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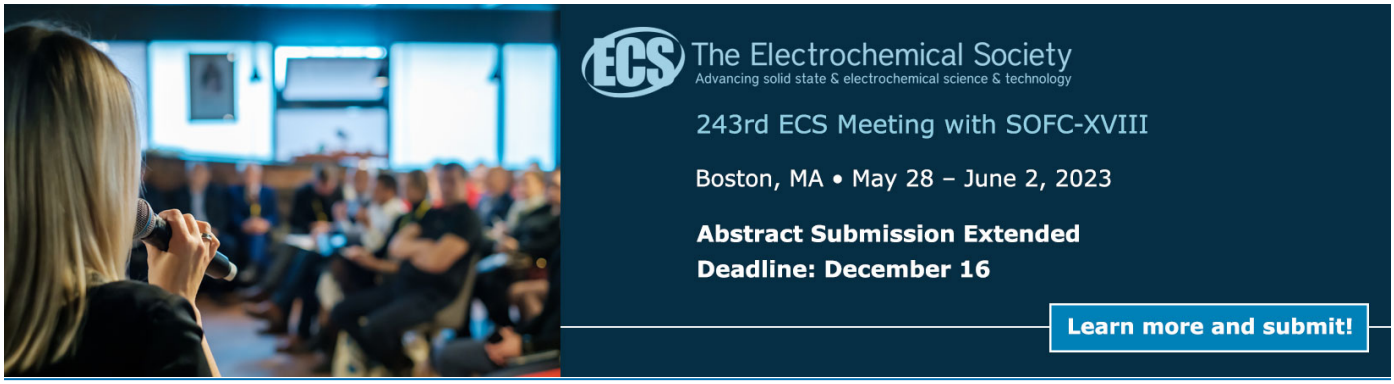

Community participation in soil and water conservation as a disaster mitigation effort

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Abstract. Upstream watershed management that is not suitable for its carrying capacity causes watershed degradation, shown by the land degradation and landslides in the upstream area (on-site), sedimentation, flooding, and drought in the downstream area (off-site). One of the disaster mitigation efforts is the implementation of soil and water conservation in the upstream watershed, which requires community participation. Generally, community participation is still passive participation. The research aimed to identify community participation in soil and water conservation, and efforts to increase community participation in mitigating hydro-meteorological disasters. The research was conducted in the Micro Naruan Catchment, upstream of the Keduang Sub Watershed, the Bengawan Solo Watershed. Data were collected through observation, in-depth interviews, and Focus Group Discussions. The data are community perceptions of soil and water conservation, local wisdom related to soil and water conservation, and community participation of soil and water conservation activities from planning to evaluation. As mitigation efforts, soil and water conservation activities include planting perennial crops and controlling surface and gully erosion. The results show that: 1) people in the upstream watershed do not fully understand the linkages between upstream and downstream in the watershed; 2) community participation in soil and water conservation is not yet optimal; and 3) the community has local wisdom in soil and water conservation. To increase community participation in soil and water conservation, it is recommended that the techniques and patterns applied are not only to reduce disaster risk but also to improve the community's economy.

1. Introduction

A watershed's upstream and downstream areas are interconnected through the hydrological cycle. The upstream mismanagement will result in damage and disaster in the local area (on-site) and the downstream (off-site). Disaster in the upstream (on-site) area is indicated by erosion, land degradation, and landslides, while the impact in the downstream (off-site) is sedimentation, flooding, and drought [1,2]. One of the disaster mitigation efforts is the implementation of soil and water conservation in the

upstream watershed. Generally, soil and water conservation practices can be carried out through civil techniques and vegetative measures [3].

