# Building Hydraulic Villages in Gunungsewu Karst Area of Gunungkidul: The Expectation and Reality

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**Abstract.** The karst landscape of Gunungkidul of Gunungsewu, Java, portrays a rural area with water scarcity problems. The Indonesian Government has initiated Water Development Programs (WDP) since the late 1990s by building piped water networks that mobilize water from underground rivers. However, today, this problem still occurs. Previous studies have shown that hydrological problems of the nature of the karst cause water scarcity in the karst region. Taking different perspectives by borrowing the "hydraulic city" proposed by Anand, casting it to become “hydraulic village” and the politic of governmentality as theoretical lenses, this paper aims to investigate why the WDP has failed to overcome water scarcity problems. First, the WDP has failed to see the human-water-nature relation as an ecological unit of the karst landscape. Second, at the local level, the PDAM also has failed to increase its capacity to be a good governance institution.

**Keywords**: water scarcity, water development program, karst

## 1 Introduction

Water is an essential substance for human life. Many countries, especially third-world countries, are facing water scarcity problems. Over the past two decades, as reported by the United Nations, 1.2 billion people do not have access to clean and safe water. According to the World Health Organization, it was predicted that by 2025, approximately 2 billion people across the globe would be facing an absolute water shortage [1]. Water scarcity problems have become a global concern since early in the 1990s. In 1992 in Dublin, water and environmental experts organized an international conference that brought water scarcity issues to global attention [2]. As a strategy to overcome the water crisis, [3][1] states that water is a finite and vulnerable

[1] (1) Fresh water is a finite and vulnerable resource, essential to sustain life, development, and the environment. (2) Water development and management should be based on a participatory approach, involving users, planners, and policymakers at all levels. (3) Women play a central part in the

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resource. The following definition defines water as an economic good. In response to that set of statements, in 2000, organizations such as the World Water Council, funded by the private sector, the Global Water Partnership, a special committee established by an international NGO, and the United Nations initiated the World Water Assessment program to build a network to promote awareness and to formalize the paradigm of water governance [4].
In 2002 in Johannesburg, as the umbrella organization for water governance and the realization of the global network commitment, Integrated Water Resources Management (IWRM) was established as the main water governance framework for solving water scarcity problems. The term "integrated" is mainly used to refer to the need for coordination among all agencies across nations and institutions by improving the framework of law, institutions reformation, and policies [4]. Following this statement, as the manifestation of water governance, there are five basic programs in the water policy agenda [5]:

> *Decentralization and development of the new forms of local governance; (participation and the quest for greater equity; liberalization and the need for financial viability and economic soundness; overall State/public withdrawal in technical and financial terms and the need for new private-public partnerships; sustainability, and especially the need for meeting environmental needs and concern.*

Due to the lack of inadequate regulatory frameworks for water supply and sanitation in Indonesia and weak cross-sector policy coordination among state institutions, the water governance program has transformed into a development program following IWRM's scheme. In 1998, World Bank finalized a US$ 300 million to the Indonesia Government. The loan mandated that the government evaluate a structural adjustment program of institutional, legal, regulatory, and organizational reforms in governing water resources and the irrigation sector [6]. Later, those policy drafts were passed in the Water Law 7 /2004. This water policy also can be seen as an invitation to private companies and development agencies to participate in WPD programs in Indonesia. As a result, in the 2000s, World Bank and ADB built more than 2000 water projects across the country, and several private water companies were established, especially in urban areas [7]. After ten years of implementation of the Water Law 7 /2004, in order to improve the capacity of local governments to manage water provisions, the Indonesian Government abolished the Water Law 7 /2004 and enacted the PERPU (government regulation in lieu of Law) Drinking Water Provision System (DWPS) 122/2015.
However, the coverage of water access has not improved yet. As reported by [8], 27 Million Indonesian people still do not have clean water services. One region in Indonesia facing water scarcity problems is the karst[2] area of Gunungkidul, Java. Although the Government had

provision, management, and safeguarding of water. (4) Water has an economic value in all its competing uses and should be recognized as an economic good.

[2] Karst terrain is usually characterized by barren, rocky ground, caves, sinkholes, underground rivers, and the absence of surface streams and lakes. It results from the excavating effects of underground water on massive soluble limestone. The term originally applied to the Karst (or Kras) physiographic region, a limestone area northeast of the Gulf of Trieste in Slovenia, but has been extended to mean all areas with similar features [15]. Literally, Gunungsewu refers to a thousand mountain. The size of Gunungsewu karst accounts 3,200 KM [16].

implemented a Water Development Program (WDP) to fight water shortages by building a water treatment installation and then establishing a local state-owned enterprise (LSOE) by the 1980s, day-by-day water scarcity problems in this region became worst. In the drought season, many people have to walk a few kilometers to the nearest springs to gain buckets of water to fulfill their domestic needs. In some remote villages, many people can desperately wait for water-aid trucks.

