe, depends on both the technical robustness of the scheme and the adaptability of its governance framework to changing regulatory pressures, societal values, and environmental and climatic conditions.

Why conduct such an assessment now, in such an early phase? There are two reasons. First, the paper's authors play various roles in establishing and implementing the offset scheme, including providing a detailed monitoring assessment to establish stressors in Jackson Creek, and a preliminary rainfall-runoff model to establish water quality and quantity impacts under the current and future scenarios affecting land use. Thus, by undertaking a proactive assessment effort, the investigators hope to incorporate social issues into the scheme deliberately.

Second, preference for an offset scheme is a policy decision adopted by the principals—Victoria EPA and Western Water—it was not chosen by the authors. Thus, while our ultimate interest is in assessing the program's achievements—which will be done in a second, *later* evaluation—at this point, we seek to identify and anticipate potential challenges with the offset scheme, as well as possible barriers to its acceptability and collaborative success. In effect, such as assessment can help to prescribe midcourse adjustments to better hasten overall project effectiveness.

This approach has a precedent. Past studies of pollutant offset schemes, for example, have noted the value in timing program evaluation to permit a greater impact on design and to hasten relevant adjustments early in the policy development cycle.[11] We will conclude our preliminary assessment by describing the efficacy of such an offset scheme for balancing social values and environmental benefits when both are measured on different scales, or when they prompt differing trade-offs in terms of risk, gain, or desired outcome. While we can offer only a progress report—since the scheme remains in early development—its value lies in reporting possible impediments while they can be discerned early enough to be managed, and so lessons can be transferred elsewhere.

JACKSON CREEK PILOT PROJECT

Site

Jackson Creek watershed is a rural subcatchment of the Maribyrnong River, northwest of Melbourne (Figure 1). The area currently supports low-density residential and agricultural land uses; however, Melbourne's expanding Urban Growth Boundary has placed significant population growth and development pressures on the catchment. Regional planners project population in the upper catchment (e.g., Gisborne, New Gisborne) to double from a 2006 population of 6398 to 12,071 residents by 2021,[11] while the principal community in the lower portion of the watershed, Sunbury, will double from 36,789 to 73,462 residents between 2014 and 2036.[12] Melbourne's regional transportation corridors will

