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# Implementing the integrated water resources management approach in a volcanic river basin: a case study of Opak Sub-Basin, Indonesia

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RESEARCH ARTICLE



# Implementing the integrated water resources management approach in a volcanic river basin: a case study of Opak Sub-Basin, Indonesia

Vicky Ariyanti [a], Jurian Edelenbos [b] and Peter Scholten[c]

**ABSTRACT**

The ways in which integrated water resources management (IWRM) is implemented in a volcanic river basin (the Opak Sub-Basin) on the flanks of Mt Merapi volcano in Indonesia is examined. Data deriving from semi-ethnographic fieldwork and in-depth interviews are analysed through a multilevel governance lens that considers three pillars of management – conservation, utilization and hazard control – and three levels of governance – national, regional and municipal. The research shows that the regional level is the priority playing field; that the degree of integration differs between levels of government; and that actors called 'whisperers' support higher integration levels, have the greatest ability to form bridges between communities and government.

**ARTICLE HISTORY**

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**KEYWORDS**

integrated water resources management, volcanic river basin, multilevel governance, interaction efforts, integration level

**JEL**

**摘要**

关于火山河流盆地水资源综合治理方法的实施：以印尼奥帕克子盆地为例. *Area Development and Policy*. 本文对于印度尼西亚默拉皮火山两侧的火山河流盆地（奥帕克子盆地）实施水资源综合管理的方法进行了探讨。研究数据是从半人种学实地调查和深入访谈中获得的，通过多层次的治理视角进行了分析。该视角从治理的三大支柱考虑——保护、利用和危害控制，以及三个治理级别——国家，地区和市政。研究表明，区域层面是被优先考虑的。治理的级别不同，程度也有所不同。综合治理程度越高，被称为"耳语者"的执行人就越有能力在当地社区和政府之间架起沟通的桥梁。

**关键词**

水资源综合治理, 火山河流盆地, 多层次治理, 相互努力, 综合水平

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**RESUMEN**

Aplicación del enfoque de gestión integrada de los recursos hídricos en una cuenca hidrográfica volcánica: estudio monográfico de Opak Sub-Basin, Indonesia. *Area Development and Policy*. En este artículo se examina de qué modo se aplica la gestión integrada de los recursos hídricos en una cuenca hidrográfica volcánica (la Opak Sub-Basin) en los flancos del volcán Mt Merapi en Indonesia. Para ello se analizan los datos de un trabajo de campo semietnográfico y de entrevistas exhaustivas a través de un objetivo de gobernabilidad de varios niveles que considera tres pilares de gestión: conservación, utilización y control de peligros, y tres niveles de gobernabilidad: nacional, regional y municipal. El estudio muestra que el nivel regional es el campo de juego prioritario; que el grado de integración difiere entre los niveles de gobierno; y que los protagonistas llamados 'susurradores', con niveles más altos de integración, tienen la mayor capacidad para crear puentes entre las comunidades y el Gobierno.

**PALABRAS CLAVE**

gestión integrada de los recursos hídricos, cuenca hidrográfica volcánica, gobernabilidad de varios niveles, esfuerzos de interacción, nivel de integración

**АГЛОМЕРАЦИЯ**

Внедрение комплексного подхода к управлению водными ресурсами в бассейне вулканической реки: исследование суббассейна реки Опак, Индонезия. *Area Development and Policy*. В статье рассматриваются подходы к интегрированному управлению водными ресурсами (ИУВР) в суббассейне вулканической реки (Опак) у подножия вулкана Мерапи в Индонезии. Данные, полученные в результате полуэтнографических полевых исследований и углубленных интервью, анализируются через призму многоуровневого управления, включающего три основных элемента управления – сохранение, использование и контроль угроз – и три уровня управления – национальный, региональный и муниципальный. Исследование показывает, что приоритетным является региональный уровень; что степень интеграции различается между уровнями управления; и что субъекты, называемые "шепчущими", с более высокими уровнями интеграции обладают наибольшей способностью создавать связи между общинами и правительством.

**КЛЮЧЕВЫЕ СЛОВА**

интегрированное управление водными ресурсами, вулканический речной бассейн, многоуровневое управление, усилия по взаимодействию, уровень интеграции

## INTRODUCTION

Dating from the 1990s, an integrated water resources management (IWRM) approach has gained popularity owing to the work of international actors such as the Global Water Partnership and the World Bank (Biswas, 2004; Jaspers, 2003; Savenije & Zaag, 2008; Snellen & Schrevel, 2004; Solanes & Gonzales-Villarreal, 1999). The IWRM approach governs Indonesian water management, having been adopted on the initiative of the World Bank after the 1997 monetary crisis (Asian Development Bank, 2016; Government of Indonesia, Inter-Agency Task Force on Water Sector Policy Reform, 1999) and enacted in Law no. 7/2004 on water resources management.

Indonesia is composed of 16,000 islands (UNGEGN, 2018), and, with 264 million inhabitants, it has the fourth largest population in the world (World Bank, 2017). In the

IWRM approach, the unit of management is a river basin, a concept translated by the Indonesians as a river basin territory (denoted here as WS) (Keppres no. 12/2012, 2012).

Indonesia faces the challenge of pre-existing management practices (Fulazzaky, 2014). Moreover, the archipelago sits in the Ring of Fire, the constellation of the majority of Earth's volcanoes in the Pacific Ocean (USGS, 2017). Mt Merapi, located upstream in the Opak Sub-Basin, is one of the most active volcanoes in this constellation. Its eruption in 2010 measured 4/7 on the volcanic explosivity index, killing around 300 people, sent 140 million $m^3$ of lahar downstream and devastated the whole of the Yogyakarta Special Region and some parts of Central Java Province.