## 2 Result and Discussion

Hydraulic city is a theoretical lens introduced by [9] to investigate the cause of techno-politic problems of the modern state and its bureaucratic system in controlling water for the public and how this dynamic infrastructure excludes marginal groups. I recast this concept to become hydraulic village to explore the effort of the water authority, as the state entity, to improve the water access to the people of Gunungkidul. However, as mentioned by [10], since choices cannot be based on a perfectly neutral criterion, the implementation of technology cannot be separated from the distribution of power in society. In the context of modern states, a technological decision is embedded with development programs, the politic of the governmentality, and techno-bureaucratic ideologies [10, 11, 12]. Afterward, those bundles of knowledge should be translated into policy languages. For instance, the implementation of the Water Law 7 /2004, as a manifestation of the WDP's framework, at least was driven by three factors; (1) the international doctrine of the IWRM as mentioned above, (2) the economic liberalization as required by IMF to increase economic growth, (3) the urgency of water treatment technology implementations [13].
Moreover, according to Ioris [14], WDPs should be seen as the contested relationship between nature and society. From the perspective of regional development, it gives the new procedural mode of water governance under certain stakeholders depending on a series of 'contextual and contingent' factors operating at the regional scale. Regarding water drinking provision management, the PERPU DWPS 122/2015 contains four key points. First, water is an economic good. Second, the private sectors have a right to sell water to the public through a private-public partnership scheme. Third, *Perusahaan Daerah Air Minum* (PDAM), or a local state-owned enterprise (LSOE), has a function to deliver water services to the public. Fourth, water services subsidy to poor people depends on the local Government's financial capacity [13].

Some scholars have investigated the exercise of WDPs through political economy perspectives. Generally, they have found that the exercise of this law, run by private companies and even PDAMs, ignited social and ecological problems. [17] found some difficulties in the exercise of water rights (Law No. 7/2004) conducted by the state water company (PDAM) in Semarang City. According to the Law, there are two water categories based on the type of users. The first is for commercial purposes (*hak guna usaha*), and the second is for daily subsistence (*hak guna pakai*). There is an unfair treatment difference between water rights holders for commercial purposes and everyday use. Commercial holders officially have a legal permit to use a large amount of water, while the daily purpose holders do not. Also, ecologically, the commercial holder practice creates a shallower water table [17, p. 486].

[18] revealed the problem of Public-Private Partnership (PPP) practices in Jakarta. He found that the role of the private company becomes so dominant that it ends up monopolizing water. On the other hand, the city government lacks the commitment to negotiate with private companies. Consequently, giving the privilege to the private sector means grabbing water rights from the public. Also, [18] says that the Government sees the private sector as a guardian angel that can contribute tax income to the Government. Still, somehow the private sector always keeps its market motives. Also, the Government has assumed that the private sector always operates on the principle of efficiency to provide a lower price with the best service [18]. Instead of implementing that principle, private sector businesses are driven by their desire for profit rather than efficiency.

Historical factors which caused the failure to provide water service for poor households in Jakarta are examined [19]. From the conceptual perspective, the authors use "governance failure." This study has shown that the Jakarta water supply system has been misgoverned because of the urban planning regime. In this case, unequal access to households has been highly fragmented economically, which means that the poor areas or slums are correlated with a lack of access to water connection infrastructure [19]. However, those studies are well-written in explaining that WDPs, as a tool of governmentality, tend to exclude poor people from accessing or limiting water needs. As for my critics of previous studies, I found that they barely touch in explaining the human-nature-water relation as an ecological unit, so the technological intervention as the disruptive agent toward humans and nature has not much been touched. Besides, those studies predominantly focus on urban areas through an institutional approach, where the people's perspective has not been revealed yet. To fill that gap, the spatial setting of this paper takes place in a rural area of Gunungsewu karst, Java. The data that appears in this paper is based on my observation from 2011-2012 and 2018.

