Document No.: 2020P1-INA-TR
Receiving Date:

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

TECHNICAL REPORT

Development Participatory Management of Micro Catchment at The Bengawan Solo Upper Watershed (Phase II)

September 2020 – August 2022

Watershed Management Technology Center
Research, Development and Innovation Agency
Ministry of Environment and Forestry of Indonesia

September 2022

BASIC INFORMATION

Project Title (ID)	Development Participatory Management of Micro Catchment at The Bengawan Solo Upper Watershed (Phase II)
Supervisory agency (if any)	Extension and Human Resources Development Agency, Ministry of Environment and Forestry, Indonesia (BP2SDM)
Executing agency	Watershed Management Technology Center (WMTC)
Implementing agency(s) (if any)	-
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Reporting Period: [September/2020 to August/2022]	
APFNet total grant (USD): 99,820	
Cumulative expenditure (USD): 99,198.13; and expenditure rate for the Year (%): 99.38	

SUMMARY

The upstream watershed area has a strategic role as a recharge area for the downstream area. The upstream watershed area which is in an area with hilly, mountainous, and steep-sloped topography requires proper management while paying attention to the soil and water conservation principles. Upstream watershed management on an operational scale (micro watershed) is very difficult to do because of the many stakeholders involved. Therefore participatory-collaborative and integrated management between parties becomes a suitable choice to be implemented in the upstream watershed area.

The objective of this project was to develop participatory management of micro catchment based on community participation and stakeholder collaboration, considering the soil and water conservation principles. The well-managed micro catchment may improve environmental services such as water sustainability and land productivity, as well as community welfare. The project is located in Naruan Micro Catchment (NMC), upstream part of Keduang Watershed, The Upper Bengawan Solo River Basin. Administratively, NMC is located in Wonogiri and Karanganyar Districts, Central Java, Indonesia. The micro catchment is divided into three villages i.e Bubakan, Wonorejo, and Wonokeling.

This technical report presents all activities carried out over the whole time of the project (September 2020 to August 2022). Five outputs and 13 supporting activities targeted in AWP1 and AWP2 have been achieved. A number of the reported statements also include the continual integration of Phase I and Phase II project activities.

At the end of the project, several points can be concluded. Micro catchment management planning activities need to start with gathering baseline data on the characteristics of the watershed, followed by participatory planning and building collaborative commitment of the parties. The implementation of micro watershed management was done through vegetative and civil technique soil conservation measures by a participatory approach, and community empowerment. During project implementation, some issues, challenges, and obstacles have been encountered and successfully overcome. Improvements in land cover and erosion control, as well as increased farmer awareness and motivation for soil and water conservation, have all been impacted by management operations. This implementation has also increased farmers' revenue from the additional value of wood and fruit crops. The project results have been publised and disseminated to stakeholders through various media such as book-chapters, journals, proceedings, workshop, and technical assistants.

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Date: September, 2022	Date: 19 September, 2022

ABBREVIATION AND ACRONYMS

AWP	:	Annual Work Plan
Baperlitbang	:	District Planning, Research and Development Agency
BBWS BS	:	Bengawan Solo River Basin Organization
BP2SDM	:	Extension and Human Resources Development Agency
BPBD	:	Regional Disaster Management Services
BPDASHL	:	Institute of Watershed Controlling and Protection Forest
BPH	:	Forest Management Center
BPSILHK SOLO	:	Institute for Implementation Standard of Environment and Forestry Instrument - Solo (ex-WMTC)
BPUSDATARU	:	Center of Public Works, Water Resources and Spatial Planning
BSI-LHK	:	Agency for Standardization of Environment and Forestry Instrument (ex-FORDIA)
BUMN/BUMD	:	State-owned Enterprise/District-owned Enterprise
CDK	:	The Forestry Services Branch
Dryland (Tegalan)	:	Land covered with seasonal crops in dryfield
FGD	:	Focussed Group Discussion
FKPWP	:	Forestry Researcher-Trainers-Extention Agents Communication Forum
FORDIA	:	Forestry Research, Development and Innovation Agency
Forum DAS	:	Watershed Management Forume
FP	:	Field Partner
GNKPA	:	National Campaign for Water Conservation Partnership
KBR	:	Village nursery
MEF	:	Ministry of Environment and Forestry
M&E	:	Monitoring and Evaluation
MPTS	:	Multi-purpose Tree Species
MRGM	:	Multipurpose Reservoir of Gajah Mungkur
NMC	:	Naruan Micro Catchment
NGO	:	Non-Government Organization
OPD	:	Local Sectoral Institution
PDAM	:	District Water Services
Perhutani	:	State-owned Forest Company
RHL	:	Forest and Land Rehabilitation
RLPS	:	Land Rehabilitation and Social Forestry
SWC	:	Soil and Water Conservation
WMTC	:	Watershed Management Technology Center

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXES

I. PROJECT OVERVIEW

The cause of the high sedimentation rate in the MRGM is the high rate of soil erosion in the catchment area, especially from the Keduang Watershed. That is a result of land cover conditions, namely a lack of forest cover. Based on the land cover analyses using the 2011 Landsat 7 ETM, forest cover in the area was only 2.25% of the total area. The condition was worsened by the behavior of people who are paying few attentions to soil and water conservation when managing their land. The high rate of population led to population pressure on land resulting in excessive land use, which is a trigger for land degradation.

The NMC is in the upper part of the Keduang watershed. NMC locations have hilly and mountainous topography. As much as 60% of the land has a slope of 25-45%, and >30% of the area has a slope >45%. Based on the results of Wahyuningrum and Supangat (2016) analysis, it was concluded that most of the NMC areas were in the land capability classes VI and VII with a slope limiting factor, which means that in theory, the area should have a permanent plant cover. However, actual land cover is mostly in the form of dry land (dryland agriculture), and forests only occupy 20% of the area. This condition causes high erosion potential (>70% in severe and very severe erosion rik classes) and is thought to have an impact on the high sedimentation rate at the MRGM.

To overcome the problems of soil erosion and sedimentation in the Keduang Sub-Watershed, the cooperation project with the title "Development Participatory Management of Micro Catchment at The Bengawan Solo Upper Watershed" has been implemented in 2017-2019. This Project Phase I have been organized to manage the NMC and aimed to build a model of participatory micro catchment management. Participatory management plans for the area have already been arranged. The plan draft contains the indicative area that should be rehabilitated as well as community development plans and coordination mechanisms between the parties.