## THEORETICAL FRAMEWORK

Previous geological, hydrological and geographical research defines a volcanic river basin (VRB) as a water catchment (basin) with an active volcano as its origin (Izquierdo, 2014; Larkin & Sharp, 1992). The volcano's activities dynamically impact both surface and groundwater hydrological conditions (Parisi et al., 2011).

Implementation of the IWRM approach can be assessed in many ways (Biswas, 2004; Burton, 1995; Cardwell, Cole, Cartwright, & Martin, 2006; Hofwegen & Jaspers, 1999; Jaspers, 2003) based on an IWRM's four dimensions: natural, spatial, temporal and human (Savenije & Zaag, 2008). In the real world, these dimensions are interrelated, and the actors are multilayered. Therefore, the authors decided to structure these complexities using the concept of multilevel governance (MLG) (Hooghe & Marks, 2001). The MLG framework specifies levels or boundaries of management, which take shape within jurisdictional scopes (Gupta & Pahl-Wostl, 2013). Only some of these boundaries are flexible. In this research, both types of boundaries are used to unravel how water is managed in a VRB. The MLG lens reveals a distinction between the IWRM policy setting and the IWRM managerial level. This study also analyses interaction efforts and integration levels in this sub-basin study.

The multilevel aspect of governance results in a jurisdictional 'spill-over' or overlap (Hooghe & Marks, 2003). This overlap arises in interactions that arise where actors from different levels and sectors convene to discuss problems and negotiate. An interaction happens when two or more entities form a reciprocally influencing interrelation (Kooiman, 1999). In this study, these interactions are termed interaction efforts because they are not always successful. Three possible kinds of interactions are interferences, interplay and interventions. The first kind is spontaneous; the second is more organized than the first; and the last is formalized (Kooiman, 1999). The interaction efforts found in the MLG examined in this study are characterized in terms of these possibilities.

The level or degree of integration is divided into coordination (lowest), collaboration (mid) and cooperation (highest), depending on the successfulness of interaction efforts (Emerson & Nabatchi, 2015; Hall, Clark, Giordano, Johnson, & Van Roekel, 1977; Kooiman, 1999). Coordination refers to the existence of information sharing (Hall et al., 1977). Collaboration refers to information and aim sharing (Emerson & Nabatchi, 2015). Cooperation refers to information, aim and budget sharing (Kooiman, 1999).

## RESEARCH METHODOLOGY

An embedded case study strategy was adopted to set a researchable scope for a wider study of the Opak Basin, of which the present study forms a part. The chosen basin is a VRB located at the flank of Mt Merapi, one of the most active volcanoes in the world. The last massive eruption in 2010 was taken as the baseline for the study. As the study required a more in-depth investigation than a general picture of the basin, subcases were examined at the village

level (representing up-, mid- and downstream locations) in Yogyakarta, Sleman and Bantul. These localities were chosen based on the severity of the lahar flood, as indicated in 2010 reports by the river basin organization (RBO) (BBWS SO) and the disaster management agency (BPBD DIY).

This study adopts a qualitative, semi-ethnographic methodology, using tools ranging from observation and interviews to focus groups. The fieldwork lasted two months in 2016 and one month in 2018 (57 respondents). The primary data emanate from observation and interviews, compiled using snowball sampling, and recorded in audio and video footage. Samples include purposive samples of the community, members of government institutions, experts on water resources and the VRB management context. The secondary data emanate from respondents' references to regulations. They consist of memorandums of understanding, planning documents, minutes of meetings, and other related materials that clarify the primary data information.

The analysis was performed with Atlas.ti for axial coding based on the theoretical framework of the four IWRM dimensions (Savenije & Zaag, 2008) and levels of MLG (Hooghe & Marks, 2001). Additionally, triangulation using a map of interaction efforts is used to determine the integration level.

Actors' interactions on each of the levels demonstrated patterns of interaction attempts that linked to the patterns of integration level in IWRM implementation. Vertical interaction efforts (between levels of governance) and horizontal interaction efforts (at the same levels: sectors, domains and public–private) reflect the characteristics of connective capacity in the water governance structure (Edelenbos, Bressers, & Scholten, 2013). Nevertheless, the effectiveness of these attempts is not automatically linked to the levels of governance. Thus, the integration level is used to differentiate this level of efficiency, which increases as integration progresses (Bouckaert, Peters, & Verhoest, 2016; Kooiman, 1999): (1) coordination, where information is shared, without shared aims; (2) collaboration, where information is synchronized, with shared aims; and (3) cooperation, where information is synchronized with shared aims and budgeting.

## DISCUSSION

The IWRM dimensions framework posits patterns of governance in two layers: the policy setting and the management context. These layers are located within the three levels of governance: national, regional and local. The first layer represents the policy setting in the context of regulations in Indonesia on managing water resources, which are divided into three phases. The second layer represents the interrelations of actors and their roles in the IWRM dimensions clustered into levels of governance and pillars of management: water conservation, utilization and hazard control.

### Policy setting

The overall policy setting in water resources management in Indonesia is aligned with the IWRM concept (Global Water Partnership, 2000; World Bank Group, 2015), although policies do not refer directly to this concept. The current water management sector in Indonesia is divided into two historical timelines: phase 1 (2004–13) and phase 2 (2013–17) because Law no. 7/2004 was revoked in 2013 (Table 1).