The disaster that made people aware of the importance of soil and water conservation through a watershed management system was the great flood of the Bengawan Solo River in 1966 [3]. The Keduang sub-watershed, upstream of the Bengawan Solo watershed, is degraded. Every year the Keduang sub-watershed contributes the largest sedimentation to the Gajah Mungkur Reservoir [4]. The high rate of population led to population pressure on land resulting in excessive use of land, which might trigger land degradation [5]. The condition was worsening by the behavior of people paying less attention to soil and water conservation in managing their land. Therefore, through Presidential Instruction No. 5 of 2008 in the land rehabilitation policy, the Keduang sub-watershed was designated as the focus of the Integrated Watershed Management Pilot Project.

Soil and water conservation effort started in 1976/1977 through the Presidential Instruction on Afforestation and Reforestation [3,6] using a top-down approach. [7] stated that watershed management that utilizrs a top-down approach and ignores local communities generally fails. That happens because humans influence watershed conditions through community behavior in managing their land [8–11]. Therefore, community participation has an essential role in soil and water conservation.

The concept of participation in soil and water conservation began in the 1990s. In this concept, the community should be involved in planning, implementation, and evaluation [12]. Practically, the community is only engaged in the performance, and its participation is only participation mobilized by incentives [13,14]. Even if the community is involved from the planning stage, then community participation is only passive participation and not as a decision-maker especially in determining cropping patterns, perennials and conservation plant species, and spacing [14,15]. This has led to the community's dependence on the government and unsustainable soil and water conservation efforts, shown by the lack of public attention to maintaining perennial crops. In addition, the community is not entirely willing to provide seedlings of perennial crop for land rehabilitation efforts and still expects government assistance, so that when the timber has been harvested, some people tends to return to cultivating seasonal crops on the sloped land and plant cassava on the terrace's edge (Figure 1), which may cause erosion [14,16]. Therefore, the research aimed to identify community participation in soil and water conservation, and efforts to increase community participation in the context of mitigating hydro-meteorological disasters.

Figure 1. Unsuitable conservation practices by communities
(Source: APFNet Project documentation)

2. Study area and method

2.1. Study area

The research was conducted in The Naruan Micro Catchment (NMC), upstream of The Keduang Sub Watershed, the Upper Bengawan Solo Watershed. Keduang Sub Watershed has a strategic role as one of the catchments of the multipurpose Reservoir of Gajah Mungkur (MRGM), which serves as the

Solo River flood control (Figure 2). The main issue in the study area is soil erosion, which contributes to the high rate of sedimentation in MRGM.

The NMC is administratively located in the Wonorejo and Wonokeling villages, Jatiyoso sub-district, Karanganyar district, and Bubakan village, Girimarto sub-district, Wonogiri district. The NMC area is dominated (more than 50%) by land with steep slopes prone to erosion. However, land cover in the NMC is dominated by dry land (38.7%), rice fields (10.7%), and settlements (6.9%), while 20.1% is forest and 23.4% is plantations [17].

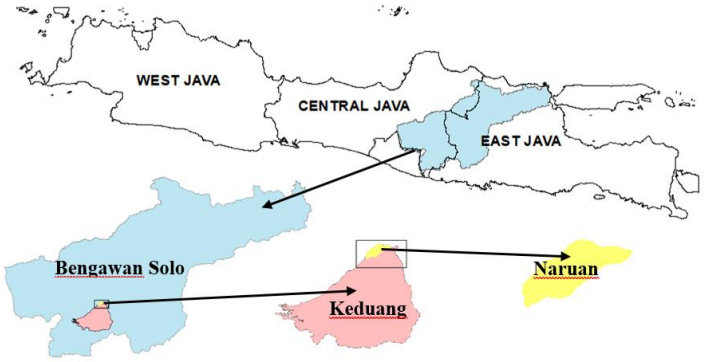

Figure 2. Research location of the NMC
Source: [18]

2.2. Method

Descriptive qualitative research can describe the conditions accurately and provide a depth of understanding of the existing phenomena [19,20]. Data collection used in-depth interviews, focus group discussions (FGDs), and observation. In-depth interviews and FGDs were conducted with the farmers participating in the demonstration plot (Field Partners). Observations were made on soil and water conservation demonstration plots in the "Development Participatory Management of Micro Catchment at The Bengawan Solo Upper Watershed Project" funded by the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet). Observations were used to see the activities implemented in the demonstration plot by Field Partners and carried out on all demonstration plots.