Based on the analysis, of the total NMC covering 957.1 ha, there were 594.4 ha (62.10%) of land that must be rehabilitated. Of the 594.4 ha, almost 30% of the area is on 45% slope which is very vulnerable to being degraded. The land use forms consist of dry field area (370.2 ha) and mixed gardens (224.2 ha). To overcome this issue, demonstration plots of the integrated farming system in the form of agroforestry have been built, covering an area of approximately 50 ha and distributed in 3 villages. Some potential

points for the implementation of technical civil activities have also been identified, including the construction of small check dams (7 units), gully plugs (67 units), landslide control buildings (37 units), and check dams dredging (7 points). Some of them have been successfully executed in the first Phase, in the form of 34 units of small gully plugs and 4 units of small check dams. To support these activities, community empowerment was carried out by establishing farmer working groups and training them on soil conservation techniques as well as comparative studies on integrated agriculture to several locations with different topics. Farmer working groups have involved 86 persons from 3 villages.

Based on the progress of activities in 2017-2019, there were still some activities needed, including: (a) Expansion of agroforestry plot on the vulnerable areas; (b) Addition of civil technique conservation structures, and (c) Establishing and training of farmer groups. Besides that, additional activities were needed to reduce population pressure on land and to increase non-land-based incomes such as processing agriculture product and apiculture. Monitoring and evaluation (M&E) were also still needed to observe the impacts of the construction of demonstration plots on the environment and socio-economic aspects.

Therefore, according to the second phase project proposal, an expansion of the rehabilitated area, an increase in the number of farmers involved and additional training activities were planned. In addition, a special demonstration area was built, mainly managed by the WMTC team by applying the best model produced by previous activities. Water quantity and quality observations were conducted continuously to assess the impact of project activities on the environment.

The goal of the project is to build a model of successful watershed management in accordance to soil and water conservation principles at the operational level (micro catchment scale). This model may be used as an example and reference for the implementing agency i.e Watershed and Protection Forest Areas Management Office (BPDASHL), and other institutions associated with watershed management, from the planning, implementation to the monitoring and evaluation process. The developed model may become a prototype applied at a broader scale. The specific objective of the project is to implement micro catchment management by improving the available management plan and extending the impact area, based on community participation and stakeholder collaboration, while considering soil and water conservation principles. The

well-managed micro catchment may enhance ecological functions by improving environmental services such as land and water quality, as well as promoting socio-economic development by increasing land productivity and community welfare.

This technical report presents all activities carried out during the whole project phase (September 2020 to August 2022). Five outputs and 13 supporting activities targeted have been achieved. A full description of the progress of the activities will be presented in Chapter 2.

II. IMPLEMENTATION PROGRESS, ACHIEVEMENT AND IMPACTS

The objective of this project is to develop participatory management of micro- catchment based on soil and water conservation principles. Some of the activities that have been done to achieve these goals are:

A. Output 1. Detailed participatory land management plan for the demonstration plot

1. Activity 1.1. FGD to develop participatory demonstration plot

Designing the participatory land management plan for the demonstration plot was done through FGD to capture the aspirations of the community so that they can play an active role. The demonstration plot location in Phase II is an area that has been included in the micro catchment management plan, but where no Phase I activities were implemented. Therefore, FGD's participants were land managers whose land was selected for the demonstration plot (Tabel 1). They then became plot participants or field partners (FP's). The FGD was also attended by village officials and community leaders.

Table 1. The list of the FGD participants, listed by village

No.	Wonorejo Village	No.	Wonokeling Village	No.	Bubakan Village
1.	Midi	1.	Parmin	1.	Sarjo
2.	Saimin	2.	Sido	2.	Warjo
3.	Dimin	3.	Sarimo	3.	Simin
4.	Slamet Riyadi	4.	Paikem	4.	Kino (Nongko Gadung)
5.	Kampret	5.	Narjo	5.	Giman
6.	Surat	6.	Larno	6.	Sarijo
7.	Lanjar	7.	Mbah Midah	7.	Kasino
8.	Tarmiji	8.	Sido	8.	Kino
9.	Kartono	9.	Tardi	9.	Kasmo (Nongko Gadung)
10	Sunu	10	Mino	10	Giman (Nongko Gadung)
11.	Wanto	11.	Midin	11.	Padi
12.	Sanem	12.	Kemis WG	12.	Sardi
13.	Mbok Jono	13.	Karyo Riman	13.	Padi
14.	Suripto	14.	Giman WG	14.	Slamet
15.	Sukino	15.	Semi	15.	Nyono
16.	Sono Karto	16.	Ramin	16.	Darmin
17.	Sularno	17.	Kasino	17.	Kasman
18.	Sukadi	18.	Suyatno	18.	Giman
19.	Jumawan	19.	Jo Sentono	19.	Karmo
20.	Sadimin	20.	Sukidi	20.	Adine Sardi
21.	Marimin	21.	Sukiyem	21.	Samino
22.	Sidin	22.	Tolu	22.	Sarmo
23.	Rebo	23.	Sri Tarjo	23.	Samidi
24.	Tanu	24.	Narno	24.	Giyarso
		25.	Suyarno	25.	Kariyo

		26.	Sakino	26.	Sugiyo
		27.	Rambat	27.	Sukini
		28.	Panut	28.	Suyar
		29.	Tino	29.	Giyanto
		30.	Mariyo	30.	Soman
		31.	Sugino	31.	Kasmo
		32.	Suyarno	32.	Giyarto
		33.	Suyar	33.	Tarman
		34.	Sular WG	34.	Yaman
		35.	Mbah Surip	35.	Warno
		36.	Sakino	36.	Mijo
		37.	Lasno	37.	Warno
		38.	Panut	38.	Gudel
		39.	Samidi	39.	Jono
		40.	Senen	40.	Sukidi
		41.	Pardi Mijan	41.	Sarjo
		42.	Sugino	42.	Yaman
		43.	Suyatno	43.	Tami
				44.	Winih
				45.	Tanu
				46.	Kemis
				47.	Kino
				48.	Tarno

The FGD amongst farmers has been held in three villages (Wonorejo, Wonokeling, and Bubakan) (Figure 1). FGD in each village was conducted once. The FGD was conducted to discuss the existing land cover, a detailed participatory land management plan suitable for soil and water conservation efforts (includes plant species and composition), the needs and location of conservation buildings, and the types of training to increase the capacity and income of the community.

The demonstration plot management plans were carried out in a participatory manner so that the planning corresponded to the community's needs. However, this plan does not only follow the community's desire, which is generally economically oriented, but also considers soil and water conservation aspects. Therefore, the resulting demonstration plot land management plan is a compromise between the pattern desired by the community and a pattern suitable for land conditions. Through FGD, it was found that at this time albizia was not in demand, because many albizia trees were attacked by Gall disease. Besides, the recent selling price of albizia wood was very low as an impact of the Covid-19 pandemic. Instead, there discussed species of woody trees such as burflower, balsa, and limpaga as alternatives. However, FP prefered to plant Multy Purpose Tree Species (MPTS) such as fruit trees and plantation crops, so the composition between timber and MPTS is 30:70. MPTS not only provide economic benefits, but is also beneficial from a soil and water conservation

perspective. Based on FGDs conducted in three villages, the land management plans are presented in Table 2.