#### *Phase 1 (2004–13)*

The essential definition of water resources management is given in Law no. 7/2004: 'Water resources management is the effort of planning, implementing, monitoring, and evaluating the implementation of conservation of water resources, efficient use of water resources and water-

**Table 1.** Phases of Indonesian integrated water resources management (IWRM) policies, 2004–17.

| Differences | Phase 1 (2004–13) | Phase 2 (2013–17) |
|---|---|---|
| Definition of water management | Water resources management | Irrigation management |
| Policy products | Law no. 7/2004, Government Regulations, Presidential Decree, Ministerial Regulations | Back to Law no. 11/1974, Government Regulation, 30 Ministerial Regulations |
| Role sharing | National and local (regional–municipal) government share roles | Most mandates are centralized to the national government (based on Law no. 23/2914 on Local Government) |
| Partnership opportunity | Private sector gets better a chance | Private sector may play an investment role after the national or local government-owned enterprises, after long scrutiny |
| Main stakeholder in water management | Collaboration of ministries as mandated by the law | Dominated by the Ministry of Public Works and Housing as mandated by the regulations |

related disasters mitigation.' This law also defines the five pillars of IWRM in Indonesia as follows: (1) increase water conservation; (2) use water resources; (3) control and mitigate the damage of water hazards; (4) expand the role of the community and private sector; and (5) build a network of information systems on water resources. The first three pillars structure the managerial layer examined here and form the boundaries of Indonesia's water MLG. The WS is taken as the scale of management. A WS is defined as one or more basins/catchments coming under one authority (RBO). The catchment (DAS: Daerah Aliran Sungai) is a smaller scale unit of management under the WS. However, it is governed by other regulations and is the responsibility of the Ministry of Forestry and Environment, and is more concerned with the conservation pillar. Water hazards control is governed by Law no. 24/2007, and comes under disaster management agencies. Management is divided, coming under national, regional and municipal administrative jurisdiction. Disaster law divides the types of hazards into natural and human-made. Concerning water hazards, the law includes the management of floods, landslides, droughts and lahar.

### *Phase 2 (2013–17)*

When Law no. 7/2004 was revoked in 2013, an older version was re-enacted: Law no. 11/1974 on Irrigation. That law was created in the period of the authoritarian New Order (Orde Baru) regime (1966–96). This law referred to the concept of water and not of water resources. In that law, the concept of management is based on technical solutions as follows: 'A water system is a set of structures and water sources and/or irrigation infrastructures according to the provisions of the engineering construction sector in the irrigation area.' Therefore, to adapt to current terminologies in the IWRM approach, this old law is complemented by the Minister of Public Works and Housing's (KemenPUPR) Regulations. Since 2015, more than 30 regulations have been involved. These regulations are all based on Law no. 7/2004. This challenging condition is exacerbated by the merging and reshuffling of ministries in 2015 (a new presidential term) and the inception of Law no. 23/2015 on Local Government that deals with the division of jurisdictions between national, regional and municipal governments across

all sectors. Regarding water resources, this division of jurisdictions applies to the management of all water infrastructures, irrigation channels, irrigation areas, drainage systems, wastewater and groundwater. This division of authority does not work, as it conflicts with the centralized nature of Law no. 11/1974. This change has resulted in a degree of stagnation at the level of the regional government, as much of the responsibility for supervision and monitoring has reverted to the national government. This situation increases the urgency of the introduction of an updated law in Indonesia to support IWRM implementation.

## Managerial context: IWRM in a VRB

This section deals with the MLG of water resources, presenting the actors and their jurisdiction at national, regional and municipal levels. At each level, the Indonesian IWRM pillars are used (water conservation, utilization and hazard control) to reveal IWRM implementation. The existing management arrangements are divided between these levels.

### *National: policy orientation*

At the national level, the IWRM suggests coordination of inter-ministerial, intersectorial and multi-interest stakeholders. However, little coordination is observable at this level. Each of the IWRM pillars – conservation, utilization and hazard control – has a lead sector headed by a ministry or an agency. Also, the VRB context is not mainstreamed in IWRM implementation in Indonesia. The monitoring of volcanic activities falls under the Centre for Environmental Geology and Volcanology (PVMBG), Ministry of Energy and Mineral Resources (KemenESDM). It acts under Ministerial Regulation no. 15/2011 on the mitigation of volcanic hazards, land movement, earthquakes and tsunami hazards. The characteristics of water management in volcanic basins differ depending on the condition of the volcano, whether it is normal or erupting. In normal conditions, river basin management is also normal, but, during eruptions, the combination of annual floods with the release of volcanic materials pose lahar threats.

The water conservation pillar is active during normal conditions. The catchment and water quality are managed by the Ministry of Forestry and Environment (KemenLHK). This ministry manages 765 DASs, in line with Government Regulation (PP) no. 37/2012 and the Minister of Forestry's Decree.

The water utilization pillar covers both surface water and groundwater. However, mandated by law, priority is given to surface water. The main works are mandated to the KemenPUPR under the Directorate General of Water Resources (Ditjen SDA: Sumber Daya Air). The Ditjen SDA issued guidelines to establish a framework and a master plan to be implemented in WSs. The Bappenas (planning agency) addresses this in the RPJPN or the National Development Long-Term Plan (20 years: 2005–25), referring to 'one river under one management' (i.e., a WS). The WS concept forms the base for the founding of RBOs under the Ditjen SDA. The Presidential Decree (Keppres) no. 12/2012 divides Indonesia into 133 WSs, which corresponds to 34 RBOs under the Ministry of Public Works and Housing along with privately owned RBOs. However, there are 127 active volcanoes in Indonesia (Permen ESDM, 2011; Vrolijks, 1998), implying a ratio of almost one volcano per WS, except for Papua and Borneo Islands. Another actor, the Ministry of Energy, Minerals, and Resources (KemenESDM), is responsible for groundwater management nationwide. The ministry defines and monitors the 421 groundwater basins (CAT: Cekungan Air Tanah) under Keppres no. 26/2011.