The data collected are community perception of the watershed and land management according to conservation principles, local wisdom related to soil and water conservation, and community participation in soil and water conservation activities from planning to evaluation and the follow-up.

3. Result and Discussion

3.1. Degradation potential characteristics in the NMC

Identifying biophysical characteristics is needed to support the analysis of how the community should behave towards the upstream watershed environment through understanding and perceptions and behavior of soil and water conservation activities. A study by [18] stated that the potential for degradation in NMC is enormous, showing that 31.7% is in the severely degraded category, and 6.6% is in the degraded category (Figure 3). The vast potential for land degradation will impact the high rate of soil erosion and cause sedimentation in the downstream area (Wonogiri Reservoir). According to [18], the NMC's average erosion rate is relatively high (341.28 tons/ha/year) and could result in a very high sediment load in river water bodies.

Additionally, the risk of landslides serves as a motivating factor for the community to value environmental sustainability in the upstream watershed. According to [21], 64.2 percent of the NMC is considered to be somewhat exposed to landslide hazards. Furthermore, according to [17], 56.24

percent of all land uses are out of proportion to their ability class, which increases the risk of land degradation.

The community's attempts to mitigate impending disasters, such as erosion-sedimentation and flooding, are guided mainly by the biophysical characteristics of NMCs vulnerable to degradation. In particular, the potential for flooding is also a concern because cases of flooding in the downstream area are caused by damage to the upstream area, which should act as a recharge area. This needs to be a fundamental knowledge in the community so that they are more concerned with safeguarding the upstream environment, even while the community in the upstream watershed, like NMC, does not feel the flood. [22] said that one of the essential points in upstream watershed management starts with planning activities in a participatory manner with the community.

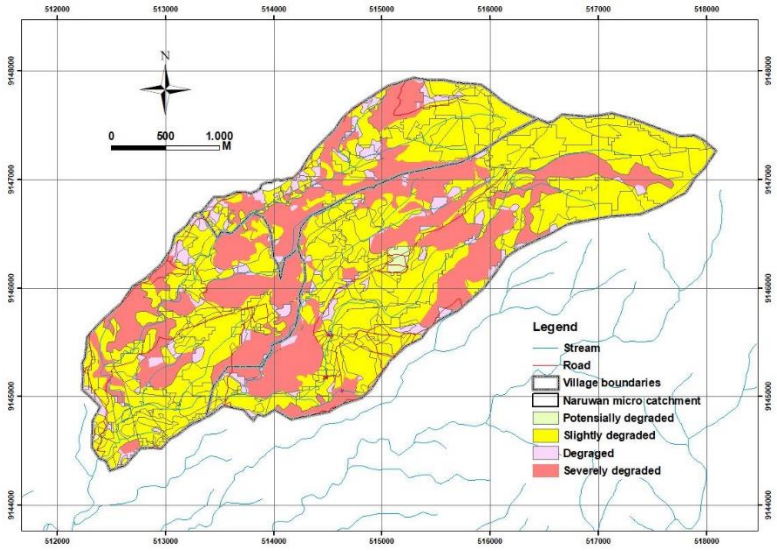

Figure 3. Degraded land map in NMC
Source: [18]

3.2. Community perception of watershed

Community perceptions of watersheds and erosion affect community participation in soil and water conservation efforts [23,24]. Therefore, before developing community participation in soil and water conservation, it is firstly important to understand community perceptions regarding watersheds and their problems.

Field Partners at NMC understands that their sloping agricultural land is prone to erosion. Erosion that continues to occur impacts the downstream area and reduces on-site soil fertility. However, because the community needs to plant seasonal crops as a source of food and livelihood, the community has been applying contour planting to reduce erosion for generations. The community is aware that their agricultural land is currently degraded and has low productivity, so it is necessary to improve the land fertility through planting perennial crops, using manure, and planting grass. This shows that the community understands their problems and some ways to overcome them.

