

Gunungsewu 喀斯特地形的水資源短缺及未來挑戰

Gunungsewuカルスト地形における水資源の欠乏と将来の課題
Water Scarcity in Gunungsewu Karst and Its Future Challenge

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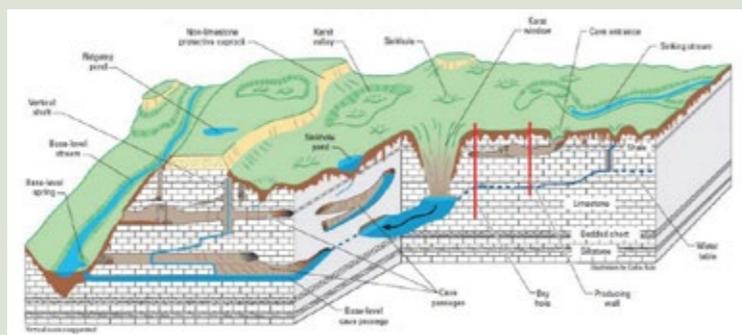
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In the southern Java lies the Gunungsewu Karst landscape. Because of its geological characteristics, the water resource is concentrated in the underground river. In other words, the karst area barely has surface water resources such as springs and rivers. However, the doline (pond) or *telaga* is the only one natural reservoir which can harvest the rainwater. Commonly, *telaga* is situated on the bottom of the karst hills. Basically, the water availability in *telaga* heavily depends on annual rainfalls, the level of evaporation, and the vegetation density. Usually, rainy season in this area runs from November to March.

Gunungsewu Karst and its people

Due to lack of wetlands, local people should practice dryland farming, following the seasonal change of monsoon cycles in order to support their livelihood. Although local people had been introduced modern means of agricultural practices, such as the fertilizer, pesticides, and mutagenic seeds, through the green revolution program, 1960-1980, they still maintain the stewardship which is locally called *Pranotomongso* to manage their crops, especially in the

在爪哇島南部有著 Gunungsewu 喀斯特地區，因喀斯特地形的地質特徵，在地表是幾乎沒有水資源的，唯一的水源是 *telaga* (池塘)。 *telaga* 的主要水源來自11月到3月的雨季。



Karst Hydrology (<https://en.wikipedia.org/wiki/Karst>)
喀斯特水文 (圖片來源: <https://en.wikipedia.org/wiki/Karst>)

timekeeping of the agricultural practice. *Pranotomongso* can be defined as the native knowledge that predicts seasonal changes by observing natural phenomena; astrological signs, wind patterns, the humidity, plant and animal behaviors, so they have a predictive decision when is the best time to start planting season. This knowledge has been inherited through generations where youngsters learn by doing from elderlies.

Usually, the planting season, *mongso kasa* or the first season, begins at the end of drought season in June. To maximize their farming production, farmers apply an intercropping system where they cultivate several crops on the same farm, such as rice, corn, groundnut, and cassava. Moreover, farmers prefer to utilize crops for subsistence rather than generate add-value from market supply and demand. However, the dryland farming is negatively seen as an unproductive farming practice, economically speaking. In contrast to the wetland farming such as rice field (*sawah*), the dryland farming has low resilience to overcome demographic pressures, especially to absorb labor demands and to double up the crop productions.

Moreover, the high number of urbanization, pursuing certain jobs as factory workers and domestic helpers, shows that the agricultural sector has failed to support their livelihood. Hence, peasants have a daily proverb to tell their misfortune, *cedak watu adoh ratu* (close to the stone far from the throne). That words illustrate that karst ecology as the symbol of poverty and the portrait of a marginal area. In the last three decades, socio-ecological stress has been exacerbated since ponds (*telaga*) could not preserve water due to the environmental damage. Therefore, during the drought season, people always face a serious problem to fulfill water needs for the domestic purpose and for their livestock. Today,



Dryland Farming Landscape (Personal Archive)
旱地農耕地 (圖片來源: 作者攝)

Gunungsewu 喀斯特地形與居民

由於缺乏濕地，當地居民應根據雨季的改變來進行耕作以維持生計。儘管通過1960-80年代的綠色革命，帶來了現代農業技術，當地人仍維持 *pranotomongso* 的農地管理方式，這是一個透過觀察自然現象預測季節變化的本土知識。通常種植季節在6月旱季結束時開始，為了最大限度的提高生產量，農民會在農地上種植多種作物。

在大量的都市化下，許多居民紛紛轉向尋求工廠工人、家庭傭工等工作，這顯示出農業收入已經不足以維持生計。這同時也使喀斯特地形的生態成為貧窮與邊緣的象徵。在過去三十年，*telaga* (池塘) 因環境破壞而無法有效儲水，在旱季時，人們因缺水而面臨極大的問題。

Gunungsewu karst region is prone to the water scarcity problem.