The water hazards control pillar operates from a technical point of view, controlling the hazard, not the people. According to Law no. 7/2004, water hazards are comprised of floods, droughts, coasts, landslides and lahar. However, for general hazards, this law correlates with Law no. 24/2007 on Disaster Management. The National Disaster Management Agency

(BNPB) and the BPBD (regional and municipal) were founded based on this law. The law identifies how people are to be kept safe from potential hazards in Indonesia. BNPB data for the period 1980–2012 indicate that floods were the most common hazard (38%), but volcanic eruption produced the most victims (32%) (BNPB, 2015). The BNPB manages disaster risks and mitigation strategies through early warning systems, land-use policy, evacuation routes, meeting points and training of trainers. If volcanoes are active in any given river basin, the monitoring agency must participate in any relevant decision-making processes. This participation is neither mandated nor implied anywhere in normal conditions, only during an eruption.

This fragmented water resources management system, with different actors with different visions and aims, contributes to the main problems characterizing national level IWRM implementation.

### *Regional: the priority playing field*

At the regional level, the water management structure is the same as at the national level. Some actors originate from the regional government and others from the national government: branch offices of the ministries. Aside from that, there are regional water supply companies (PDAM: Perusahaan Daerah Air Minum) and community-based organizations (CBOs) (AKSY and Pammaskarta DIY).

The water utilization pillar is managed at the WS scale at the WS Progo Opak Serang. The RBO that manages it is called the BBWS SO, under KemenPUPR, Ditjen SDA. The IWRM pillars are translated into public works domains relating to water infrastructure planning, implementation, operation, maintenance, monitoring and evaluation. The WS is comprised of three DASs (Progo, Opak and Serang). The Opak Basin itself originates from two sources: Mt Merapi (Opak Sub-Basin) and the Karst area of Gunungsewu (Oyo Sub-Basin). The Opak Sub-Basin – the focus of this paper – portrays the condition of water utilization in a VRB. The Opak Basin water balance is shown in Figure 1, based on a 20-year analysis of hydrological data (1995–2015) presented in the RPSDA, the Basin Water