Table 2. Participatory management plans for demonstration plots in the three villages

No.	Village	Selected cropping pattern	Spacing (m)	Compotition	Commodity		FP's contribution
					Woody plants	MPTS	
1.	Bubakan	Mix (Woody trees. MPTS, and seasonal crops)	6 x 6	70 % MPTS and 30% woody plants	Albizia	Avocado, cacao, citrus, and cloves	- Labor - Manure - Seasonal crops
2.	Wonorejo	Mix (Woody trees. MPTS, and seasonal crops)	6 x 6	70 % MPTS and 30% woody plants	*Ochroma sp* and burflower	Avocado, cacao, citrus, nutmeg, and durio	
3.	Wonokeling	Mix (Woody trees. MPTS, and seasonal crops)	6 x 6	70 % MPTS and 30% woody plants	Albizia, limpaga, burflower, and *Ochroma sp*	Avocado, cacao, mango, durio, and nutmeg.	

(a)

(b)

(c)

Figure 1. FGD in 3 villages. (a) Bubakan, (b) Wonokeling, and (c) Wonorejo

2. Activity 1.2. FGD among stakeholders to support the implementation of activities

The objective of FGD among stakeholders was to increase the stakeholder's commitment in upper watershed management, especially in NMC, through the support of activities and funding according to their duties and functions. The stakeholder FGD was scheduled to be held in October 2020, but it was postponed to June 2021. The stakeholder FGD in Karanganyar District was held on June 23, 2021, and was attended by 40 persons consisting of several parties, such as sectoral institutions in Karanganyar District, BPDASHL Solo, BBWS Bengawan Solo, Jasa Tirta, Pusdataru, the head of Jatiyoso SubDistrict, Solo Watershed Forum, the extension agents of forestry and agriculture, the head of Wonokeling village and, the head of Wonorejo village (Figure 2).

FGD of the parties in Wonogiri District was held on November 16, 2021. The FGD was attended by 40 participants, consisting of various sectoral agencies in Wonogiri District, BPDASHL Solo, BBWS Bengawan Solo, BPUSDATARU Bengawan Solo, CDK Region XI, PDAM Wonogiri, the head of Girimarto Sub District, Solo Watershed Forum, the extension agents of forestry and agriculture, the head of Bubakan Village, and NGO Persepsi (Figure 3).

Figure 2. The FGD among stakeholders in Karanganyar District

Figure 3. FGD among stakeholders in Wonogiri District

As a result of the FGD in Karanganyar District, we noted some of the results that can be underlined and be followed up, i.e: (1) Activities related to the NMC management can be integrated into the work plan of the local government. However, there needs to be a synchronization of work plans and funding from the ministry through each local sectoral institutions in the district; (2) Several agencies have provided tree seedlings (avocado, coffee, agathis, durio, and soursop);(3) BPDASHL Solo and Pusdataru can provide support for soil and water conservation activities, but the village has to propose officially; and (4) Forestry and agricultural extension agents can be actively involved in assisting the community, both individuals and farmer groups, to increase community participation and self-reliance in soil and water conservation.

Based on the discussion, the stakeholders have carried out several, partially ongoing, programs to support upper watershed management in Wonogiri District. Some of the programs potentially to be followed up by village government. The programs that have been carried out are presented in Table 3.

Table 3. Matrix of FGD among stakeholders' results

No.	Stakeholders	Programs	Follow up
1.	Agricultural Services	- Providing seed of annual and seedling of perennials crops (longan and coffee) in 2018 – 2020 - Construction of Small Gully Plug - Development of horticultural crops	- Application for perennial crops seedlings assistance, appropriate to the village potential and needs - Due to limited funds, stakeholders' collaboration in the small gully plug construction is needed
2.	CDK Region XI	- Enrichment of private forests through the assistance of perennial seedlings to the Forest Farmers Group	- Proposed the construction of the gully plug through forestry extension agents

		- Construction of civil technique of soil and water conservation measure - Forestry Extension Volunteer to support the task of forestry extension agents	
3.	BPDASHL Solo	- Establishment of permanent nurseries for perennial crops - Construction of civil technique soil and water conservation measures	- Application for perennial crops seedlings assistance - Application for assistance in the construction of civil technique soil and water conservation measures
4.	Environmental Services		- Facilitation for biogas construction for the livestock farmer groups - Assistance and training on waste management
5.	Marine, Fisheries, and Livestock Services		Application for assistance for fishery activities either for farmers' group or household level
6.	PDAM Wonogiri	Planting Ficus for spring protection	

In addition, there are several suggestions that can be followed up in NMC management, including the development of Bubakan Village as a tourism village (agrotourism or ecoedutourism), the commitment of the village government to allocate village funds for soil and water conservation activities, as well as efforts to change community behavior in handling livestock and household waste.

B. Output 2. Demonstration plots of conservation farming and watershed rehabilitation

1. Activity 2.1. Determining the site of demonstration plot

Field measurements using GPS were carried out to determine the demonstration plot area (Figures 4-6). Tracing ownership boundaries was carried out with the help of farmers participating in the demonstration plot. The measurement results were then mapped and its physical characteristics were identified, such as the current land use type, slope, and cropping pattern and the name of the landowner. The land ownership area of each participant is different, so the number of group members for each village is different. Of the total area owned, not all of them are in open conditions due to seasonal crop cultivation, some of which are already covered by perennial trees (timber

or fruit trees). The list of farmers participating in the demonstration plot and land conditions in each village are presented in Annex 1, 2, and 3.

Figure 4. Lay-out plot in Wonorejo Village

Figure 5. Lay-out plot in Wonokeling Village

Figure 6. Lay-out plot in Bubakan Village

For a control treatment, the research team has constructed a non-participatory demonstration plot that is totally maintained by the research team and follows the treatment plan that the research team has devised. This demonstration plot served as a control plot for the participative demonstration plot, to be compared afterwards. The control plots, which cover around 3 hectares are located in Wonokeling and Bubakan Villages, have been delineated.

They are under cultivation, with the primary crops are corn and cassava (Figures 7 and 8). As a marker of ownership borders, woody plants are placed along the boundary. The slope of this annterrain is more than 40%, with deep soil. A sloping outward terrace and a mound terrace were used as soil conservation measures. This condition, however, is still prone to erosion, particularly when land is cleared for the cultivation and planting of seasonal crops. Tillage was done, particularly before the rainy season began. When the rain starts to fall, the soil is prone to erosion because the seasonal crops have not yet sprouted. Perennial plants are needed in these situations because they are reasonably durable and protect the land surface.