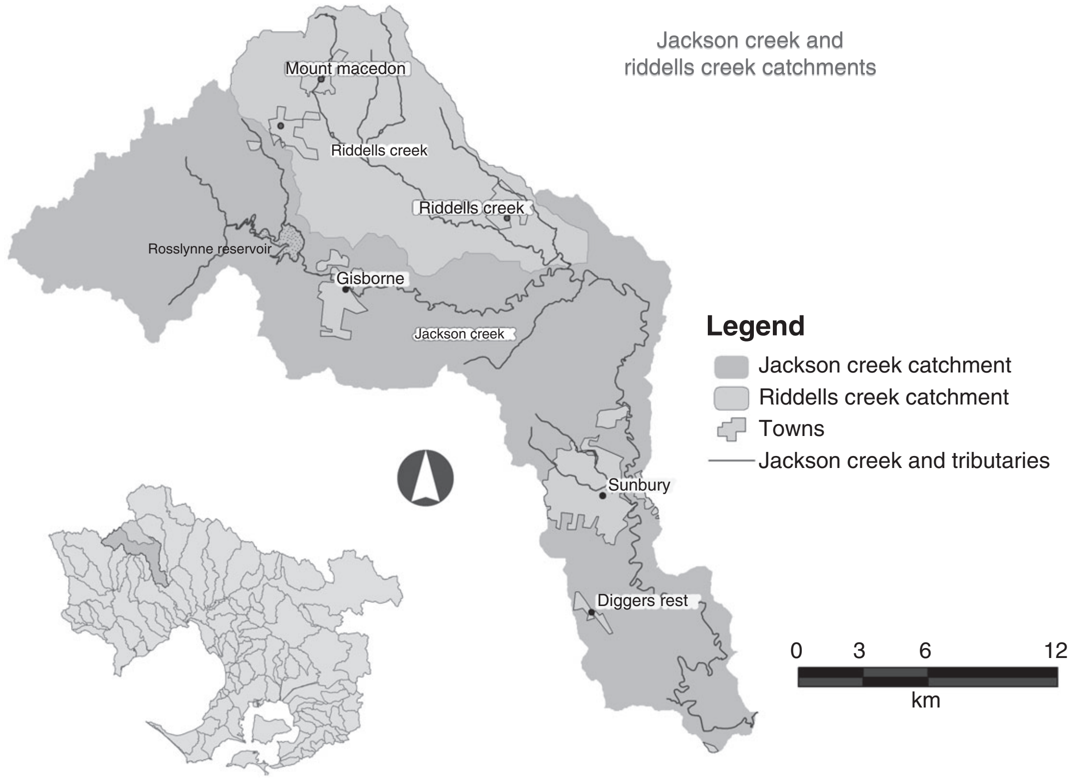

FIGURE 1 | Image of the Jackson Creek catchment area highlighting major population centers and geographic features. An inset of the greater Melbourne area provides a scalar reference for the catchment area image.

expand into this watershed, spurring additional residential and commercial developments and making anticipation of future growth impacts critical.[11,13]

Jackson Creek rises northwest of Gisborne and is formed by the confluence of Distill, Gisborne, and Slaty Creeks. The current water quality concerns include nutrients from effluent discharged from the Gisborne WRP and diffuse pollution from urban and agricultural runoff. Urbanization, land use changes – especially intensification of agricultural practices—and climate change are expected to exacerbate these issues. The flow of Jackson Creek is regulated by the Rosslynne Reservoir located 2 km upstream from the Gisborne WRP. The extraordinary climatic conditions of the Millennium Drought caused dam holdings to drop to 3% compelling reservoir managers to restrict water releases to Jackson Creek to emergency flushes only. This resulted in low flow conditions that posed a threat to the hydrologic and ecological health of the Creek. For a brief period during the drought, Western Water sought to classify the treated effluent discharged to Jackson Creek as supplemental environmental flows, but regulatory and water quality issues made these efforts contentious.[14]

Rationale

Resumption of more normal rainfall stabilized flows in Jackson Creek and led to a drop in demand for recycled water within the catchment– from 73% reuse in 2008–2009[15] to 10 and 9% reuse, respectively, in 2011–2012 and 2012–2013.[16] Downturn in demand led to an increase in treated effluent discharged from Gisborne WRP to Jackson Creek. The treated effluent entering the Creek is high in total nitrogen and total phosphorous[17] and is considered out of compliance with Victoria's state environmental protection policies (SEPPs), which require wastewater agencies to progressively reduce the nutrient concentration of effluent discharged to receiving waterways over time,[18] (Meenakshi Arora, 2014, personal correspondence)

Currently, approximately 400 ML of recycled water are available for reuse annually within the catchment. However, the current demand is 200 ML per annum and the projected demand is estimated to only reach 280 ML by 2018.[17] Moreover, the anticipated growth should increase the amount of recycled water generated by Gisborne WRP, leaving Western Water with little choice but to discharge surplus effluent to Jackson Creek to comply with the state's water quality standards. Full compliance with the SEPP guidelines would require Western Water to upgrade the treatment capacity at Gisborne WRP from its current level of advanced secondary treatment (Class B) to a tertiary level of treatment (Class A). Although treatment upgrade would satisfy state guidelines and provide new options for reuse (e.g., for in-home residential purposes), undertaking these costly upgrades would constitute a significant economic cost.[17]

In lieu of an expensive upgrade, Western Water is exploring the use of a water quality offset—an alternative regulatory compliance measure afforded by a clause in SEPP guidelines that allows wastewater agencies with exceptional needs to take intermediate, cost-effective steps toward full regulatory compliance.[18] In effect, Western Water has made a policy decision to adopt an offset scheme if it can achieve environmental objectives prescribed by regulators. If approved by the EPA, this offset measure would allow Western Water to continue discharging recycled water, but in a manner that produces net environmental benefits to Jackson Creek through a trade-off between treated wastewater effluent and other pollution sources. Preliminary studies show that synthetic pyrethroids from urban runoff and nutrients from livestock are major stressors to the aquatic ecosystem of Jackson Creek.[19] This approach will test whether offset options can be designed to use advanced secondary effluent to mitigate the negative effects of pollution in the Creek, along with generating other desired environmental outcomes developed in exchanges between ecologists and community stakeholders.[20] If successful, further adoption of the offset scheme would allow discharge of effluent to waterways, allowing environmental benefits to be counted as a beneficial reuse of recycled water. This reclassification would allow Western Water to achieve the goal of 100% beneficial reuse of effluent.[17] While use of effluent discharge in an offset scheme is seen as a money-saving approach by Western Water, Victoria EPA would also like to determine if an offset approach offers greater flexibility for meeting environmental objectives.