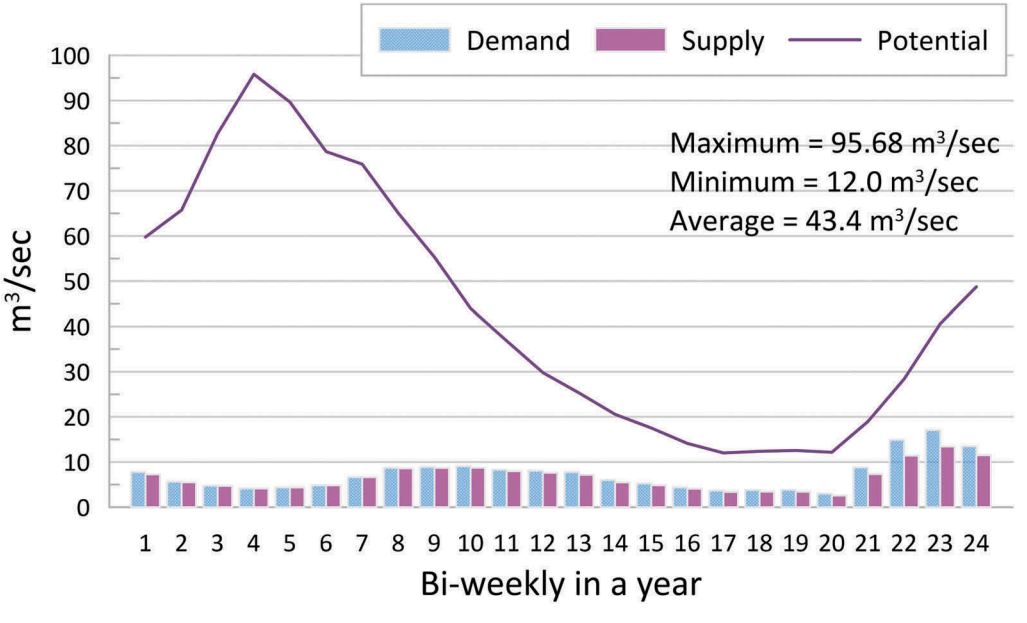


**Figure 1.** Opak River water balance.

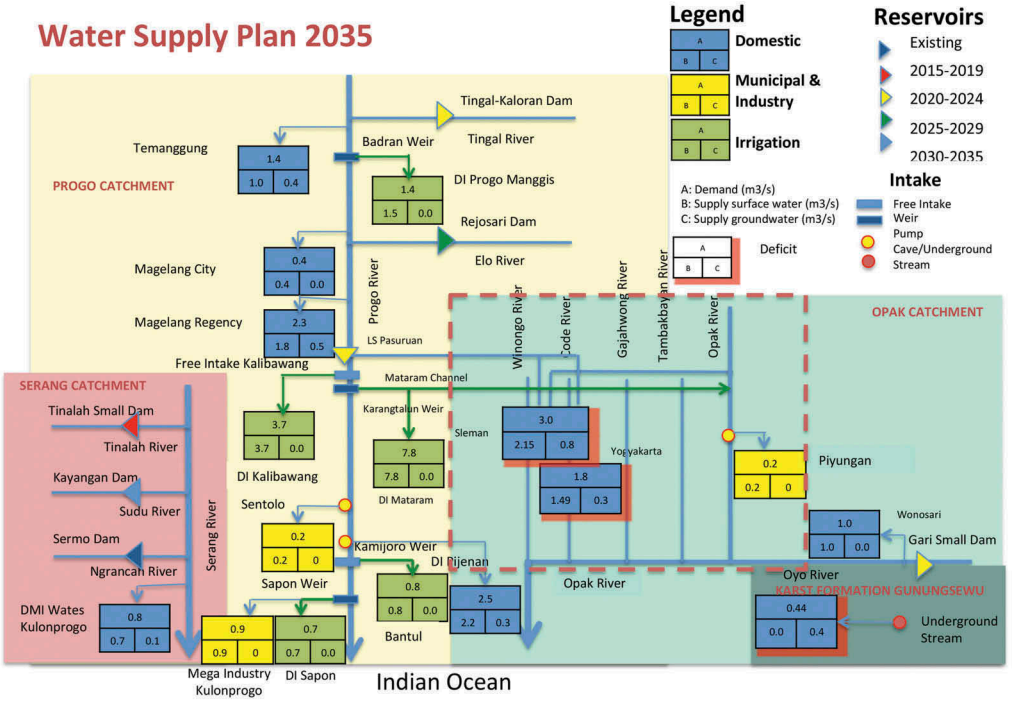


**Figure 2.** Water supply plan for WS Progo Opak Serang (BBWS SO, 2015).

Resources Master Plan or BWRMP for WS POS. It shows that demand is still low in comparison to its potential.

A utilization scheme based on this water balance is shown in Figure 2. The Opak Sub-Basin is highlighted inside the dashed-line box. Shown is the water supply plan for water utilization for domestic and industrial use and the irrigation inter-basin transfer between the Progo and Opak. It shows that the existing water supply infrastructures do not include big dams; rather, they are comprised of weirs, small dams, groundsills or river intake, and even Sabo Dams (lahar control structures) with water intakes.

This water supply plan is part of the BWRMP for WS POS and was agreed by the water resources management coordination team (TKPSDA WS POS). The RBO hosts a coordination team. The groundwater balance has never been included in the calculation, as it is not part of the RBO's responsibilities. Before the existence of the WS, the utilization pillar used irrigation areas (DI: Daerah Irigasi) as the management unit. The irrigation areas date back to the Mataram Kingdom (Christie, 2007; Ravesteijn & Kop, 2008), with the Mataram Channel serving as an essential infrastructure connecting the Progo and Opak Basins. The management of DI Mataram falls under the BBWS SO. An actor here is the Pammaskarta DIY (water supply cooperative), which aids in supplying non-piped drinking water to communities. However, under the current policy setting, the regional actors have little involvement in water management. Their works on rivers and small dams have stopped; now they work only on irrigation channels.

Regarding the water conservation pillar, land use in the Opak Sub-Basin is divided between a national park, forest, farmland and residential. As land in VRBs consists mostly of sand, which is very good for water infiltration, the Opak Sub-Basin has good groundwater reserves. The upper stream within a 4 km radius of the summit of Mt Merapi is a dedicated

National Park managed by the Ministry of Forestry and Environment. The BPDAS-HL SOP (Catchment Management Office) administers the rest of the catchment, which created the RPDAST Opak (Opak Catchment Conservation Master plan) and initiates the Local Regulation on Catchment Management (Perda DAS). This local regulation emphasizes the importance of the region's special status. It highlights its cultural values, such as the *hamemayu* philosophy (humans are responsible for conserving the beauty of the world) and local knowledge on resources management. The spatial plan (RTRW DIY) suggests that the WS consists of only the space around the river, where it controls forms of land-use disruption around the WS. The Conservation Master Plan of Opak Basin proposes water conservation through land-use proposals, which is in line with the spatial plan drawn up by the basin water resources master plan. Although the approximate alignments of the conservation areas are the same, the priorities differ and, at times, they conflict with current land use. Another existing actor is AKSY, the association of river community-based organizations in the Special Region of Yogyakarta, which helps to develop community river restoration awareness.

For the water hazard control pillar, the leading agency is the BPBD (Disaster Management Agency), which works collaboratively with the BBWS SO (RBO) and the PU-P ESDM (Regional Public Works, Housing, Energy and Mineral Resources Agency) in the disaster taskforce. A lahar flood comes later than the volcanic eruptions, but it is not recorded on a separate list by the Disaster Management Agency. For lahar occurrences, more data are obtained at the BPPTKG, the Volcano Centre, as a branch office of the Ministry of Energy and Mineral Resources (KemenESDM). The RBO works with the infrastructures to control floods as they are located by the river (embankments and Sabo Dam). The Public Works Agency no longer has authority for river management, but as it possesses the capacity (heavy equipment and human resources), it helps during the onset of eruptions. All rivers originating at a volcano are natural channels for pyroclastic and lahar flows. This condition affects the physical and chemical conditions of aquifer systems and rivers. The water in the upstream area is not potable during an eruption; alternative water resources have to come from elsewhere. In such circumstances, the water supply cooperative helps to provide the affected area with water from other sources.

This conjunction of conditions explains why the regional level is the priority playing field for IWRM implementation because the capacities and budget support for implementation are located at this level. The RBO's roles in all pillars reflect the high degree of national government involvement at the regional level.

