Sustainable use of water resource at North Kendeng Mountain, Central Java, Indonesia

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Abstract. Conflict between local community on one side, and government and private sector on the other side over the utilization of limestone at North Kendeng Mountain area, Central Java, Indonesia has been occurred since 2008. The government prefers to utilize limestone for mining in order to create economic growth, job opportunities and other positive impacts. Local community are worried about mining activities which will potentially deplete water resources currently being utilized for household use and irrigation for rice production. Strategic Environmental Assessment (SEA) is expected to mediate conflict by recommending on the allocation of areas for conservation and for mining. SEA found that the demand of water at research area has been exceeded the availability of water due to increase of population, government policies and planned activities of cement factories. Institutional and substantial arrangements are required to create a sustainable use of water resources.

1. Introduction

North Kendeng Mountain is located throughout of Regencies of Grobogan, Pati, Rembang and Blora in Central Java and Bojonegoro, Tuban and Lamongan in East Java as shown on the following map (figure 1).

North Kendeng Mountains is categorized as dried area in which local people rely on water supplied from Karst area for household use and irrigation. This area is also rich in limestone resources potentially utilized for cement production and other products. Conflict of utilization between those who pro development specifically for mining and those who pro conservation has been occurred since 2008 when the State owned Cement Company planned to build its factory at the district of Sukolilo, Pati Regency, Central Java. To mediate the conflict, National government of Indonesia initiated to conduct Strategic Environmental Assessment (SEA) expected to recommend on the location of areas for mining and for conservation [1]. SEA found that spatial planning at provincial and local level tends to utilize this area for mining and other uses.

Based on spatial planning of Central Java Province of 2010-2030, article 79 states that mining area located at North Kendeng Mountains covering Regencies of Grobogan, Pati, Rembang, Blora and Kudus [2]. Article 80 stipulates that these areas are determined as a growth center with mining
activities as priority sector. Spatial planning of Pati Regency of 2010-2030, article 59 stipulates that limestones mining at North Kendeng Mountains are located at districts of Sukolilo, Kayen and Tambakromo reach to 9,101 hectare as compared to conservation area which only 2,262, 55 hectare [3]. At Rembang Regency, based on its spatial planning of 2011-2031, the area for mining reach to 37,79%, production forest 27,93% and for conservation is only 8,02% [4].

![Figure 1. Map of North Kendeng Mountain.](source)

Source: Ministry of Environment and Forestry, 2017 [5].

SEA also found that the demand of water for household, industries, urban, irrigation and fisheries exceed the availability of water [5]. The potential loss of water as implication of spatial planning policy predicted severely affect to household and agriculture. The SEA methods utilized are the projection of the demand and the availability of water based on spatial planning, and water environmental carrying capacity model. SEA recommends the substantial and institutional arrangements of spatial planning for sustainable use of water resource.

2. Research method
This paper is part of Strategic Environmental Assessment (SEA) focusing substantially on water resources issue in Pati regency, Central Java, Indonesia [5]. Over all SEA studies deal with water carrying capacity, land cover, biodiversity, economic valuation, regional economic, disaster risk, natural resource conflict. The SEA utilized secondary data consisting of spatial planning at national, provincial and Regency level, EIA studies and other publications related to water resources use. In addition, public consultation and informal survey were conducted to identify the issues regarding the utilization of water resource at North Kendeng Mountains. The stages of SEA consist of (1) the description of existing condition of water resource (2) the issues related to water resources (3) spatial planning predicted to affect the water resource and (4) the alternatives and recommendation [6]. Data
concerning existing condition of water resources and issues related water resources were conveyed by local people during public consultation and informal survey. The reason for taking Pati Regency as a sample area is that the conflict of utilization of natural resources has been occurred since 2008 and continued in 2012 up to now.

3. Result and discussions

3.1. The existing condition of water resource

Water resource is a strategic component of environment at North Kendeng Mountains. This is because of limited supply of rain water. During the dry season, most of the area experience water deficit. However, due to karst mountains, many springs provide water resources for potable water, household use and irrigation. High volume of recharge water of springs indicates that Karts area has function as a natural regulator in absorbing, flowing and producing rain water. High volume and constant water supply throughout the year also indicates a continual and stable supply system. To maintain the quality and quantity of water resource as important indicators of sustainability, it is required to maintain North Kendeng ecosystem as water carrying capacity. Any activity adversely affects to North Kendeng ecosystem, in turn, will disrupt water balance system and hydrology system of river watershed.

Karst area at Pati Regency located at the district of Sukolilo (1682 hectare), Kayen (569,5 hectare) and Tambakromo 11,05 hectare. In Sukolilo district, springs which have varied flow rate of 1 liter/sec up to 178.90 liters/sec spreading out at several villages as shown at table 1.

| Village      | Capacity (l/s) | User (number of household) |
|--------------|---------------|----------------------------|
| Keceh        | 7.5           | 40                         |
| Doplang      | 5.0           | 50                         |
| Wonokusumo   | 20.0          | 40                         |
| Sumbersoka   | 5.0           | 200                        |

In addition, Kancil and Tompegunung villages have 9 springs, Gadudero village has 5 springs and Sukolilo village has 10 springs. The springs at Wareh Cave, the village of Kedumulyo, with its capacity of 20 liters per second utilized for potable water, household use and irrigation. The recipient of water resources at Sukolilo district reach to 580 households and 200 hectares of rice field. While in the district of Tambakromo and Kayen, spring water located at Jogoboyo Village flowing to Gede River and watering about 600 hectares of rice fields at the districts of Tambakromo, Kayen and Gabus. In addition, the water also is utilized for household use. Spring water at Pari cave also flows to Gede River. The most source of water in Sukolilo district namely Sumber Lawang located in the Tengahan Hamlet, Sukolilo Village flowed water in the dry season 178.90 liters/sec.

