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Research article

Linking community-based monitoring to water policy: Perceptions of citizen scientists

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ABSTRACT

This paper examines the relationships between Community-Based Water Monitoring (CBM) and government-led water initiatives. Drawing on a cross-Canada survey of over one hundred organizations, we explore the reasons why communities undertake CBM, the monitoring protocols they follow, and the extent to which CBM program members feel their findings are incorporated into formal (i.e., government-led) decision-making processes. Our results indicate that despite following standardized and credible monitoring protocols, fewer than half of CBM organizations report that their data is being used to inform water policy at any level of government. Moreover, respondents report higher rates of cooperation and data-sharing between CBM organizations themselves than between CBM organizations and their respective governments. These findings are significant, because many governments continue to express support for CBM. We explore the barriers between CBM data collection and government policy, and suggest that structural barriers include lack of multi-year funding, inconsistent protocols, and poor communication. More broadly, we argue that the distinction between formal and informal programming is unclear, and that addressing known CBM challenges will rely on a change in perception: CBM cannot simply be a less expensive alternative to government-driven data collection.

1. Introduction

Involving communities in tracking freshwater quality and availability is often referred to as Community-Based Water Monitoring (CBM) (Conrad and Daoust, 2008; Whitelaw et al., 2003). This approach usually entails volunteers, either non-experts or trained scientists, engaging in one or more stages of collecting, analysing, and using data to answer locally-relevant questions (Conrad and Hilchey, 2011; Whitelaw et al., 2003). CBM is implemented with varying degrees of community participation and collaboration with governments, industry, academic institutions and/or civil society. As such, CBM is generally compatible with the concepts of citizen science (Silvertown, 2009), community science (Armitage et al., 2017), crowd-sourced data collection (Lowry and Fienen, 2013), and participatory monitoring (Danielsen et al., 2005). Above all, CBM is marked by an emphasis on community-driven motivations for generating environmental data (Conrad and Hilchey, 2011; Pollock and Whitelaw, 2005; Whitelaw et al., 2003).

In recent decades, CBM has expanded rapidly – particularly in North America and Europe (Conrad and Daoust, 2008; McKinley et al., 2017; Silvertown, 2009), but also in other countries, including Australia (Wiseman and Bardsley, 2016), Brazil (Cunha et al., 2017), China (Zhang et al., 2017), Malawi (Wanda et al., 2017), New Zealand (Harmsworth et al., 2011), South Africa (Rivett et al., 2013), and Vietnam (Nhan et al., 2015). This growth is attributed to many factors including (1) the limited capacity and scope of monitoring conducted by scientists in government and academia; (2) the growing concerns of communities regarding the health of their local environment; and (3) the rise of affordable and simple technologies for crowdsourcing data and undertaking robust and accurate water monitoring (Buytaert et al., 2014; Conrad and Hilchey, 2011; Pollock and Whitelaw, 2005; Silvertown, 2009). Consequently, data collected through CBM are filling gaps in environmental monitoring, promoting sustainable natural resource management, and engaging communities in the conservation and stewardship of ecosystems (Buytaert et al., 2014; Ochoa-Tocachi et al., 2016). As this phenomenon continues to grow, there is an

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emerging need to understand and document the conditions that foster success in improving local environments through CBM data, as well as the ongoing barriers to community-based approaches in environmental monitoring (Conrad and Hilchey, 2011).

To further explore factors that foster or hinder the usability of CBM data, we conducted a cross-Canada survey of over one hundred CBM organizations. In this paper, we map those findings onto existing academic and grey literature on CBM with an emphasis on four key considerations highlighted in previous scholarship (Alender, 2016; Burgess et al., 2017; Buytaert et al., 2014; Conrad and Hilchey, 2011; Danielsen et al., 2009; Scott and Frost, 2017; Kouril et al., 2015; Pollock and Whitelaw, 2005). Our survey results are presented later in the paper; below, we outline the existing literature on CBM, and highlight four themes. First, we explore the reasons for which CBM programs initiate and the different data trajectories of CBM. Second, we review the credibility of CBM methodologies for collecting, storing, and/or analysing environmental data. Third, we discuss implications of the varying degrees of participation by local citizen scientists and external professional scientists throughout a CBM project life cycle. Fourth, we examine the potential benefits of CBM partnerships with governments, CBM networks, and other institutions in building capacity and fostering data-policy linkages in CBM programs. We utilise these four themes of CBM to shed light on outstanding questions in the CBM literature and to provide an analytical frame for our subsequent research questions: (1) Are CBM programs across Canada addressing the reasons for which they were originally initiated? (2) What protocols are being followed by CBM groups and which parameters are being monitored? (3) To what extent to do CBM program members feel their findings are incorporated into government-led decision-making processes?

