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# Understanding water pollution management: Evidence and insights from incorporating cultural theory in social network analysis

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## ARTICLE INFO

## ABSTRACT

Social network analysis gives a rigid assessment of network structure while cultural theory helps explain management outcomes in more detail. The combination of these methods provides significant and alternative insights about the complexity of water pollution management. Applied in the case study of the Calumpang Watershed in the Philippines, two types of relations were evaluated, namely, resource sharing and cooperative activities. Factors affecting cooperation and the creation of bridges were assessed in social network analysis, while cultural theory was used to reveal the underlying views of key actors on the nature of the river and its management. Evidence showed that cooperation was significantly influenced by resource sharing regardless of institutional affiliation, while bridges were created by becoming the pools of information and resources in the network. Using cultural theory, this study found out that local government officials dominantly have a mixture of hierarchist and egalitarian views characterizing belief in both rule-bound and group-motivated actions to solve the water pollution problem. However, their egalitarian views on management did not manifest in the current network. The study concludes that collaborative partnerships for water pollution management can be facilitated by promoting resource flow, utilizing influential bridges in the network, and understanding the unconventional values of government actors. Combining social network analysis and cultural theory is recommended to generate a more critical assessment of the institutional complexity of pollution and other water issues in watersheds.

## 1. Introduction

Water pollution is a transboundary environmental problem manifesting across different political and institutional jurisdictions. The dynamics of water pollution emerges throughout scale, space, and time requiring a substantial amount of resources for management, which many local governments do not have the capacity or commitment to invest in. Water pollution cannot be predefined by separate, self-supporting, autonomous units alone (Bodin and Crona, 2009) and integration of institutions involved and should be involved becomes increasingly complex in higher levels of scale (Wolfe, 2011). Scholars indicate that the complexity in water pollution could be more appropriately addressed by a network perspective of the hydrosocial relations (Loftus, 2009; Budds and Hinojosa, 2012), particularly regarding challenges in communication and information exchange (Horning et al., 2016).

Assessment studies of networks used in natural resource management have focused on generation, acquisition, and diffusion of resources and information (Isaac et al., 2007), mobilization and allocation of resources (Carlsson and Sandstrom, 2008), alignment and maintenance of commitment to common rules (McCauley and Van Velsor, 2004; Scholz and Wang, 2006), conflict resolution (Wolfe, 2011), and trust building (Borg et al., 2015). Analysis of networks helps increase awareness about power relations to catalyze information flow and strengthen its capacity for collective action (Diani, 2011; Hoppe and Reinelt, 2010). Social network analysis (SNA) has been applied to natural resource governance practice (Bodin and Crona, 2009; Bodin et al., 2006; Ernston et al., 2010; Stein et al., 2011) to better inform policy makers, but this emerging concept has not yet been consolidated (Newig et al., 2010) and more empirical studies are needed to explore its potential.

In this study, SNA was used to investigate local government efforts to address water pollution, specifically from pig and poultry farming, in the Calumpang Watershed, Philippines. In particular, two types of relations were assessed in the local government and the watershed level, namely, resource sharing and cooperative activities. However, what can be deduced from the SNA of local government ego networks may only reflect connections dictated by the formal government structure. This

can overlook important viewpoints that government nodes may hold to motivate partnerships with other important actors. In order to elicit latent views of government officials about the nature of the river and its management, the grid-group cultural theory was applied.

Cultural theory came from anthropology which was conceptualized almost five decades ago by Douglas (1970). It has been used in other disciplines but the most successful incorporation would be the myths of nature employed by ecologists studying institutions in natural resource management (Mamadouh, 1999). Cultural theory categorizes views of nature, in this case, the river and its management into four (or five) categories—fatalist, hierarchist, individualist, egalitarian, and autonomous. Rather than assume that local government officials embedded in the hierarchical model of the state strictly perceive from a hierarchists' point of view, the application of cultural theory in this paper challenges how the organizational context and individual views relate to one another. Doing so can identify incongruences and gaps between assumed tasks of local government offices and personal views, which can better understand how collaborations can be evoked beyond role-determined scripts.

## 2. Material and methods

### 2.1. Study site

The Calumpang Watershed is situated in the province of Batangas, Philippines. It is composed of eight municipalities/cities (Fig. 1). The Calumpang River is a perennial body of water and is one of the five major rivers in Batangas province. Agriculture is the primary economic activity in the province, particularly pig and poultry farming. While pig and poultry farmers contribute to economic progress from the increased demand of animal products in developing countries since the 1970s

(Delgado et al., 2001), the sector capitalizes on the negative externalities by profiting from production without accounting for the total social cost. Consequently, water pollution of rivers and creeks is inevitable when there is intensification of inputs without wastewater treatment facilities.

Water quality analysis of the Calumpang River done by the School of Environmental Science and Management, University of the Philippines Los Baños (SESAM-UPLB) in 2013 indicated that there was low dissolved oxygen and high biological oxygen demand in the water. Depleted dissolved oxygen is indicative of high organic matter in the water that may come from leaves and woody debris, dead plants and animals, animal manure, wastewater, and feedlots. Total coliform in the river was high ($> 15,000$ MPN/100 mL) which could emanate from livestock wastewater, septic tanks, and animal manure.