Figure 7. Lay-out of non-participative plot in Wonokeling Village

Figure 8. Lay-out of non-participative plot in Bubakan Village

The non-participatory design was the result of Phase I development, which yielded the best economic and environmental effects, namely an agroforestry pattern focused on fruit crops. The initial conditions of the plots are in Figure 9.

(a) (b)

(c) (d)

Figure 9. Initial condition of non-participatory demonstration plots: (a) Wonokeling: upper slope, (b) Wonokeling: bottom slope, (c) Bubakan: upper slopes, and (d) Bubakan; Bottom slopes

2. Activity 2.2. Applying vegetative soil conservation measures

An agroforestry demonstration plot is a form of vegetative soil and water conservation techniques. The initial conditions of the demonstration plot area can be seen in Figure 10. The number of seeds, both fruit trees and tree crops (forestry), was adjusted to the area of land and cropping patterns of each participant as well as the spacing agreed upon during the planning of the demonstration plot. Seed distribution was carried out after group members made planting holes and prepared manure (independently). Planting grass in the sewerage was carried out independently by the farmer. The research teams, forestry extension agents and village apparatus monitored planting activities until all seedlings were planted in the field according to the design (Figure 11 & 12).

The research teams and forestry extension agents continued to monitor every stage of activity, including the process of distributing seedlings so that they were right on target and ensuring that all seedlings were planted in the field according to the design. One week after the seedlings were distributed to the farmer groups, the research teams examined the planting results. The condition of the seedlings a week after planting can be seen in Figure 13.

Bubakan

Wonorejo

Wonokeling

Figure 10. Land conditions before planting, mainly dry field agriculture

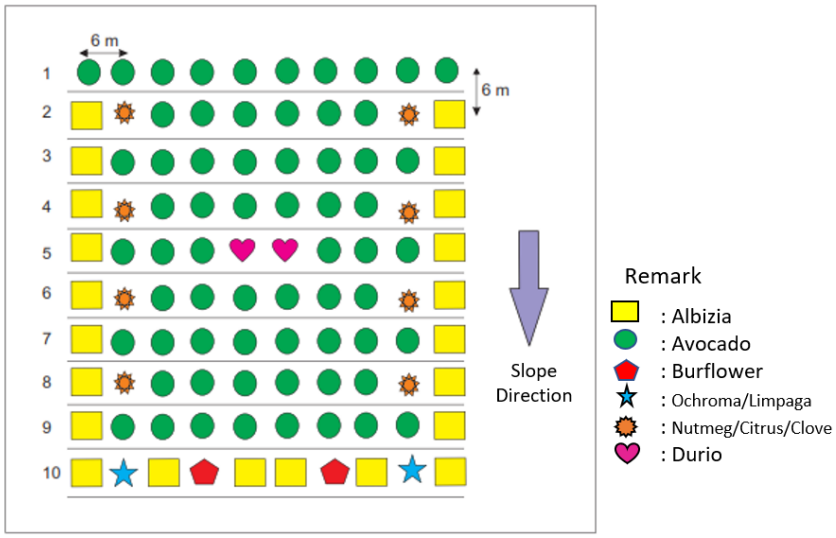

Figure 11. Planting layout of fruit plant-based agroforestry plots (participatory design)

Figure 12. Seedling distribution and planting activities

Avocado Mango Albizia Clove

Nutmeg Durio Cacao Citrus

Ochroma Burflower

Figure 13. Plant performances one week after planting

The non-participatory demonstration plots were divided into upper and lower slopes. As a form of vegetative soil conservation, the agroforestry pattern for the upper slopes is different from that applied at the bottom. The upper slope is coffee-based

agroforestry, while the lower slope is avocado-based agroforestry. The planting design of each plot is presented in the Figure 14.

In the upper Wonokeling plot, limpaga and albizia were planted at a distance of 6 x 6 meters, while coffee was planted between them at a distance of 3 x 3 m. The same as that designed in Wonokeling, the coffee in the upper Bubakan is also planted at a distance of 3 x 3 m between albizia with a distance of 6 x 6 m. The lower slope of Wonokeling and Bubakan were planted by avocado and limpaga, with the distance of 6 x 6 m.