This writing is mainly based on my daily observation. I have a strong relationship with that area and its people because I spent nine years (2004-2013) in Yogyakarta for pursuing my bachelor and master degree at Universitas Gadjah Mada. During those years, I often visited Gunungsewu Karst area, as a local traveller or as a research assistant for my professors. The location where I frequently visited is located in Karangasem Village. Administratively, this village is situated in Ponjong District, Gunungkidul Regency, Yogyakarta Province. So, the story below is a general description of the everyday problem about water scarcity problems faced by Gunungsewu people.

Forest gone, water gone

“When I was around 20, most likely in 1970’s, it was the greenest time of my village, and it looked like a forest instead of settlement.” Mr. Sular told how the condition before his village became so barren. He said that there were a high density of vegetation around the hills; teaks (*Tectona grandis*), acacias (*Acacia auriculiformis*), and scattered bushes (*Gramineae*). Moreover, he mentioned that the *telaga* was still perennial. Thus, *telaga* was seen as the melting point where every person could interact and share their story. In the past, in every morning, women washed her family member’s clothes, and they also had a responsibility to carry water stock for domestic purpose. The *telaga* became so crowded in the evening when the men shepherded their caribou(s) to wallow and to graze. As well as children saw *telaga* as their playground. To classify clean and dirty areas, the community separated *telaga* into two sides by building a boulder wall. The dirty area was for livestock while the clean one was for bathing and washing. For the potable area, community drew water from a well located in the inner side of *telaga*.

In the past, after the harvest season, community organized *merti logo*, a thanksgiving rite. In this rite, community members symbolically served the agricultural products to the deity who was believed as the guardian of the *telaga*. Then, they also refortified the boulder structure and resealed the *telaga* base with clay to prevent the leakage of water down to subsurface karsts. However, because *telaga* has dried up, there are significant changes in livelihood aspects. For instance, the farmers

森林消失，水也隨著消失

telaga (池塘) 在村落有重要的功能，它提供人們的生活用水、農牧的使用，當地居民透過建石牆來區隔乾淨、髒的水，以供應不同的用途。過去人們會在豐收後舉行 *merti logo* 的感恩儀式，但隨著池塘乾枯，人們無法再養馴鹿，對當地人而言，這等於是少了一個提供生計的財產來源，也因此無法再繼續舉辦 *merti logo*。

水資源缺乏與環境變遷及大片毀林有密切的關係。砍伐柚木以擴展農地是造成毀林的主要原因，雖然政府並未在旱地推動農地擴展的工作，但由於人口膨脹，人們不得不藉由擴大農地來應付糧食需求。雖然伐木擴大農地確實增加了短期的農業收益，卻對 *telaga* 生態造成負面的影響。植被的減少使當地溫度上升、風速加快。這加速 *telaga* 的蒸發，山坡地水土流失也減少了 *telaga* 水份的儲存。

eventually stop keeping caribous because there are no places to wallow. For this reason, they also lose their future saving as Mr. Yar said: "there were four worthy properties for poorer like me, caribous, cows, and teaks, since that time we have could not keep the caribou, we lose one of our future savings." Since then, people have not practiced *merti tlogo* rite anymore, as explained by Harris, the depletion of natural resources will change the religious aspect, including the existence of the ritual practice.

Discussing water scarcity, we cannot separate it from environmental changes, especially deforestation process. Sunkar found that the extensive logging of teaks for agricultural extensification is the ultimate cause of the deforestation process in Gunungsewu karst land region. Although the government did not introduce agricultural extensification programs in the dryland farming area, the farmers were driven to open new farmlands on hill slopes because they needed to increase their food supply due to the population growth. This practice extensively happened during 1970-1980. For reducing the time and labor costs in opening new farm such as timbering the vegetation, removing a high density of scattered stones, building the terraces, and spreading the manure, farmers initiated *kyuyukan*, a collective work. Mr. Yar remembered that one group of *kruyukan* could reach 3-4 households and it depended on how many families who maintained the land on the same hill.

Although farmer obtained a short term agronomic benefit from selling woods and doubling the production, the agricultural extensification has deteriorated the ecosystem of *telaga* because less vegetated area increases

the local temperature and the wind velocity (see fig.4). As mentioned by Haryono, those activities increase the evaporation process. Also, the sedimentation accumulation caused by soil erosion on hill slopes decreases the storage of *telaga*. Furthermore, as reported by Yogyakarta Forest Agency, the size of the critical land in this region reaches 18.000 hectares.