Local governments are aware of the pollution problem by responding through ordinances and other legislation since the 1990s. There have been at least fifteen environmental ordinances about pig and poultry farming since 1993 including the prohibition of the disposal of dead animals to the river, prohibition of constructing new farms near creeks and rivers, and the temporary suspension of operation. Despite these policy efforts and the observed transboundary effects of water pollution, inter-local government policy for collaboration was limited to a "call" by the Provincial Government of Batangas to municipalities and cities to commit to stopping pollution, and a memorandum of agreement between selected municipalities like Padre Garcia and Lipa City requesting for a field inspection and investigation of piggery farms located near rivers. Cooperative efforts between and among local government organizations and other actors to address water pollution are more evident in the organizational context than in the policy context. Organizations—government and non-governmental—initiate trainings, seminars, tree planting, river clean-up
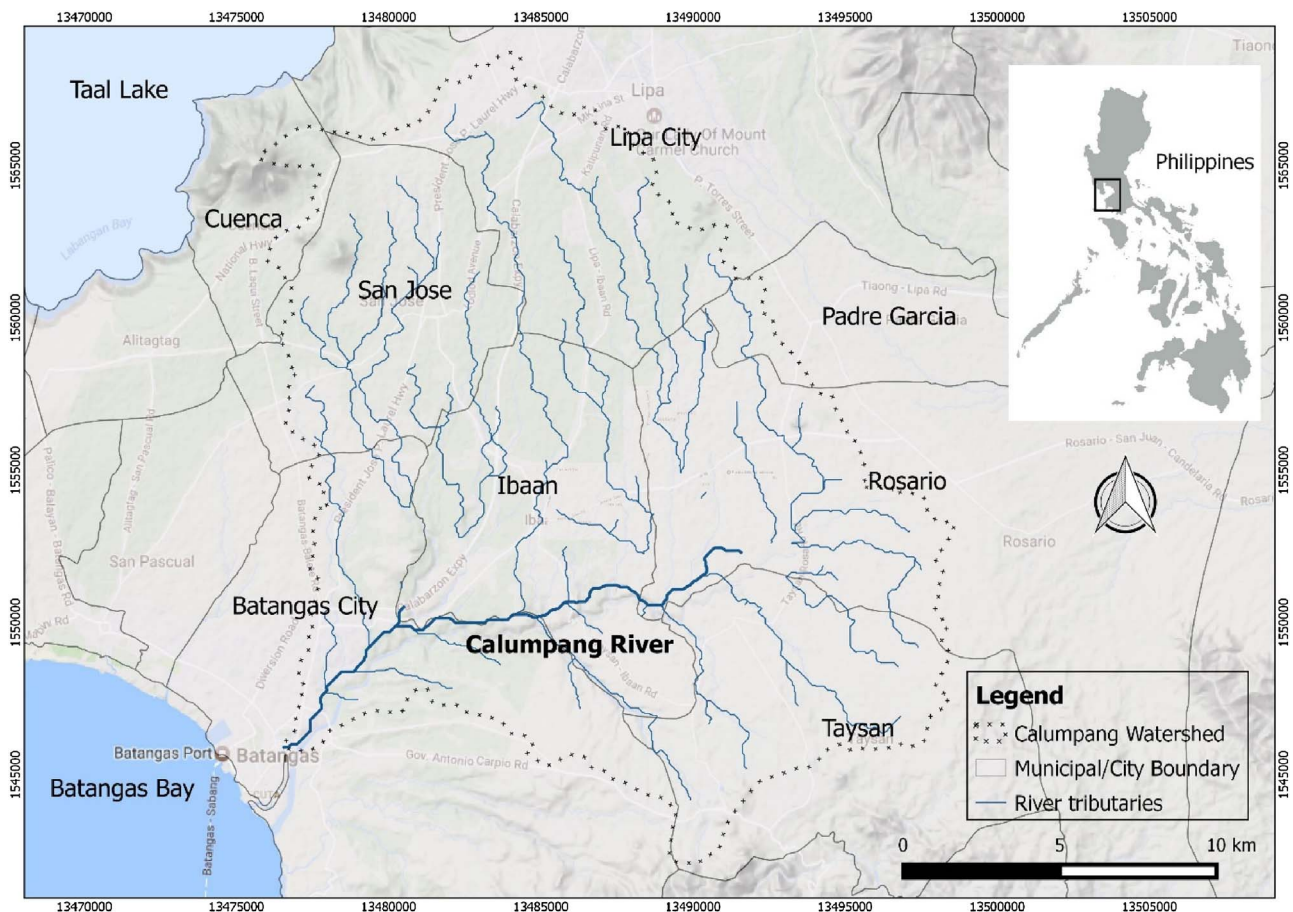


Fig. 1. Local governments in the Calumpang Watershed, Philippines.