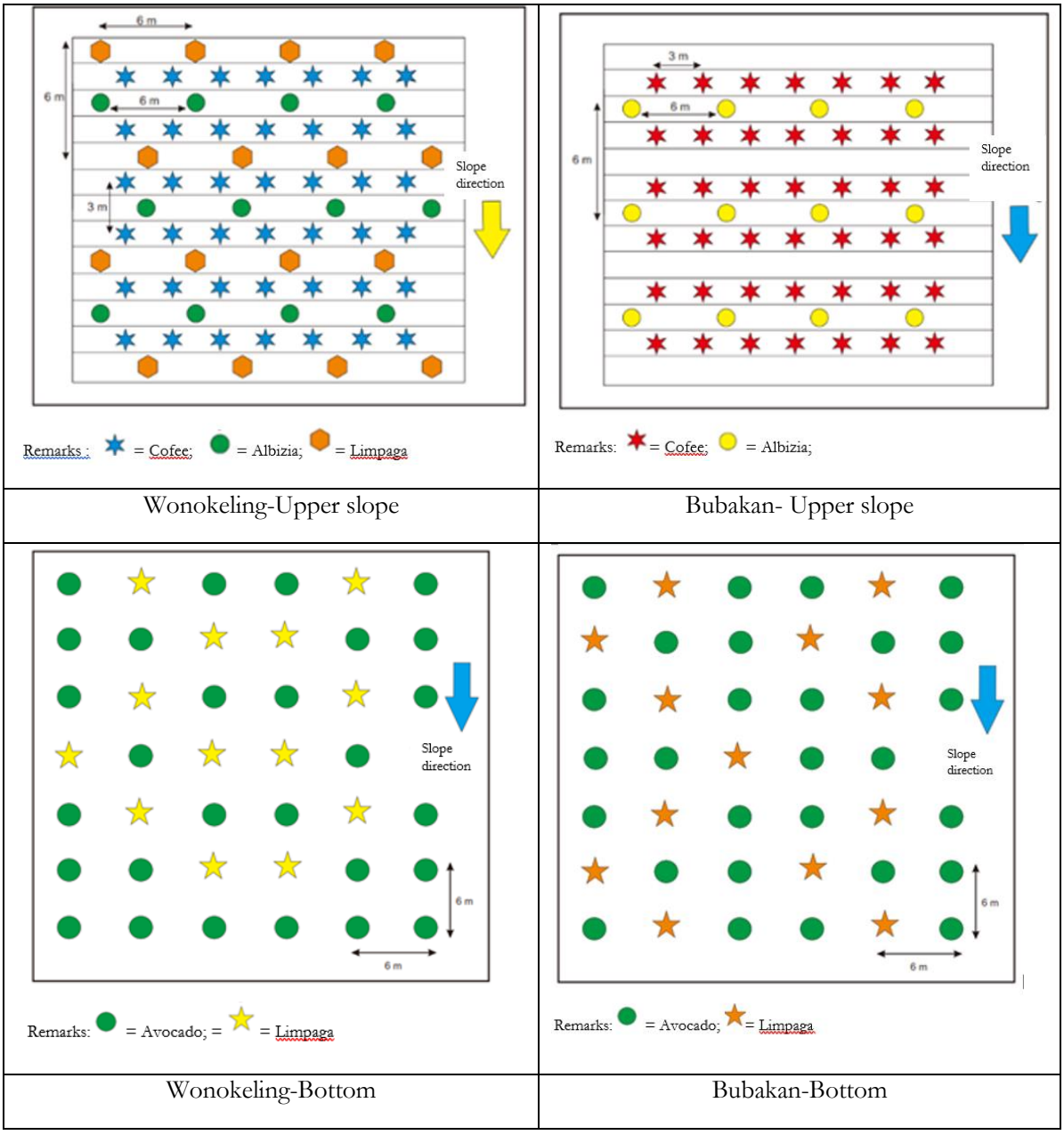

Figure 14. Non-participatory agroforestry plot design

Planting distance measurements were carried out using a measurement tape and pole. Planting holes were marked with stakes colored according to the code of the plant species (Figure 15.).

(a) (b)

(c)

Figure 15. Planting preparation activities: (a) Measurement of planting distance, (b) Installation of stakes, (c) placing signboards

The number and species of plants in the non-participatory demonstration plots are adjusted to the available land area. Besides contributions from APFnet, coffee was contributed by the plantation services of the district. Albizia was chosen as shading for coffee.






Avocado Coffee Albizia Limpaga

Figure 16. Non-participatory agroforestry plot development activities

3. Activity 2.3. Applying civil technique soil conservation measures

In the first year of project, we planned to build 7 units of gully erosion control including 1-unit small check dam using "spesi (cemented stone) construction", and 6 units small gully plug using "bamboo construction". Based on the contours and straightness of the gully in the field, the number of the types of gully construction has changed. More gully controllers were needed with specific materials stronger than those made of bamboo. We built two units construction using spesi materials and one head structure using gabion (Table 4). These buildings were made in a serial order from the head to the toe of the gully. This change in the type of building material increased costs approximately 30%. At this moment, this additional cost was

substituted from the cost of Activity 1.2 and 3.1. In the second-year project, the adjustment of the budget had been made to accommodate these changes. Implementation of the civil techniques for soil conservation was a collaborative effort between research teams, extension agents, and farmer groups with the goal of transferring technology and building human resource capability.

Table 4. The construction types of gully controllers in Wonokeling Village

No.	Description	Volume
1.	Head Structure (Gabion)	1 unit
2.	Gully Plug (Bamboo)	4 unit
3.	Gully Plug (Spesi)	1 unit
4.	Small check Dam (Spesi)	1 unit

Spesi Gabion Bamboo

Figure 17. Types of gully control construction materials

In the second year of the project, we built 16 units of gully erosion control, consisting of 14 units of Small Gully Plug (SGP) using bamboo/gabion materials and 2 units of small check dam (DPn) using cemented stone (spesi) construction. According to the AWP 2, construction was scheduled for January-March 2022. However, there was a labor shortage in the field, which created a constraint. All the farmers were busy with other tasks, such as land preparation and corn planting for the second crop season, which began in February. Therefore, we postponed the construction to March for bamboo and gabion SGP, while small DPn construction was shifted to April and May.

Based on filed survey, two gully points have been identified as the locations for the construction. Both points are in Wonokeling village. The gullies' initial conditions and after constructions are presented in the Figures below.

a. Gully 1; before (left); after (right)

b. Gully 2; before (left); after (right)

Figure 18. Gullies condition before and after construction of gully controls

C. Output 3. Enhancement of farmers' skill and income through on-farm and off-farm activities

1. Activity 3.1. Development of apiculture

Participatory watershed management requires qualified human resources (HR). The increase in human capacity can be done through training. The training of apiculture aims to improve the skills of farmers as well as to increase other income besides from agricultural activities.

The development of honey beekeeping is a follow-up of the recommendation from the FORDIA monitoring and evaluation team to improve the community income.

Beekeeping training was conducted in November 2021 in three villages (Wonokeling, Wonorejo, and Bubakan), which was attended by 30 persons in each village. Participants included representatives of FP's, farmers (non-FP's), and village officials. The trainer was an experienced beekeeper from Klaten District. The training materials covered theory (species of *Trigona sp.*, beehives, types of *Trigona sp* feed plants, environmental needs etc.), as well as practice, especially how to develop new colonies. After training, the team provided 10 colonies of *Trigona sp* as an incentive to each village.

Wonokeling

Bubakan

Wonorejo

Figure 19. Training of Beekeeping

2. Activity 3.2. Training to improve farmer's skill in processing agricultural yields for higher value-added products

The objective of the training was to improve the farmer's skills in increasing crop yields, especially fruit and horticulture, and increasing the added value of the yields. The training was divided into two topics, namely 1) training on coffee cultivation and post-harvest processing and 2) training on avocado cultivation and grafting technique.

The training on coffee cultivation and post-harvest processing were chosen because the community is passionate about cultivating coffee. This was also based on the historical experience of the farmers who had planted coffee, but the plants were cut down in 2014 because the price was not profitable.

The training was carried out in three villages, Wonokeling, Wonorejo and Bubakan. The training was conducted in January 2022. The participants consisted of 15 peoples from each village. They were coffee growers and traditional beverage traders.

There were two training sessions covering how to grow and process coffee, and how to serve coffee in a modern way. The trainers have experience as coffee farmers and baristas. The trainers came from a coffee farmer group and coffeeshop owners in Boyolali District.

The training materials included the introduction to the types and characteristics of coffee in the world and the history of the entry of coffee into Indonesia. Their explanation was starting from seed germination, seedling, planting, fertilizing, pests and diseases controlling, fruit controlling, fruit harvesting, and post-harvest processing. The training ended with the barista's style coffee serving techniques such as espresso, americano, and vietnam drips. Older participants tend to be more interested in coffee growing techniques while younger participants tend to be more interested in the processing and serving of coffee.