METHODOLOGY

Western Water will employ an expanded life cycle analysis (LCA), which, together with the TBL principle, will be used for trade-off evaluation. The LCA compares options developed through the offset formation process in two ways. First, a detailed ecological assessment will determine the net impact of stressors and of potential management measures in a watershed, thus yielding appropriate offset options. Second, a stakeholder participation process for option development will engage the community through workshops and surveys to assess values and elicit willingness-to-pay (WTP) for improved stream health. Results from the ecological and community assessments will be incorporated into an offset option analysis framework that will weigh the cost-effectiveness and expected community value of each offset option against the costs and impacts associated with its implementation.[20]

Role of Adaptive Governance

A long-standing criticism of regulatory schemes for water quality and supply is their failure to develop institutional arrangements for management that match up well with watersheds as units of governance, and which encourage collaboration with civil society groups in decision making. Efforts to rectify these deficiencies are legion, and include publically-engaged watershed restoration and pollution offset programs in places as varied as Nigeria, northeast Brazil, eastern North Carolina and the Colorado River (USA), and Europe's Rhine and Danube basins. The Australian government established the importance of community representation in water policy as early as 1970 by requiring consultation in the policy development process.[21] However, adoption of more integrated, adaptive forms of governance were catalyzed by the Millennium Drought during the late 1990s, which revealed the shortcomings of traditional governance and management approaches that failed to reflect public expectations and were insufficiently responsive to changing social and environmental conditions within key watersheds.[22]

Adaptive governance emerged to fill this role by providing a more resilient governance framework capable of evolving along with changes in local conditions by including mechanisms to ensure social and policy learning.[23] Adaptive governance adheres to a polycentric decision-making approach, in which stakeholders from multiple, overlapping jurisdictions—all within a single basin or watershed—contribute to decisions.[8] It emphasizes collaborative engagement between state and non-state actors from a multitude of civil society, nonprofit, and industry groups in an effort to integrate both specialized and local knowledge. The goal is to encourage coproduction of information and a sharing of values to inform policy.[23] Policy learning is encouraged through structured, iterative experiments such as pilot offset programs that can be modified and even revised in the light of lessons learned.[8,23]

Adaptive governance is being used in Australia to help prepare for climate change,[23] bolster water system reliance,[24] and strengthen drought resilience.[23] We contend that it also provides a useful tool for assessing the versatility and inclusiveness of Western Water's plans for Jackson Creek. As we discuss in the next section, adaptive governance also provides a means of forestalling problems in implementing an offset program.

Optimizing Adaptive Governance: Involving the Right Players, Choosing the Right Tools

In the process of developing the Jackson Creek offset framework, parties responsible for its design have opted to organize workshops to bring together different stakeholders—each with unique suites of values, knowledge, and concerns—to share perspectives, frame problems, and discern creative solutions.[8,9] Two distinct types of workshop, (1) industry stakeholders and (2) community engagement (public), will strategically seek to formulate different sets of outcomes.

The industry stakeholder workshop is considered a critical step in developing the offset policy options that will be offered to the public.[20] This workshop will serve as the primary medium of exchange for technical, scientific, and industry-related knowledge, including information about new technologies, cost-sharing possibilities, anticipated regulatory changes, and existing management plans (e.g., Port Phillip Bay & Westernport Catchment Management Plan)—all valuable input, that once shared, could lead to the emergence of innovative offset options that could more effectively achieve TBL objectives.[8]

From an adaptive governance perspective, the industry stakeholder sessions can provide more inclusive input by affording an opportunity for direct interaction between scientists and industry stakeholders to develop technically robust, efficient outcomes. Ideally, participants from many institutions and diverse scales of environmental governance, including local and regional water management agencies, state environmental regulatory entities, other public officials, research institutes, and catchment management authorities—each of whom will have a role in offset policy making and implementation—will conjointly frame options for offset design.

Yet to be determined is whether local citizen groups and other organizations currently engaged in environmental activism in Jackson Creek[25] will be invited to participate in the industry stakeholder session and whether they will fully embrace the purported advantages to the environment and other outcomes from the offset policy. Including these organizations would indicate that local expertise, values, and concerns are welcome in the offset option development process and not viewed as a challenge to traditional regulatory authority—we recommend their inclusion. Participation of locally active groups is significant because it constitutes the only nonexpert, locally derived form of knowledge in offset option development, and could influence the public's receptivity to offsets as a means of achieving the same level of protectiveness promised by regulations.