### 2.1 Gunungsewu and Its People

In southern Java lies the Gunungsewu Karst landscape. Because of its geological characteristics, the karst area barely has surface water resources such as springs and rivers. The doline landform (pond) or *telaga*, resulting from the ponor plugging process, is the only natural reservoir. T*elaga* (s) are situated on the bottom of the karst hills. Moreover, telaga (s) 's water availability heavily depends on annual rainfalls, evaporation, and vegetation density [16]. There are 443 *telaga* (s) randomly distributed across this region, but because of deforestation, today, only 30 telaga(s) are still perennial [16]. Geologically, karst topography is formed by a high permeability of soluble limestones. Thus, water runoff is easily transported and collected to the underground karst system [20]. Due to the lack of available wetlands, local people practice dryland farming, following the seasonal change of monsoon. Although local people had been introduced to modern means of agricultural practices, such as fertilizer, pesticides, and mutagenic seeds, through the green revolution program (1960-1980), they still maintain stewardship which is locally called as the *pranotomongso* to manage their crops, especially in the timekeeping of the agricultural practice [21].

*Pranotomongso* can be defined as the native knowledge that predicts seasonal changes by observing natural phenomena, astrological signs, wind patterns, humidity, and plant and animal behaviors. By combining the Gregorian calendar system with the *pranotomongso*, they can predict when they should begin the planting season [21]. Furthermore, Gunungsewu karst has an average precipitation of approximately 1,831 mm/year, with the highest rainfall rates in January-March and November - December and lowest rainfall rates in May-September [22].

Therefore, the planting season, *mongso kasa* or the first season, begins at the end of the drought season in June. To maximize their farming production, farmers practice intercropping system where they cultivate several crops on the same farm, such as rice, corn, groundnut, and cassava. By paraphrasing "safety first" [23] and avoiding the risk, farmers prefer to utilize crops for subsistence rather than generate add-value from market supply and demand. However, it shows that dryland farming is less productive, economically speaking [24]. Moreover, the high number of local people pursuing certain jobs as factory workers and domestic helpers illustrates that the agricultural sector has failed to support their livelihood. In the last three decades, the socio-ecological stress has been exacerbated since the ponds could not preserve water as they used to. As confirmed by [25] who found that the extensive logging of teaks for agricultural extensification during the 1970-the 1990s was the ultimate cause of the deforestation process and the damaged ecosystem in the Gunungsewu karst region. Although the Government did not introduce an agricultural extensification program in the dryland farming area, the farmers were driven to open new farmlands on hill slopes because they needed to increase their food supply.

### 2.2 Water Development Program in Karst Area of Gunungkidul and Its Problems

Economic development is an ideology promoting the modernization agenda where the state drives the implementation of science and technology to procure and distribute natural resources [11]. Then, people can gain use-values from certain commodities to satisfy their desire. To meet the following condition, technological development and global market integration must be the motor of economic growth in the long run [11]. In line with technological development, developing countries like Indonesia heavily rely on a techno-bureaucratic perspective to overcome developmental problems, so-called *rendering technical* [12]. It is a series of practices to identify remaining issues and how to make them logical, explainable, and understandable. The identification of the problem is correlated to the set of technical solutions. Then, the practice of *rendering technical* will place experts who can diagnose objects of the development [12]. However, the *rendering technical* in the politic of governmentality tends to simplify the complexity of social realities. As a consequence, it is the potential to exclude marginal classes. In the WDP context, the technical solution is entrusted to state water bureaucracies where hydraulic scientists, engineers, and state bureaucrats have the power to design and run hydraulic missions; clean water provisions, hydro powers, and irrigations [26]. In WDP in the karst area of Gunungkidul, four actors are working on this project; (1) a long-term research collaboration between Indonesian and German scientists, (2) state engineers, (3) PDAM officers, (4) professional cavers from Indonesian caving club. Their mission is to bring up underground water to the surface and distribute water to the public to eradicate water scarcity problems.

Based on karst underground river exploration conducted by MacDonald and Partners (1981-1984), then recently continued by Acintyacunyata Speleological Club (ASC) and Faculty of Geography Universitas Gadjah Mada, they found that the flow rate of groundwater resources in surveyed caves was extremely high. For instance, Bribin-1500 lit/s, Seropan –400 lit/s, Baron-8000 lit/s, Ngobaran-150 lt/s [27]. By assuming 100 lit/day as the average water consumption for one person, water expert feasibility studies claimed that the volumetric flow rate of water was adequate to fulfill water needs for 1.000.0000 individuals [28]. In order to eradicate water scarcity in Gunungkidul and to improve old water infrastrcture, the National Public Work Service initiated a water project involving Karlsruhe Institute of Technology (KIT), a research center based in Germany. KIT provided technical assistance to install turbines in the underground river networks of Bribin to pump the water. This water project was begun in 2001