Terrace on Hillside (Photo taken by Hilary Reinhart)
山坡上的台地 (圖片來源: Hilary Reinhart攝)



Drying Telaga (Personal Archive)
乾枯的 *telaga* (圖片來源: 作者攝)

The dilemma of water provision in Gunungsewu Karst

Based on karts underground river explorations 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 debit of groundwater resources in surveyed caves is extremely high. For instance, Bribin-1500 lit/s, Seropan -400 lit/s, Baron-8000 lit/s, Ngobaran-150 lit/s. According to Haryono and Yuwono, by assuming 100 lit/day as the average water consumption for one person, water experts feasibility studies claim that the volumetric flow rate of water is adequate to fulfill water needs for 1.000.0000 individuals. In order to eradicate water scarcity problems in Gunungkidul, the National Public Work Service initiated a water project by involving Karlsruhe Institute of Technology (KIT), a research center based on Germany. KIT provided the technical assistance to install turbines in selected caves to pump water. This project was begun in 2001 and opened to the public in 2006. *Perusahaan Daerah Air Minum* (PDAM), a municipally-owned corporation, is the party that has a responsibility in managing the water service.

This is a promising improvement program but until today water scarcity problems still occur. As reported by KOMPAS.com (2018) there are 122.104 out of 756.024 people who face the water shortage during the dry season. 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 that price bothers him as a small farmer. "I am a small farmer, and I do not have the monthly income like the urban people." He added that even though they only use one bucket of water, they still have to pay Rp.36.000. 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 priceless things around us."

Once upon a day during my fieldwork, I met Ms. Minah, an old widow. She carried two water buckets. At that time, she was heading back to her house from a neighbour village where she usually gained some water from a cave. I offered her a help to

Gunungsewu供水的兩難

由MacDonald and Partners (1981-1984) 開始，近期由Acintyacunyata Speleological Club (ASC) 和日惹大學地理學院繼續進行的地下水研究發現，他們所探索的這些洞穴的水資源十分充足，足以提供10,000,000個人的用水，為了消除水資源短缺的問題，國家公共工作服務局參與由德國的研究中心卡爾斯魯厄理工學院 (KIT) 啟動的一個水計畫。KIT提供技術援助，在選定的洞穴中安裝渦輪機以抽水。

雖然此計畫有其前瞻性，但水資源短缺的問題仍未解決。其中一個很大的問題是經濟因素，設置抽水機器須要支付大量的費用，作為小農，有許多農民是無法應付這些費用的，因此無法得到供水的服務。

carry one of her burdens, and we sat for a while and had some talk. After taking a deep breath and wiping her sweat, she said that it is her daily activity during the dry season. "I always suffer in this season, this is a matter of dead or alive." It sounds exaggerated but in fact, every day she should walk roughly for three hours forth and back, and she should use the water wisely at home. Indeed two buckets of water are inadequate for her to fulfill domestic needs, so she prioritizes water need for drinking. In short, this story indicates that the water management practice classifies the water as the commodity and neglects it as the essential basic human need.

What do we learn from the past and what should we do in the future

In conclusion, I can tell that the water scarcity problems in Gunungsewu Karst are caused by two phases. The deforestation causes the critical damage of *telaga* ecosystem. Second, the demand-oriented approach in water service constraints poor people to access water needs. As my reflection, this small story leaves two recommendations for the future plan which can be manifested in basic or action research. Therefore, the investigation about how a local knowledge like *pranotomongso* responds to crucial issues such as the reforestation and climate changes in the Gunungsewu karst context is urgently needed. Also, the research action which involves civil society (Non-Governmental Organization and communities) is also required to advocate the water rights of Gunungsewu people. The agenda of those future research is to find an alternative practice of water service such as the community-based water resources management, prioritizing and delivering the water service to poor people. Last not but least, rehabilitation of *telaga* and environmental education programs, as the unity of the karst ecology knowledge, should be initiated, so people can re-utilize, preserve, and inherit the *telaga* to next generation.

我們從過去學習到的以及未來應該做的

Gunungsewu喀斯特地區的水資源缺乏可以歸納為兩個原因，一是砍伐森林造成*telaga*生態系統的破壞，二是因經濟因素限制了窮人的水資源使用。

在未來的計畫中，調查關於*pranotomongso*等當地知識是如何對應Gunungsewu喀斯特地區的環境，另外由當地人參與的研究活動也是倡導水權的重要因素。未來應以社區為基礎進行水資源管理，並啟動*telaga*的環境教育，使喀斯特生態知識整合，讓人們能夠重新利用、保存並繼承*telaga*給下一代。◆



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