The second collaborative element of the framework as currently designed focuses exclusively on eliciting public values through a community workshop and surveys. This phase provides an essential governance element as regards the acceptability of offsets particularly as anticipated demographic changes lead to further changes in local community values that must be reflected in policy outcomes to ensure the latter's acceptability. An added benefit of incorporating community values in decisions is development of local social capital, ensuring that changes needed to the Jackson Creek offsets program in light of the changing environmental or other conditions will be easier to adopt, while also reducing political conflict.[8]

A major concern in moving forward will be determining the types of stakeholder and community engagement processes needed to afford participants the opportunity to express wide-ranging values as well as permit the use of innovative tools to accurately elicit those values. This process has yet to be fully defined and until it is, the chances of fully encompassing a wide range of values remain problematical. Studies suggest that approaches depicted in the top-right quadrant of the typology of Figure 2 offer water managers the most comprehensive tools for eliciting public values.[25,26]

Focus groups, depicted in Figure 2, are small, orchestrated discussions that encourage participants to reveal preferences and viewpoints on a predefined topic, and to interact, learn, and 'build upon the responses' of fellow participants.[26] Practitioners involved in transboundary water management in Europe's River Dialogue project, for instance, have utilized focus groups and found that greater diversity of participants yields deliberation on a wider range of topics and collectively held values than would otherwise be the case.[27,28] Another potential method is scenario analysis, which engages groups in problem identification and forecasting and educates participants on a particular issue while eliciting stakeholder input. Researchers engaged in river basin planning under the European Water Framework Directive have shown this approach to be suitable for developing strategic dialog. However, its potential to generate solutions to challenges defined by social and environmental complexity and uncertainty remains open to debate.[28,29] In sum, several methods for acquiring public input are available to Western Water's

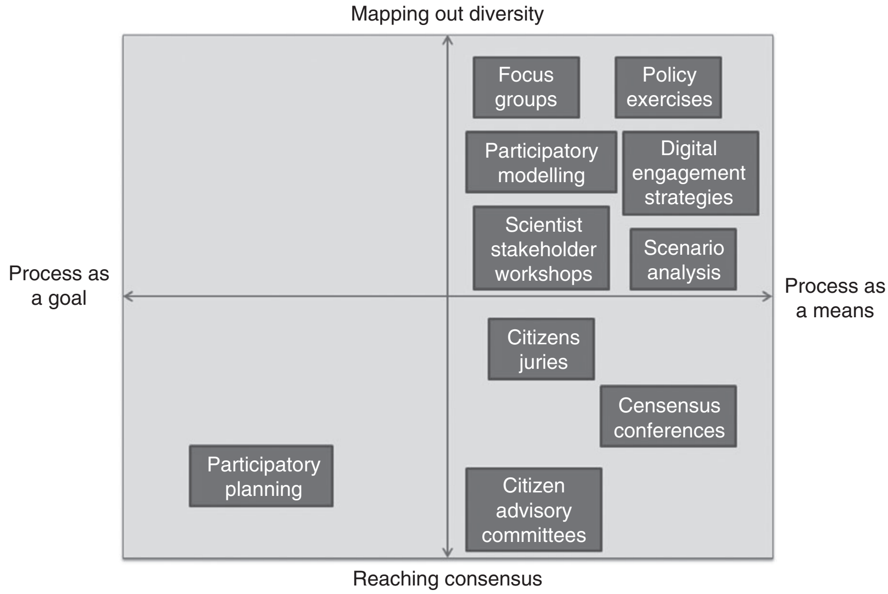

FIGURE 2 | Depicts a typology of public participation methods based on goals and processes associated with public participation. Figure has been slightly altered from the original to include digital engagement strategies and citizens committees. (Reprinted with permission from Ref 28. Copyright 2002, Elsevier)

offset project. Ultimately, we feel, if the project is to be successful in identifying the best means to incorporate an offset framework into the efforts to achieve environmental compliance in the catchment, the methods selected must satisfy the project's paramount objective: to 'determine (the) value of preferred offset options'.[4] Specific examples of the desired outcomes that could be recommended include community-chosen dollar values attached to certain benefits and publically-generated objectives as well milestones for measuring their achievement.