Figure 20. Training on coffee cultivation and processing

The training on avocado cultivation and grafting technique was chosen because most people have cultivated avocado. In addition, one of the perennial species planted in the demonstration plot is avocado. The training was conducted in August 2022 in three villages namely Wonokeling, Wonorejo, and Bubakan. Participants were 15 people from each village consisting of FP representatives and village communities.

The trainer was the extension agent in Wonogiri District. The training materials were avocado cultivation and grafting techniques (theory and practice). Through this training, the community is expected to be able to reproduce avocado seedlings by themselves. In addition, if people are able to practice proper avocado cultivation techniques, plant productivity will increase.

Figure 21. Training on avocado cultivation and grafting

3. Activity 3.3. Training to improve farmer's skill in processing household and and agriculture waste

   The training was conducted to overcome the waste problem which has been a problem arising in the watershed. In addition, waste management is also expected to be a source of community off-farm income. The training is carried out in two sessions with different topics and participants. Session I was focused on household waste management, while session II focused on agriculture waste. The training was conducted in three villages (Wonorejo, Wonokeling, and Bubakan) with 15 participants in each session from each village.

   The trainer was the Berseri waste management group from Kradegan Village, Bulukerto District, Wonogiri Regency. The training materials covered the management of non-organic waste (plastic bottles, plastic, metals and others), organic waste (paper, leftovers and others), the managerial aspect of waste management, and agriculture waste.

Figure 22. Training on processing household and and agriculture waste

D. Output 4. Information on the impacts of the demonstration plots of conservation farming and watershed rehabilitation

At the initial stage, the activity to support output 4 is the collection of baseline data before agroforestry activities are implemented. The parameters collected include 3 aspects, namely water system condition, land condition, as well as economic and social aspects. The baseline data is also used as reference data for monitoring and evaluation activities of micro watershed management at the land unit and micro watersheds scale.

4. Activity 4.1. Water yield and sedimentation monitoring

Continuous hydrological monitoring was carried out in the main river of NMC and its three tributaries, namely Branjang, Muncar, and Naruan (Figure 23). The data collected includes discharge, sediment and total run off. Rainfall data was also observed through two rain gauges installed in Bubakan and Wonorejo. The results of monitoring within the year 2020-2022 are presented in Table 5.

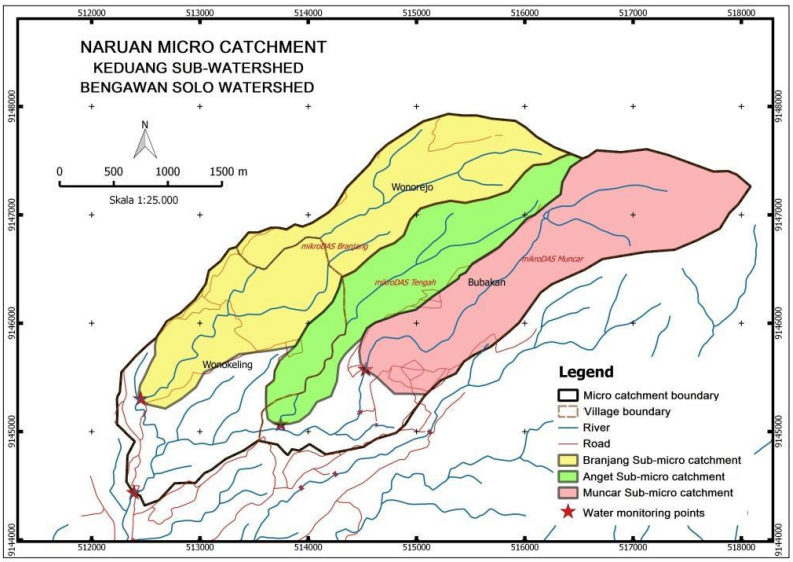

Figure 23. Hydrological monitoring and the gully erosion control points at the NMC

Table 5. Hydrological data of NMC

Tributaries	Area (ha)	Rainfall (mm/year)	Discharge (m^3/sec)	Runoff (mm/year)	Sediment (t/ha/year)
Branjang	282.2	2,877	54.0	1,652.9	138.82
Muncar	307.2	2,877	153.7	4,321.8	233.53
Naruan (Outlet of micro catchment)	957.1	2,877	360.6	3,254.8	146.53

Remark: Reporting period from September 2020 to August 2022

Monthly hydrological data showed that the average rainfall is 2,877.3 mm with average of monthly rainfall is 240.5 mm, and number of the rainfall day is 9 days/month. While the average water discharge is 189.40 m3/s. Based on the reported data, from 2,877.3 mm/year of rainfall, it produced an average runoff of 3,076.5 mm/year and sediment yield of 172.23 tons/ha/year. This condition means that in terms of quantity, the condition of the water system in the NMC is in good condition. The monthly distributions of hydrological data are presented in Figure 24-26.