Nevertheless, Field Partners generally does not understand the relationship between upstream-downstream in a watershed. They did not realize that the land management practices also influence the people in the downstream area. This can also be seen in selecting soil and water conservation efforts and motivation to do it. The community conducts soil and water conservation to reduce erosion and increase land productivity (on-site impact) so they prefer vegetative measures and are infrequent to apply civil technique measures.

3.3. Community Local Wisdom in Soil and Water Conservation

Local wisdom is knowledge and various life strategies in the form of activities carried out by local communities in overcoming various problems to fulfill their needs [25]. [26] states that local wisdom is a factor in the success of environmental management. Ignoring it is one of the reasons for the failure of land rehabilitation.

The community at NMC has already applied vegetative soil and water conservation for decades because they have some local wisdom. Initially, farming land in NMC was planted with maize and cassava. The cultivated commodities are growing along with increasing the community's knowledge and needs. At that time, they also realized that without preventive measures, the soil fertility of the land would decrease; as a result, yields would also fall. Therefore, they have made efforts to maintain the fertility of the land. They did not realize those actions were part of soil and water conservation efforts.

That local wisdom such as planted perennial crops, grass barriers, and clumped plant species was aimed to prevent erosion and protect soil fertility. Grass barriers were planted in the waterways (*panciran*) to trap surface erosion (Figure 4). The fodder grass was chosen as a grass barrier because it was used to feed the livestock. Livestock is closely linked to farmer culture to ensure farming sustainability and economic stability [23]. Therefore the link between fodder grass and livestock will ensure the sustainability of the grass barrier. The mounds were also carried out on strips for seasonal crops to trap surface erosion.

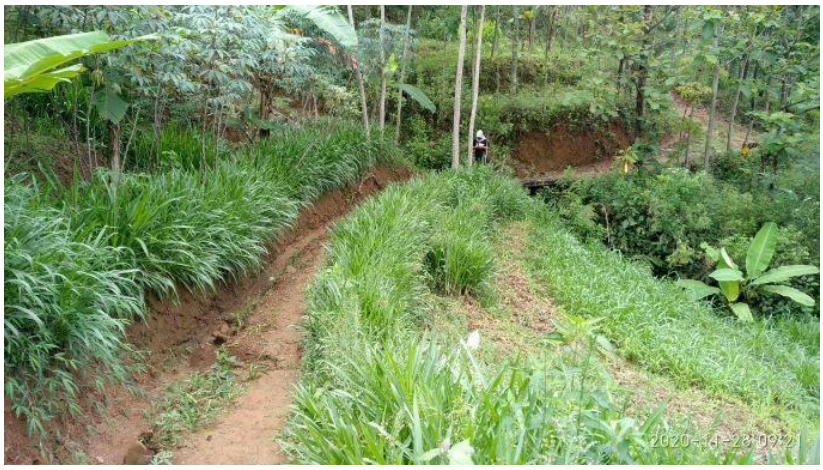

Figure 4. Grass barrier
(Source: APFNet Project documentation)

The community had also planted perennial plants. The species of perennial crops commonly grown were woody plants such as pine and albizia, expected to give conservation function and provide wood for housing. Along with developing community knowledge in woody plant species, woody plants also function as savings. Unfortunately, the timber plantation is only carried out on the land boundaries, so its conservation function is not optimal.

In some places, there are gully that potential to be bigger if not addressed. Several clumped plant species were planted to trap and control the gully erosion (Figure 5). The species commonly planted are bamboo, cordyline, and king grass. To trap the soil eroded, those species were planted at the toe of the gully. Hopefully, the eroded soil would be restrained by the plants and accumulated in the gully. That local wisdom showed that the community was already aware of soil and water conservation, and it becomes a capital to increase community participation.