FORECASTING THE CHALLENGES

Three adaptive governance challenges face the Jackson Creek Offset program. First, while the goals of the program's workshops are to develop a valuation process that accurately discerns the community's vision and values relative to the ecological health of the Creek, it is unclear how the framework will integrate qualitative responses for preferences with more discrete forms of valuation. Such forms of valuation typically include WTP surveys that present community members with a choice of hypothetical costs for each offset option, for instance, and which are in the planning stages for ultimate application. A traditional method is to query the public on quantifiable outcomes, such as those accommodated by dollar units, and any subjective responses omitted. The community's values relative to the uses, health, and environmental values of Jackson Creek will be quantitatively assessed by measuring the community's WTP, an especially critical method for generating a hypothetical dollar value that captures the benefits, and uses of, Jackson Creek as perceived by the local community. Although assigning value to subjective responses is a complex process, it would be a novel step forward if the social and ecological values fed into the life cycle assessment are not gauged solely in monetary terms.

Second, as previously noted, the success of the Jackson Creek offset program depends both on the scheme's technical robustness and the adaptability of its framework. On the technical side, stream monitoring has established the main watershed stressor (micro-pollutants vs nutrients). Watershed modeling to test various mitigation scenarios is currently underway.[19] The model estimates micro-pollutant and nutrient loads to Jackson Creek from modeling efforts, while the scenario analysis encompasses changes in the loads with changes in land use, population, and climate. While a significant achievement in the design of an offset framework, measuring actual success will require long-term monitoring. Adequate flexibility needs to be built into the monitoring framework to accommodate significant changes, including shifts from one stressor being dominant to another. A framework for such a monitoring network needs to be established as soon as practicable.

A third issue is continued transparency: the need to keep stakeholders and communities engaged on a long-term basis and make them aware of the intricacies of processes of continued assessment and criteria analysis as well as the anticipated changes in the offset plan. As a regulatory compliance measure, the offset program will likely be incorporated into the Gisborne WRP's operating license, which is evaluated on a 5-year relicensing schedule set by the EPA. Although the 5-year cycle provides a predictable timeline for reevaluation, criteria need to be developed that indicate to the public and water managers when incremental changes through monitoring and evaluation will be needed, and whether reassessment and possible reformulation of the offset is warranted.

Major changes in the form of cleaner, more efficient technologies; availability of more precise environmental information; as well as the occurrence of significant external changes such as protracted drought, demographic shifts or changes in public support, pollution mitigation failures, and other events could modify cost-effectiveness or heighten (as well as diminish) community benefits—as well as support. Ideally, any of these should trigger the revision of offset criteria, making these determinations clear and transparent. Fortuitously, periodic review is an approach supported by the EPA's guiding document on environmental offset frameworks.[5]

An ideal adaptive governance framework based on the ideas and concerns discussed in this section is conceptualized in Figure 3. The framework is iterative and allows for monitoring and evaluation of periodic programs to ensure continuing relevance. A feedback mechanism allows the manager to critically assess the current project and also provide a policy learning mechanism. The authors would urge adoption of a comparable structure for the Jackson Creek framework. It is anticipated that these adaptive management measures will be included in other water quality offset policies and frameworks being contemporaneously developed in Australia.[5] However, it will be essential for project protagonists to carefully monitor feedback, update measures in light of what is learned, and be prepared to amend policies. At this juncture, details regarding this aspect of governance are too vague to ensure meeting these goals. In the conclusions, we point to specific models for emulation.

CONCLUSIONS—LESSONS FROM JACKSON CREEK

As noted earlier, adaptive governance has arisen in various settings to help ensure that water management programs better integrate quality and quantity issues within entire watersheds—transcending the limits of jurisdictionally-constrained rules and regulations. What makes such governance 'adaptive' is its dependence on stakeholder collaboration and inclusive decision making—and its capacity for allowing processes and procedures to be revised in the light of collaboration. While it remains to be seen whether the implementation of the Jackson Creek program will reduce pollution and generate benefits to the catchment's larger community, inclusion of the public and polluters in decision making would reaffirm the value of strong stakeholder engagement. If successful, the approach may drive the accumulation of social capital and make future endeavors more representative of public values and able to generate public confidence.