3.2. Issues related to water resources

The issues related to water resources are the plan of building cement factories at that area and narrowing of karst natural landscape area (KBAK). With regard to cement factories, in 2008, state owned cement company planned to build its factory at the district of Sukolilo [7]. This plan was opposed by local people particularly for water resource reason. Local people were worried about the adverse impacts to water resources utilized for household use and irrigation. According to local people, there are 42 permanent spring water will be adversely affected by mining activities of planned cement factory, even though EIA studies stated that only seven non-permanent springs would be affected. Due to high tension of conflict, Cement factory moved its plan to the Regency of Rembang. In 2012, a private cement company planned to build its factory at the district of Tambakromo and Kayen, few km to the north of Sukolilo district [8]. Local people, again, opposed this plan for the similar reason with the case of Sukolilo.
3.3. Private and government policy pressure
Spatial planning at national level has changed from government regulation no 26 of 2008 to government regulation no 13 of 2017 determining that national conservation forest area at North Kendeng Mountains became narrowed from 151.775 hectare to be 3.185 hectare in which Pati Regency is part of it. This change indicates the trend to be more utilization rather that conservation. Based on Government regulation no 13 of 2017 it is determined that Karst natural landscape area locally called KBAK Sukolilo consisting of districts of Sukolilo, Kayen and Tambakromo as uniqueness of natural area located at Pati Regency. However, on spatial planning pattern, its location and the wide area is not being mapped. This creates uncertainty as basis for formulating spatial planning at provincial and regency level. In addition, it also creates unclear on delineation of karst. According to Ministerial Energy and Mineral Resource Decree 0398 of 2005 the wide of karst area (KBAK) is 118,02 km\(^2\) [9], while based on Ministerial Energy and Mineral Resource Decree no 2641 of 2014, the wide area of KBAK become 71,80 km\(^2\) [10]. According to Widjanarko (2012: 2) the latest Ministerial Decree did not incorporate the area which should be included as Karst Natural Landscape Area (KBAK) [11]. This area has the similar characteristics as KBAK such as cave, recharge area and springs indicating the existing of underground river system. It can be concluded that the water resources at Pati Regency has been under pressure by both proposed cement companies and government policies.

3.4. Water carrying capacity calculation
Water carrying capacity can be counted by calculating the availability of water that can be utilized compared to the total of water needed at this area. The potential water supply consists of rainfall, river (surface water), springs and groundwater. Main factors affecting the volume of water include number of people, irrigation, animal husbandry and fisheries, and industries. The prediction of water needed in the future calculated by exponential approach based on spatial planning of 2011-2031. The analysis of water needed for domestic and the volume of water compared to water discharge, springs and groundwater based on hydrogeology to identify the status of water availability covering all districts at the Pati Regency.

With this formulation, the availability of water in Pati Regency in 2015 was 804 million m\(^3\) per year while the demand in the same year has been 1,265.4 million m\(^3\) per year. It is predicted that in 2020 the demand will increase to be 1,267.7 million m\(^3\), in 2030 reach to 1,307.2 million per year and in 2040 escalates to be 1,341.1 million m\(^3\) per year. If it is compared with policy, plan and program from the government, the demand in 2020 will be 1,278,1million m\(^3\)/year in 2030 reach to 1312.9 million m\(^3\)/year and in 2040 to be 1,351,9 million m\(^3\)/year. The environmental carrying capacity with policy, plan and program in 2020 will be deficit or -472,8, in 2030, will be deficit of -503,2 million m\(^3\)/year and in 2040, -537,1 million m\(^3\)/year. If it is compared with policy, plan and program the deficit follows. In 2020 will be -474,2 million m\(^3\)/year, in 2030, will be -508,9 million m\(^3\)/year and in 2040 will be -548,0 million m\(^3\)/year. The calculation is summarized at tables 2 and 3.

| Year | Current Availability (million m\(^3\) per year) | Demand Prediction (million m\(^3\) per year) | Future Prediction with PPP (million m\(^3\) per year) |
|------|---------------------------------|---------------------------------|---------------------------------|
| 2015 | 804                             | 1265.4                          | 1278.1                          |
| 2020 | 1267.7                          | 1307.2                          | 1312.9                          |
| 2040 | 1341.1                          | 1351.9                          |                                  |
Table 3. Water carrying capacity.

| Year | Without PPP (million m$^3$ per year) | With PPP (million m$^3$ per year) |
|------|--------------------------------------|-----------------------------------|
| 2020 | -472.8                               | -474.2                            |
| 2030 | -503.2                               | -508.9                            |
| 2040 | -537.1                               | -548                              |

Note: PPP = Policy, Plan and Program

4. Conclusions and recommendations

Availability of water resource at Pati Regency specifically at North Kendeng Mountains relies on springs formed by karst. This water resource is essential for fulfilling household use and irrigation. However, these resources have been threatened by planned activities of cement factories and government policies which tend to allocate spaces for utilization rather than conservation.

Based on such conclusions, the recommendation proposed follows. It is recommended to utilize the area particularly for developing agriculture proved providing more added value for local people. The industries suitable developed are the ones based on local economic bases such as agro-industry ensuring environmental friendly and providing more local added value. The extractive industries must be limited and heavily controlled and the mining area must be directed to the areas which are not categorized as Karst Natural Landscape Area. The transformation of policies is required to orient toward conservation. Institutional arrangement recommended is to revise spatial planning at provincial and local level which must be based on environmental carrying capacity by involving all stakeholders including local people at the earliest stage of planning.

References

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