and opened to the public in 2006. Perusahaan Daerah Air Minum (the PDAM), a local state-own enterprise (LSOE), is the party that has responsibility for managing the water service [29]. This project is a promising WDP, but until today, water scarcity problems still occur. More than 100.000 people in Gunungkidul face severe water shortage problems during the dry season [30, 31]. I found that economic factors are the reason why people are not able to access the water service. To be able to be a consumer, people have to pay Rp. 1.800.000 for the installation fee and Rp. 36.000/10 m3 per for the monthly tariff. Mr, Budi said the PDAM's tariff bothers him as a small farmer. "I am a small farmer and do not have a monthly income like the urban people. It is unaffordable for me." A complaint also comes from Mr. Yanto. He romanticized the past situation where humans were closed to nature" in the past, everything was given by nature for free, but today all of the things are measured by money, even more for water, no more free things around us."

During my preliminary observation, I met Miss Minah, a poor widow. She said that in every drought season, she should walk 3 kilometers to the nearest water spring in a neighboring village to have three buckets of water. Indeed, these water supplies were not enough to fulfill her domestic needs for a day. I also found that many households have built water tanks to harvest rainwater during the rainy season. However, this attempt still cannot solve water scarcity problems because the water supply in the tank house can hold water only for two months after the rainy season ends. The dry season in Gunungkidul can last for five months.

In contrast to the poor people, I saw that many wealthy households, such as village elites, civil servants, and landlords, got some advantages from this WDP. For instance, Mr. Syam said that the water tariff offered by the PDAM was cheaper than that of private companies. Moreover, some wealthy households could generate their capital to open a water-based businesses such as water gallon refill kiosks, laundries, and car wash services. How is the PDAMs perspective seeing this inequality? They know that the water tariff plays a significant role in water access inequality phenomena, and they realize that it is still unaffordable for poor people. As stated by Mr. Kristiana, General Director of the PDAM in [32], the tariff adjustment could not be separated by PDAM's cost of production, especially the electricity bill.

Moreover, the PDAM has to pay 2-3 Billion Rupiah to the Perusahaan Listrik Negara (State Electricity Company) every month. He added that in 2018, their monthly gross income was only 2 Billion Rupiah, excluding maintenance costs and employee salary. In other words, the high tariff is the only way the PDAM can continue its business. The water reform program or WDPs in developing countries have created social injustice [14]. Instead of promoting water for all, WDP gives great access to the elites but restricts poor people from accessing the water service. In other words, water market pricing mechanisms where cost and benefit estimation becomes an inevitable instrument tend to treat people as customers rather than as citizens [32]. The scientific technology manifested in water development programs mainly focuses on a narrow economic view to meet higher operational efficiency [14]. It also ignores the socio-natural complexity of the target area. This techno-economic simplification can be described as a 'techno-bureaucratic' shortcut [34].

Because water always has political and economic values, controlling water is a fundamental element in the socio-political organization [35]. Thus, state control through managing technical infrastructures and establishing powerful water bureaucracies are important ways to see state intervention in society [35]. Moreover, the complicated relationship between hydro-ecological regions and political, economic, and social organizations might lead to differential possibilities to access and use water regarding rank, class, age, and gender. Even though water is not scarce in terms of hydrological availability, it can be made scarce because of political organization and decisions [35]. Back to [12], technological power in governmentality creates unwanted results

instead of delivering prosperity and tends to exclude vulnerable communities. Moreover, as mentioned by [10]:

> *When a decision is made, and physical apparatus is in the place, a technological system begins act to according to its own (albeit humans-installed) logic and thereby discourages, and even forecloses, other options. Although technology empathically is a "creature of our Art and craft," it also can generate effects that are no part of any conceivable human intention*.

## 3 Conclusion

The WDP practice in the karst area of Gunungkidul shows that technical fouls create water access inequality phenomena in society. As mentioned above, the WDP has tended to exclude poor people economically and culturally. They have been excluded from their water rights. In terms of availability, based on the feasibility study of the water resources conducted by water experts, it is reliable to overcome water scarcity problems in the karst area of Gunungkidul. Here, I can conclude that technical fouls cause the water scarcity problems which have occurred for the last ten years. I note two fundamental factors of technical fouls in the WDP in the karst area of Gunungkidul. Firstly, water bureaucracies have failed or ignored to see the human-water-nature relation as an ecological unit of the karst landscape where they perceive that water is not part of nature but it is a commodity. Secondly, at the local level, the PDAM, as a water management institution, has also failed to increase its capacity to be a good governance institution responsible for delivering water rights to the public. In other words, the WDP in the karst area of Gunungkidul has not yet prioritized its service to poor people.

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