### *Municipal: the informal playing field*

The municipal level follows the regional level, but here there is also informal governance by the community. This level does not have a coordination team or jurisdiction in managing water, and some actors are not as capable as the regional actors. The examination of subcases as representative of the general situation reveals 'boxed' sectors and domains. Although governmental structures such as the Municipal Development Agency (Bappeda) and the Municipal Water Resources Agency (DSDA) exist, they are not apparent to village communities. These actors have limited capacity and budget to address problems, especially when it comes to inter-municipality coordination. The priorities of the water management pillars differ. The communities in subcases 1 (Forum SKSB, the social communication forum) and 2 (Paguyuban RW, self-governed riverside community forum) are more active in managing floods than in subcase 3, where the community relates water to agricultural tourism. The type of CBO espoused is based on each community's needs. In this research, hamlet chiefs provided relatively better inputs about potential water sources, local knowledge and water needs in isolated areas. They are more knowledgeable than the village chief because they are indigenous

people. Furthermore, the village chief is an appointed person who can be from somewhere else.

Water utilization is divided between drinking water supply and irrigation. Regarding water supply, the drinking water company is owned by the municipal government (PDAM). Located upstream at Sleman Regency, Argomulyo Village, District Cangkringan, the PDAM Sleman affords an example. The water is taken from the river Gendol near Sabo Dam GE-D, which has multi-functions of lahar control, water intake and a temporary bridge. Although the water is processed *in-situ*, it is distributed to other areas. The villagers do not use water supplied by this company but rely on wells for drinking water. This case is representative because: (1) piped water is available, but limited for the three subcases; and (2) communities used wells long before the existence of piped water in the 1960s. The quality of the water from the wells is trusted more than the piped water, and they do not need to pay extra for water use.

Irrigation use still dominates the management of water resources in Indonesia because the government has to provide big infrastructures that villagers cannot provide for themselves. Farmers constitute the main local communities involved in irrigation management. Irrigation is managed by P3As (water user associations – WUAs). The village-level WUA falls under the coordination of water resources agencies. These agencies manage the irrigation water supply, but, in reality, the farmers manage water circulation, maintenance and operation. WUAs also have strong ties with the RBO, as the water they use comes mostly from a weir in the main river. However, there is a steep hierarchy between the WUAs and the RBO. The WUAs need first to contact their municipal water agencies, the regional level water agency, and then the RBO. This hierarchy hampers the provision of on-time aid needed by the community.

At the municipal level, there are variations of CBOs for river communities. At the city level, the Pemerti Code (Code River Awareness Community) has established a citywide river community, as found in subcase 2. This type of community, hosted by Forum Sungai (river forum) and sponsored by the BBWS SO, aims to provide a better communication channel. Future aims for these communities include river restoration. In this case study, the lead was taken by an academician and pioneer of the Indonesian River Restoration movement. He explained the importance of river communities as follows:

> It is urgent. So, the growth of these community organizations affects the quality and quantity of water available. Then, new awareness will emerge on reduced groundwater, which was experienced by the public and the government. There is a problem, there is a solution, but there has to be a bridge. The bridge that connects is this [human dimension]. (respondent expert in water resources management, Gadjah Mada University, 2016)

Water hazards control is led by municipal BPBDs with the collaboration of a disaster forum. Most of the CBO members mentioned above are also members of their Tagana (village disaster response team) and work collaboratively with the municipal BPBD. The forum works through visual monitoring of the river condition during floods and communication by walkie-talkie radios. The radio affords two-way communication, reaching communities up- and downstream. These people are volunteers. Most are villagers with another job, but whose houses or fields are near the rivers. Therefore, this level sees a proliferation of informal sectors, bottom-up initiatives, but their approach is 'boxed' within their municipalities.

## Interaction efforts

Although water management is arranged based on IWRM pillars, interaction efforts cannot be categorized in the same way. The findings indicate that these efforts are arranged on themes where IWRM pillars are practiced. Each theme is located in the governance hierarchy. The themes are: (1) budget for water utilization and conservation based on building infrastructure;