Figure 5. Cordyline as gully erosion
(Source: APFNet Project documentation)

3.4. The development of demonstration plots of soil and water conservation

The development of the soil and water conservation demonstration plot in the NMC was started in 2017. Considering that community perspective influences community participation [23,24], the early stage is the efforts to build community perceptions of soil and water conservation and the concept of linkage of the upstream and downstream areas in the watershed.

The involvement of Field Partners in demonstration plot development has been started since the planning stage includes mapping their agricultural land. The approach used in the planning process is a combination of top-down and participatory (bottom-up) systems. The top-down approach provides land management guidelines following the conservation rules in the upstream watershed, one of which is planting perennial crops on the demonstration plot. The preparation of the soil and water conservation plan is carried out in a participatory manner [22].

However, due to the Field Partners need for agricultural land, there needs a compromise in planning the activities to be carried out. The agreed planting pattern to be applied in the demonstration plots is an agroforestry pattern, a mixture of seasonal and perennial crops consisting of woody and fruit species. Perennial crops are planted in the whole land (not only on land boundaries), but with wide plant spacing so that Field Partners can still plant seasonal crops under the stand. This shows that current economic considerations are more dominant than long-term environmental considerations. In addition to providing land for demonstration plot, Field Partners also provide manure and labor as a form of participation in implementation. Project funds provide perennial seedlings.

In addition to vegetative measures, civil technique measures are also built, such as Small Gully Plug (SGP), Small Check Dam (DPN), and Head Structure using Gabion, Cemented Stones, and Bamboo (Figure 6). The land owner and the surrounding community participated in the construction and are expected to be learning material to increase their knowledge. The use of bamboo material is

also intended to be applied by the community independently because the material is easily obtained and cheap.

(a) (b) (c)

Figure 6. Types of gully control technique (a) bamboo, (b) cemented stones, and (c) gabion (Source: APFNet Project documentation)

3.5. Community participation in soil and water conservation

Field Partners are involved in the arrangement of demonstration plot design, land preparation, planting, and maintenance in the demonstration plot development. The participation of Field Partners in the planning stage is outstanding. This can be seen from the presence of Field Partners in each FGD in the planning process and their awareness of the land condition. The community is aware that land has not been managed appropriately so erosion increases and soil productivity decreases. In addition, Field Partners' willingness to contribute labor and manure is also shown the community participation.

In the implementation stage, the participation of Field Partners is not as good as in the planning stage. Field Partners actively participate in land preparation and planting of perennial crops, as well as contributing to the provision of manure according to the plan. However, some activities are not carried out as planned, for instance:

- Some Field Partners have not made planting holes and have not planted the distributed seedling until the agreed deadline. This is due to the unavailability of labor because they migrate to other cities to make a living in the long and/or short term. That is why at certain times the labor is not available.
- Spacing is not following the agreed design or only planting on the land boundary. That is caused by narrow land ownership and the existing land cover. Farmers with limited land and which makes agriculture the primary source of income tend to hesitate to plant perennial crops on their farms. They are worried that their seasonal crops will be disrupted. Field Partners whose land is currently covered by seasonal crops tend to be reluctant to plant perennial crops because they are not willing to lose the yield from seasonal crops to get timber yield in a relatively long time. This is in accordance with the results of [23] research, which states that farm size affects community participation in soil and water conservation. Farmland fragmentation, which often occurs due to the inheritance process, makes agricultural land ownership smaller and this usually discourages farmers' participation in watershed management.

The participation of Field Partners in implementation is also seen in the maintenance stage. Some Field Partners have relatively high participation in maintaining the perennial crops. This was shown by their effort to provide additional fertilizer, buy seedlings to replant dead plants or take care of stumps in the fields. However, some Field Partners almost do not maintain perennial crops, so many plants

die. This condition is influenced by the mind-set of the people who still depend on government assistance.