1.1. Motivations for CBM

Understanding the diverse and place-based motivations for engaging in CBM is essential to generating sustained interest and participation in CBM programs (Bonney et al., 2014; EPA, 2016; McNeil et al., 2006; Pollock and Whitelaw, 2005). Although the spectrum of community-specific reasons for collecting and using water data can be challenging to classify, at least three broad categories (or progressive stages) exist. First, motivations can stem from a desire to generate community awareness, increase scientific literacy, and contribute to scientific research (Cohn, 2008; Dickinson et al., 2012; EPA, 2016). Second, communities may undertake CBM to fill gaps in government-led monitoring, and to identify and track local concerns about ecosystem and human health (Whitelaw et al., 2003; Conrad and Hilchey, 2011; Garda et al., 2017). Third, CBM can be initiated to leverage scientific knowledge to inform and improve policy and decision-making at various scales of governance (Danielsen et al., 2009; McKinley et al., 2017; McNeil et al., 2006), and to promote better compliance with environmental laws (EPA, 2016). The degree to which these categories motivate individuals will vary, as participant motivations often change across time (Rotman et al., 2014), and can diverge based on age, gender, level of education, and socioeconomic circumstances (Alender, 2016; Beza et al., 2017; Danielsen et al., 2005; Lewandowski et al., 2017; Raddick et al., 2013).

Another angle for examining motivations for CBM is to consider the potential uses of community-generated data. CBM data are variously used in academic publications (Ochoa-Tocachi et al., 2016; Scott and Frost, 2017), collected to supplement datasets collected by governments or NGOs (CABIN, 2012; Mackenzie Datastream, 2017; McNeil et al., 2006), provided as evidence for prosecution in cases of violations of environmental laws (EPA, 2016), and disseminated to the public through reports, workshops, and conferences (Pollock and Whitelaw, 2005; Weston and Conrad, 2015). However, using citizen data to potentially inform and improve policy and decision-making is emphasized consistently across both academic and grey literature on CBM (Alender, 2016; Buytaert et al., 2014; Castleden et al., 2016; Conrad and Hilchey, 2011; Danielsen et al., 2010; EPA, 2016; Kanu et al., 2016; NWT, 2010; Pollock and Whitelaw, 2005). To this effect, Conrad and Daoust assert that “regardless of the specific mandate, [participants in CBM] tend to have the hope that their efforts will be used to assist in local decision making” (2008, pg. 359). Moreover, Alender (2016) studied volunteer water quality monitoring in the United States and found that the highest ranking motivators for CBM was enhancing the environment and using data to address environmental problems, which implicitly requires some level of action by decision-makers.

Thus far we have explored literature on motivations for CBM without explicit attention to place, but connecting data to decision-making also needs to be situated within socioeconomic and geographic realities. For instance, Danielsen et al. (2009) suggest that local communities in poorer countries are more likely motivated by the potential benefits that monitoring offers in terms of community ownership, empowerment and decision-making surrounding their local environment and natural resources. This is supported by Buytaert et al. (2014), who highlight several case studies of low-income rural farmers utilising CBM primarily to inform and improve governance of water resources vital to agrarian livelihoods in Ethiopia, Kyrgyzstan, Nepal, and Peru. Additionally, Berkes et al. (2007) highlight cases of Inuit fishers and hunters in the Canadian Arctic using CBM and Indigenous knowledge to support integrated management of marine ecosystems on which their subsistence depends. These cases highlight the motivation of conducting CBM with the intention of securing remote and vulnerable livelihoods dependent on the preservation of ecosystems, which contrasts with more affluent regions where monitoring can arise out of a culture of volunteerism and outdoor recreation (Danielsen et al., 2005).

Considering the centrality of data-policy linkages within most CBM, it is important that monitoring programs are deliberately designed and implemented with the intention of generating actionable and credible information to decision-makers (Buckland-Nicks et al., 2016; Buytaert et al., 2014; McKinley et al., 2017). However, the credibility of CBM remains an ongoing challenge to achieving linkages between data and decision-making. Indeed, the issue of credibility has sometimes led government agencies and academic institutions to reject CBM findings that could otherwise potentially fill critical information gaps and guide environmental management decisions. Therefore, exploring past literature that has tested the validity of CBM and citizen science programs may shed light on approaches to avoid potential methodological issues that may arise in CBM and maximize the utility of citizen-generated data.

1.2. Credibility of CBM

A long-standing barrier to CBM is the perception among scientists that citizen-generated data is not reliable (Conrad and Hilchey, 2011). In particular, skepticism is often directed toward issues of data accuracy and biases (Burgess et al., 2017; Kosmala et al., 2016). Scientists have expressed concern about the capacity of non-experts to mitigate data errors, calibrate equipment, and undertake robust data analyses, especially in more complex fields of scientific inquiry. Generally, the literature asserts that citizen science and CBM, while suitable when using basic methodologies in fields such as ecology, hydrology, and astronomy, is not appropriate in many other fields of science (Cohn 2008; McKinley et al., 2017).