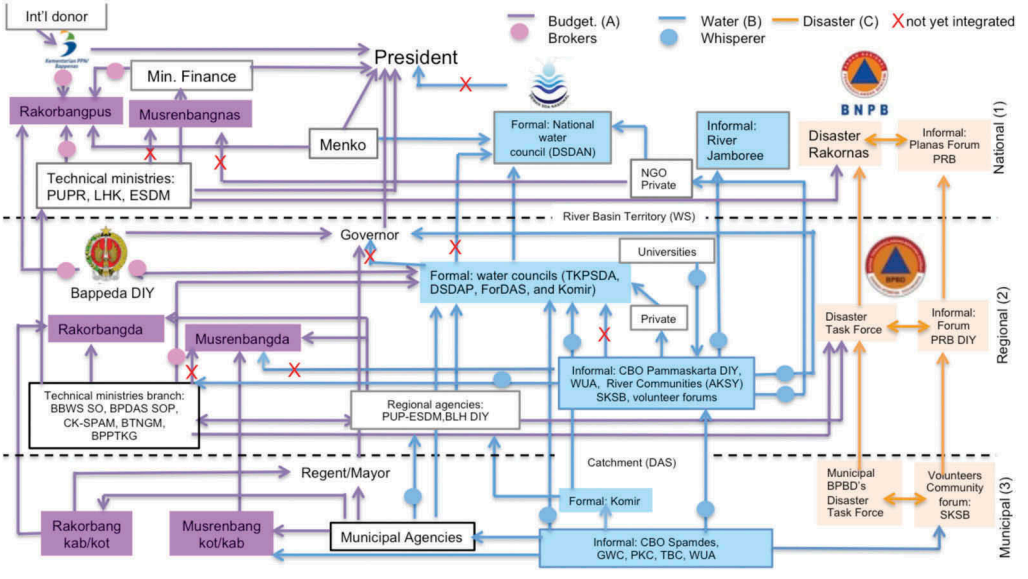


**Figure 3.** Interaction efforts.

(2) water for general utilization and conservation; and (3) disaster hazard control (Figure 3). Formal interaction efforts are initiated by government agencies and informal efforts by non-governmental actors. They are located on each level of the governance hierarchy (horizontal) and also intermediate levels (vertical).

## *Budget: the formal efforts*

Budgets are available and exist in the horizontal arrangement at each level (national, regional and municipal) but also function as a vertical arrangement when representatives of lower levels of governance attend higher level meetings. Two types of meetings are held: *Rakor* (government coordination meetings) and *Musrenbang* (public–private–society representatives' meetings). Annual national budgeting (APBN) is an essential aspect of this engagement, continuing throughout the year and usually involving a smaller budget team: technical ministries (either KemenPUPR and KemenLHK), the Bappenas, and the Ministry of Finance (KemenKeu). The person who coordinates this limited effort is termed as the broker. It functions as an inter-ministerial bridge and operating at each level of governance, especially concerning the budget mechanism.

> Yes, only one [broker], which changes each year. Later, we need to find who is arranging the budgeting priorities and boosting the possibility of getting the budget; we need to prepare additional projects, if the original project got cancelled. (respondent, BPSDA DIY, 2018)

At regional and municipal levels, similar arrangements exist for preparing the local budget (APBD). This condition implies that interaction mechanisms are available, but they are not used as a way to connect effectively, instead of focusing back on the 'boxed' budgeting for each sector. The nature of these meetings is ceremonial, and sectorial ego exists between ministries.

> Not yet [effective], well the bad thing in Indonesia, especially at the national government, sectorial ego still exists. In front of the President, things look good, but afterward, everyone goes back to their offices, each on their own. (respondent water expert, 2016)

### *Water: formal and informal efforts*

The formal interaction efforts involve water councils and an irrigation commission with a 50%:50% ratio of governmental and non-governmental representatives. At the national level, the Ministry of Public Works and Housing (KemenPUPR) hosts the National Water Council (DSDAN). At the regional level, this is translated into the TKPSDA (hosted by the RBO based on the WS), the DSDAP (hosted by the PU-P ESDM based on provincial administration), and Forum DAS (catchment conservation hosted by the BPDAS-HL SOP). The meetings of these water councils are also ceremonial. Many results are general recommendations to the head of government. However, there is no mechanism available to ensure that these recommendations are adopted in action planning or budgeting for the members. Furthermore, at the regional and municipal levels, there are the Komir or irrigation commissions. Coordination at the municipal level is more technical as it deals with the day-to-day basis for irrigation practice, whereas at the regional level, it is more concerned with irrigation water allocation.

Coordination works better in the Komir than in other water councils, as it offers direct benefits for farming activities.

> Even if as the [water council] head, I never had time to dwell on [problems]. What I feel as a bureaucrat, there are too many meetings. So, we do not have time to think about necessities. I have not accomplished many things. Komir is more technical [than the TKPSDA]. (respondent PU-P ESDM, 2018)

The informal efforts emanate from community initiatives, originating at the municipal level but working up to the regional level. The three main ones are Pammaskarta DIY meetings (water supply communities at the regional level), River Jamboree AKSY (river communities at the national level), and AKSY meetings (river communities at the regional or even municipal level).

At the municipal level, both formal and informal efforts are done through 'whisperers', those who have useful contact networks and are members of a community, an institution or an independent entity. These people function as trusted persona to convey important messages and, at times, hint at priorities for action. 'Precisely whispering it [is better than] submitting a proposal [as it will] just be stacked' (Respondent, Case 3, Argomulyo, 2016).

The Pammaskarta DIY convenes its meetings not as part of government initiative activities but as part of its organization of Spamdes (municipal and village water supply communities). The Pammaskarta effort – region-wide water supply coverage – was acknowledged nationally, as 80% of its piped water supply target was achieved.

The River Jamboree has been held twice, in 2016 and 2017. The aim is to raise awareness of the river restoration movement, especially for urban rivers in Indonesia. The jamboree held in 2017 in Yogyakarta attracted national attention. Its activities included direct observations in the rivers to record waste and to understand the ecosystem. In these informal efforts, the government sometimes provides budget support, collaborates with action or provides premises for meetings. Participants can also be invited to informal meetings, for example, the BBWS SO, as the RBO was invited to AKSY meetings to discuss river matters. These meetings are two-way discussion forums, creating a useful bridge between government and non-governmental actors.