Adaptive governance schemes in Nigeria (Joint Wetlands Livelihood),[30] northeast Brazil (Jaguaribe-Banabuiu participatory management councils),[31] and the Lower Colorado basin (Glen Canyon Dam Adaptive Management Program)[32,33] have confronted similar challenges and utilized comparable public elicitation, stakeholder engagement, and expert–local knowledge integration efforts—with varying levels of success. All the three schemes have made considerable progress in introducing policy learning experiments, stakeholder workshops, and monitoring programs[30–33]—and their experiences should be closely followed as the Jackson Creek project moves forward. As these other initiatives have learned, if key stakeholders see that their input was considered in decisions that altered management of such innovations, then they are more likely to remain engaged over the long term and invest in the process. Moreover, stakeholder involvement—particularly in the development or refinement of tradable permit or other offset programs—serves to link policy evaluation with decision making through: (1) compelling decision makers to review programs in phases, over prescribed time periods of, say, 2 or 3 years to permit adjustments in their operation and (2) adequate collection of data—including social, economic, and demographic data—vital to program design.[33] As noted earlier, an express aim of the authors is to evaluate how social and decision-making elements are embraced in design and implementation of the proposed Jackson Creek offset framework. We intend to prepare a *post hoc* assessment of the project at its conclusion to evaluate how well these governance issues were embraced.

Development of a water quality offset program in Jackson Creek is a significant undertaking because of the framework's flexibility and potentially broad applicability to a number of water management issues that also resonate with these other basin experiments noted above. While initially being developed to address environmental flows more than pollutant

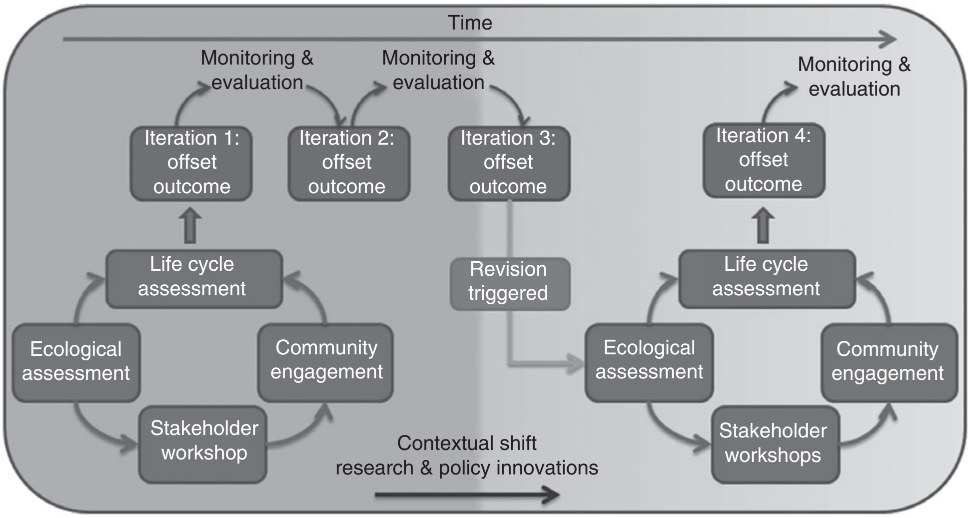

FIGURE 3 | Figure provides an idealized policy learning cycle of the Jackson Creek offset policy. The bottom left corner illustrates the components of the methodological approach taken to create the first iteration of the water quality offset policy. The top part of the figure shows the iterative policy learning process achieved through the adaptive management provisions of experimentation, monitoring, and evaluation. The shifting background color indicates a substantial alteration of the policy's contextual environment, which potentially triggers a full revision of offset process (bottom-right) and the process repeats itself.

concentration, the intent is to expand it to generate management options to mitigate sewerage overspills, as well as point- and nonpoint pollution.[5] Successful implementation across a range of water quality challenges will further test the program's efficacy and flexibility. Again, this is a challenge similar to that which other adaptive governance and offset programs seek to realize. Useful examples include pollution-reduction programs in the Rhine and Danube basins[33–36] and the Tar-Pamlico initiative in North Carolina—an innovative U.S. offset program designed to reduce nitrate and phosphorus pollution from farming[37] while reducing compliance burdens on urban sewage treatment plants. All three initiatives continue to grapple with persistent water quality challenges that, in part, remain intractable due to demographic and land use change, varying annual in-stream flow, and the need for multi-jurisdiction agency coordination.[33–36]

If successful, offset schemes such as that being introduced for Jackson Creek could afford powerful models regarding how to achieve water quality goals in comparable regions such as Southern California, which have a similar climate, face intense land use pressures, and continue to experience population growth. The latter example shares with southeast Australia water quality and quantity stresses for which innovative nonregulatory measures are being contemplated. Jackson Creek might hold lessons for how to overcome institutional impediments to such innovations experienced in other rapidly-growing, semiarid regions—and which seek to integrate remedial efforts throughout a watershed while harmonizing the interests of different stakeholders.[37] This is especially true if evaluations can be conducted early enough in its development to permit useful adjustments.

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