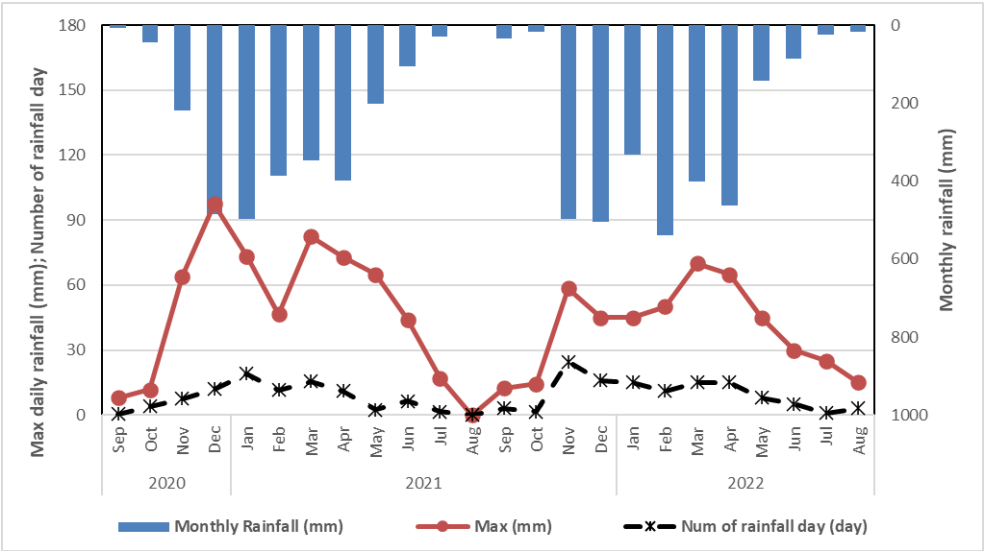

Figure 24. Distribution monthly rainfall data in year 2020-2022

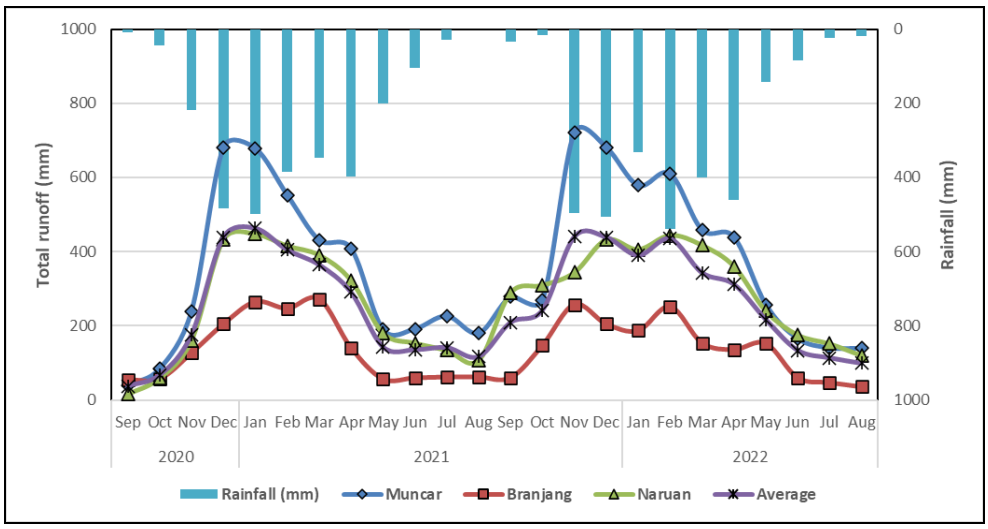

Figure 25. Distribution monthly runoff data in year 2020-2021

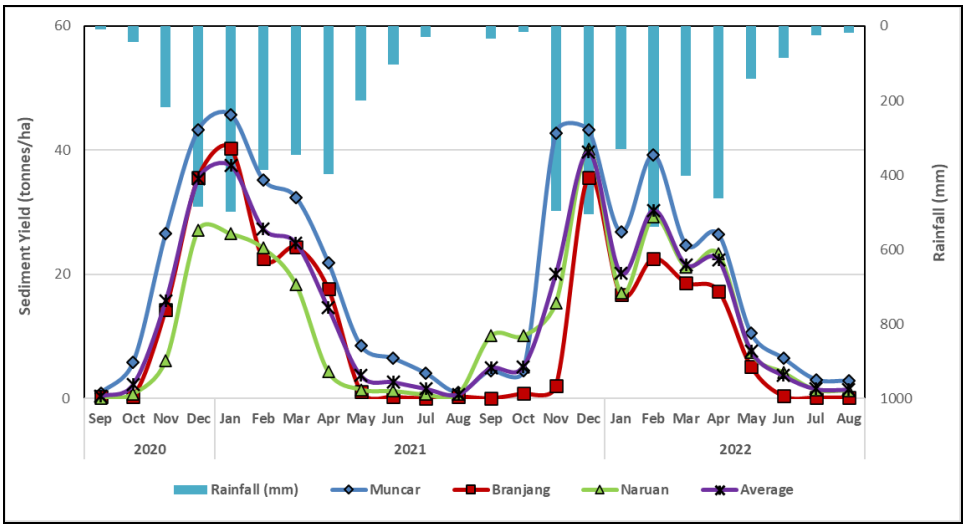

Figure 26. Distribution monthly sediment yield data in year 2020-2021

According to Figure 24, the wet months occurred between October and May, while the dry months occurred between June and September. This is also shown by the condition of monthly fluctuations in river flow (discharge).

The monthly data distribution has not shown any relationship between the activities of the project with the hydrological condition in the NMC. Of the NMC area which almost 1,000 ha, it has been developed vegetative plots of less than 89.5 ha starting at the end of 2016, as well as 58 units of technical civil structures to controlling small gully erosion. In the micro catchment scale, these are classified as small activities and the hydrological impact has not been seen at the catchment outlet. However, on the onsite scale (plot), the impact of activities could be seen on erosion control, as discussed in Activity 4.2.

The hydrological data shows the NMC's role as a water recharge area of the Bengawan Solo Watershed. Quantitatively, the state of the water resources is still quite good. This is demonstrated by the significant base flow, which is relatively abundant during the dry months of the river. Even in terms of annual data, the amount of total river flow exceeds the total rainfall. This illustrates that the watershed roles as a water storage and regulator is still functioning well. This condition cannot be separated from the presence of a forest area in the upstream part of the NMC, which functions as a sponge to control water flow.

5. Activity 4.2. Land evaluation

The baseline data collected from the land aspect includes the initial land cover conditions and the level (index) of soil erosion. The initial cover of the demonstration plot consisted of almost 100% of seasonal crops, such as corn, beans, cassava, and various types of vegetables. The location is following the target of vegetative SWC development, namely dry land planted with seasonal crops on steep slopes.

The results of the DEM analysis show that the demonstration plot locations generally have a slope of 24-65%, but the results of direct measurements in the field show that the actual conditions are generally more than 45%. The average slope of the demonstration plots was 35% for Bubakan, Wonokeling, and Wonorejo Villages. The soil is dominated by inceptisols which have an effective soil depth that is quite deep (> 90 cm). Based on the results of soil analysis (texture, structure, and organic matter)

used to calculate the soil erodibility (K) value of the USLE formula, the K value range is between 0.16-0.33. The average value of K used in the calculation is 0.28. The type of land cover consists generally of seasonal crops with a contouring planting system. There are perennials trees mainly on the boundaries of plots or in the tillage area with sparse density and irregular spacing.

Figure 27. Contouring pattern of perennial trees in the boundary

Figure 28. General condition of soil depth at the study area

The average rainfall taken from Gondang and Bubakan rain station was 2.688 mm/year while the average monthly rainfall was 269 mm. Based on the above land characteristics, soil erosion can be predicted using the USLE (Universal Soil Loss Equation) formula. At the start of the activity, erosion in the demonstration plot was predicted to be moderate in average. Erosion has decreased to approximately 33% of the initial erosion in the five-year forecast, assuming forestry and fruit crops grow. This takes into account the decrease in the value of C due to the improvement of land cover by forestry and fruit crops. Initial erosion before project implementations in Bubakan, Wonokeling, and Wonorejo was moderate (147 tons/ha/yr, 120 tons/ha/yr, and 106.35 tons/ha/yr). After five years, the erosion is expected to decrease to 45.9 tons/ha/yr, 37.5 tons/ha/yr, and 33.32 tons/ha/yr, all of which are considered lower risk (Annex 4, 5, and 6.).

The main factors causing erosion are the land slope and rain, while the land management factor which is planting in the direction of the contour, can reduce erosion so that it does not become severe or very severe erosion.