> We may not have the [formal] 'umbrella.' Nevertheless, we are as responsible party for the entire rivers. We are there, so they always discuss things related to rivers with us. (Respondent BBWS SO, 2016)

### *Disasters: formal efforts and combined with informal efforts*

In times of disaster, formal efforts involve the disaster taskforce (Satgas Bencana), and informal contributions involve the disaster management forum (Forum PRB), both located in each level of governance. The National Disaster Management Agency (BNPB) hosts these efforts at the national level, with the Local Disaster Management Agencies (BPBD) hosting them at regional and municipal levels. The Ministry of Public Works and Housing (KemenPUPR), as a technical ministry and its branch office (RBO), has to report water hazards monitoring data to the Disaster Management Agency as the base for evacuation decisions. Meanwhile, for volcano eruptions, the responsible technical ministry is the Ministry of Energy and Mineral Resources (KemenESDM), with the PVMBG as the Volcano Monitoring Centre. Forum PRB has more influence and flexibility in disseminating information and supporting coordination, collaboration and even cooperation, as it works without ministerial boundaries. However, pre- and post-disaster, inter-ministry coordination (KemenPUPR–KemenESDM–BPBD) is non-existent for water, volcano and disaster management.

## Integration level

The integration levels are not the same for each managerial level and do not correspond to the governance level. However, an explanation of the situation is set out by the level of governance: national, regional and municipal. On each level, based on the findings, there are progressive integration levels as defined in the research methodology section: coordination, collaboration and cooperation.

At the national level, attempts at coordination confront difficulties. Despite the efforts of national actors to coordinate, jurisdictions between ministries overlap, and the different ministries have sectorial egos. Each has its own set of regulations and different ways of thinking.

> Not integrated, because what I saw from past experiences. Usually, when something happens, then people just 'throwing hands' [Indonesian term for not my responsibilities]. It [IWRM] does not yet happen. (respondent, BBWS SO, 2016)

The fragmented IWRM implementation-specific tasks reflect division and diverse priorities. Stakeholder coordination at the national level is still only an idea. As the VRB condition is not mainstreamed, it is not prioritized in the interrelations between the Ministry of Public Works and Housing and the Ministry of Energy and Mineral Resources. There is no trace of water whisperers at this level, but there are budget brokers. The brokers can secure financial gains through bridging interactions. However, the position is rotational so that they are not as reliable bridge-builders, with the result that the integration level is low.

At the regional level, seeds of collaboration and cooperation exist, but overlaps still dominate management patterns, as explained below:

> So, when we talk about the regulation of water resources management, we are talking about who did what, whether it can overlap, yes, it may, but mandated for coordination. (respondent BBWS SO, 2016)

Water management coordination at the regional level occurred in the TKPSDA, but successful interaction efforts are happening in informal ways. For example, the memorandum of understanding for SPAM Kartamantul on a regional water supply plan for Yogyakarta, Sleman and Bantul between the Regional Public Works Agency, the RBO and the water supply

company is ranked as cooperation. Another example is river restoration activities involving the RBO and river communities. Existing CBOs use their whisperers to get support and sponsorship from the government. Many of them are located at this level, as informal interactions proliferate at this level. This arrangement indicates that main stakeholders are aware of their roles, but there are limitations to working in an integrated way. During the onset of water-related and eruption hazards, integration ranges from collaboration to coordination within the disaster taskforce. In this situation, the regional government (Disaster Management Agency and Public Works Agency), the national government (RBO), and the CBOs (river and water supply communities) work hand-in-hand to cope with the disaster. On average, the interaction level is ranked as coordination towards collaboration.

At the municipal level, integration mostly involves collaboration, with communities being more engaged in informal ways. The whisperers also exist at this level, but their impact is not as significant as at the regional level. They have already realized that the main playing field is at the regional level, so they focus more on that level. However, the integration of informal efforts is achieved more easily as a result of the collective action of *gotong-royong* (mutual assistance within a community) and local knowledge about water management practices.

## CONCLUSIONS

This paper adopts an MLG lens through which to examine the implementation of the IWRM approach in a VRB. The methodology is useful for achieving an in-depth understanding of the complexities and messiness of the albeit functioning networks of different management regimes. This understanding is obtained through the authors' sensitivity to actors' clustering around interaction efforts. Also, the method is helpful for sensing the existence of whisperers. The method shows that the IWRM approach is adopted in policy settings through pillars of management. More specifically, the lahar is addressed in water hazards control, but water conservation and utilization pillars also exist.

The management contexts cover national, regional (where river basin territories and catchments exist) and municipal levels, showing that, although the IWRM approach is used, it faces challenges from existing governance levels, which still use administrative boundaries. However, the results of this study suggest that the way forward involves adapting the current administrative boundaries as part of the river basin territories and working collaboratively, rather than forcing the adoption of the river basin concept. The case study reveals that the regional level, where all national, regional and municipal actors congregate, is the priority playing field. It also points to the existence of different management approaches during normal and eruption conditions, where these differences reflect differences in the leading actors. The RBO, in collaboration with local and regional agencies, is the leader during normal conditions, but the disaster management agency is the leader in the case of eruptions. This study also reveals that, because of periodic lahar sedimentation problems, non-massive water infrastructures are preferred in such a basin. These infrastructures include, for example, small dams, weirs and multifunctional Sabo dams. The IWRM pillars are evident as the levels of governance where actors' jurisdictions, sectorial ego and overlapping exist.

This case study reveals that effective water resources management arrangements exist, as a result of the flexibility of interaction efforts. However, current practices lack a formal mechanism to connect the different efforts. Interaction efforts are also developing between existing IWRM actors, and different integration levels exist. The types of interaction efforts depend on the theme: budget, water and disaster. Within the informal water interaction attempts, the whisperer is an actor who serves as an information-sharing bridge. Whisperers are useful assets for connecting government and communities, and integration levels rise where they exist. Therefore, to achieve a higher integration level in IWRM implementation,

informal ways of interacting must exist alongside formal ways; and whisperers should be supported and trusted to function as a bridge between communities and government.

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