As a priority watershed, there are many projects related to soil and water conservation carried out in the upstream area of the Bengawan Solo watershed, especially since the establishment of the Keduang sub-watershed as the focus of the Integrated Watershed Management Pilot Project through Presidential Instruction No. 5 of 2008 in the land rehabilitation policy [27]. Projects started in 1976/1977 through the Presidential Instruction on Afforestation and Reforestation [3,6] were mainly carried out using a top-down approach, and community participation was mobilized by incentives [6,27]. Therefore, the community mind-set that leads to incentive-driven involvement has not been fully changed. As a result, activities do not continue if there is no assistance.

The community participation will also be seen from the follow-up carried out by Field Partners independently.

- In the case of perennial crops, Field Partners wish to continue planting perennial crops. However, the species planted have changed. Initially, Field Partners intended to cultivate albizia because of its economic value and market opportunity. Based on financial analysis according to the harvest cycle, monoculture planting of albizia gives the highest B/C ratio (6.10) compared to agroforestry (5.86) and seasonal crops (5.90). Because of the gall attacks and the low price of albizia wood during the Covid-19 pandemic, people tend to replace their plant types with Multi-Purpose Tree Species (MPTS). MPTS was chosen because it can be harvested yearly without cutting down trees. This is good from the conservation aspect. The selected species are those that have a market opportunity and a reasonable price such as avocado and coffee.
- Regarding civil technique conservation using bamboo, there are participants from Wonokeling Village who has already practiced this technique. However, in general, the Field Partners still hopes for assistance to make it. This shows that the community mindset is still focused on government aid. This is because they have been conditioned to rely on assistance in carrying out soil and water conservation.

In general, community participation in soil and water conservation is passive participation and participation mobilized by incentives [5,13–15]. It means that the community is not in a position as decision-makers, especially in the selection of plant species and cropping patterns [14]. As a result, the community does not have a sense of belonging, affecting activities' sustainability [2]. In addition, these conditions also make the community dependent on the assistance of other parties in carrying out soil and water conservation [14]. The results of this study also show that community participation in soil and water conservation has not been entirely successful. However, several field partners have shown good participation in the sustainability of activities through maintaining perennial crops and constructing civil technique measures from bamboo. That is because they participate in decision-making so that the activities carried out are under their needs.

The facts also show that the community participate more in vegetative measures than civil technique measures. This is related to their perception of their agricultural land condition that is prone to erosion and their lack of understanding of the upstream and downstream relationships in the watershed. Because of that, the community only focuses on conservation efforts that have an on-site impact. The [16] study result also stated that upstream communities are more involved in vegetative conservation efforts because they can directly receive the benefits. In addition, the community is not fully aware that activities carried out in the upstream area will impact the downstream. The local wisdom of the community to control erosion and rehabilitate land, at that time was also based on the community's perception of their land which was slope land and prone to erosion. This means that perceptions affect the actions taken [23,24]. Therefore, local wisdom should be considered and used for the success of community participation in soil and water conservation [26].

4. Conclusion

Agricultural land in NMC is an area with a steep slope that is prone to erosion, so it is necessary to be conserved as a disaster mitigation effort. The agricultural land is private, so community participation is needed. Community participation in soil and water conservation demonstration plots starts from the planning stage. Community participation at the planning stage is relatively good, but involvement in the implementation stage is not yet optimal. This is because the community's mind-set has been conditioned to rely on assistance.

On the other hand, community perception and local wisdom will influence the choice of the type of activity to be carried out. People in the upstream watershed do not fully understand the linkages between the upstream and downstream areas in the watershed. However, the community already has local wisdom to control surface and gully erosion. To increase community participation in soil and water conservation, it is recommended that: 1) the techniques applied are not only to reduce disaster risk but also to improve the community's economy; 2) the community is involved in this decision-making and planning process; 3) community understanding of upstream and downstream relationships in watersheds needs to be improved, and 4) the use of local wisdom in soil and water conservation efforts.

Acknowledgments

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