(a) (b)

Figure 29. Erosion on agricultural land, macro (a), and micro appearance (b)

We measured crop performance on the selected permanent plots (SPP) in each village start from January 2021 (one month after planting). Each village was represented by three permanent plots which was purposively represented by 20 trees in one stretch. The average mortality percentage of avocado, the main plant, in the plots was 9% while albizia was 30%. Within six months after planting there were plants that decreased in height and diameter. This was due to the accumulation of

soil in the artificial mound so that the height and diameter of the plant decreased such as the height of cacao in in the plots of three FPs, namely Kartono, mbah Jono, and Mijo. The accumulation of soil in the mound is a type of maintenance by FP. Beside that, the broken plant shoots also may cause a decrease in plant height. Maintenance of seasonal crops in the form of weeding must be done carefully so as not to cut the cultivated perennial plants.

From January 2021 to June 2022, there were some plants that died and some that have broken shoots in one SPP. Some broken plants recovered. To replace dead plants, replanting was also done. Until 18 months after planting, the average survival rate of the main tree (avocado) is 80.0%. Burflower had the greatest increase in height and diameter (375 cm and 2.7 cm, respectively), followed by Albizia (276.8 cm and 2.6). These burflower and albizia trees are located on land owned by Sanem (Wonorejo) and Mijo (Bubakan), respectively.

Table 6. The trees performance of the selected permanent plots in each villages

			January 2021			June 2021			October 2021			February 2022			June 2022			Average			
Villages	Name	Species	Height (cm)	Diameter (cm)	Number of trees	Height (cm)	Diameter (cm)	Number of trees	Height (cm)	Diameter (cm)	Number of trees	Height (cm)	Diameter (cm)	Number of trees	Height (cm)	Diameter (cm)	Number of trees	Height (cm)	Diameter (cm)	Number of trees	The percentage of live plants
Wonorejo	Kartono	Avocado	37.5	0.7	18.0	39.9	0.8	18.0	41.9	1.1	13.0	83.6	1.7	16.0	113.8	2.3	10.0	63.3	1.3	15.0	83.3
		Cacao	69.5	1.0	2.0	49.3	0.7	2.0	62.0	1.3	1.0	52.0	1.4	1.0	52.0	1.1	1.0	57.0	1.1	1.4	
		Citrus	60.0	1.1	1.0	78.5	1.3	1.0	93.0	1.3	2.0	122.5	2.1	2.0	0.0	0.0	0.0	70.8	1.2	1.2	
	Mbah Jono	Avocado	47.2	0.7	17.0	44.3	0.8	17.0	53.1	1.2	18.0	87.1	1.8	17.0	108.3	2.0	15.0	68.0	1.3	16.8	98.8
		Cacao	76.0	1.0	2.0	63.0	1.0	2.0	70.5	1.3	2.0	73.5	1.2	2.0	87.5	1.0	2.0	74.1	1.1	2.0	
		Durio	50.5	1.0	1.0	-	-	0.0	-	-	0.0	-	-	0.0	-	-	0.0	50.5	1.0	0.2	
	Sanem	Avocado	47.8	0.7	19.0	45.4	0.8	16.0	40.2	0.9	14.0	51.7	1.3	12.0	68.9	1.7	16.0	50.8	1.1	15.4	81.1
		Citrus	82.0	0.9	1.0	82.0	0.9	1.0	58.0	0.7	1.0	63.0	0.9	1.0	66.0	1.0	1.0	70.2	0.9	1.0	
		Burflower	75.0	0.6	4.0	79.3	1.0	4.0	111.7	2.3	3.0	175.7	2.9	3.0	450.0	3.3	1.0	178.3	2.0	3.0	
Wonokeling	Sakino	Avocado	44.0	0.7	20.0	39.0	0.7	20.0	44.9	1.2	15.0	64.2	1.4	13.0	88.6	1.9	13.0	56.2	1.2	16.2	81.0
	Sukidi	Avocado	43.4	0.7	16.0	42.1	0.8	11.0	70.4	1.3	8.0	98.7	1.5	10.0	143.8	2.1	8.0	79.7	1.3	10.6	66.3
		Durio	73.0	1.0	1.0	-	-		50.0	0.7	1.0	103.0	1.0	1.0	180.0	1.3	1.0	101.5	1.0	1.0	
		Nutmeg	52.3	0.8	3.0	27.5	0.6	3.0	74.0	1.1	3.0	83.0	83.0	2.0	86.0	1.5	2.0	64.6	17.4	2.6	
	Marjo	Avocado	43.0	0.7	20.0	44.9	0.9	18.0	58.6	1.3	18.0	76.6	2.1	17.0	108.3	1.9	17.0	66.3	1.4	18.0	90.0
		Ochroma	54.5	1.1	2.0	-	-	-	294.5	6.7	2.0	650.0	10.5	2.0	89.5	1.7	2.0	272.1	5.0	2.0	
Bubakan	Mijo	Avocado	47.8	0.7	14.0	43.8	0.8	12.0	45.0	1.0	6.0	65.5	1.2	3.0	98.3	2.5	4.0	60.1	1.2	7.8	55.7
		Albizia	74.6	0.6	5.0	85.8	0.9	4.0	182.0	1.8	4.0	154.3	1.8	2.0	351.3	3.2	4.0	169.6	1.6	3.8	
		Cacao	73.0	1.3	1.0	68.0	1.1	1.0	74.0	74.0	1.0	81.0	1.8	1.0	100.0	1.8	1.0	79.2	16.0	1.0	
	Jono	Avocado	46.0	0.7	16.0	44.8	0.9	16.0	44.8	1.0	16.0	61.1	1.4	14.0	89.5	1.8	11.0	57.2	1.1	11.0	68.8
		Albizia	69.7	0.5	3.0	63.5	0.7	2.0	81.5	0.7	2.0	58.0	0.5	2.0	87.5	0.8	2.0	72.0	0.6	2.2	
		Clove	55.0	0.5	1.0	72.0	0.6	1.0	130.5	1.4	2.0	126.3	1.7	2.0	220.0	2.9	1.0	120.8	1.4	1.4	
	Kamo-Giman	Avocado	46.7	0.7	15.0	51.9	1.0	14.0	60.0	1.3	14.0	81.8	1.8	14.0	104.8	2.2	14.0	69.0	1.4	14.2	94.7
		Albizia	77.6	0.4	5.0	107.3	0.8	3.0	140.3	1.1	3.0	236.5	2.2	2.0	330.0	2.8	2.0	178.4	1.5	3.0	

6. Activity 4.3. Evaluation of economic and social aspect on land management

Monitoring and evaluation of economic and social aspects were carried out to provide information on the socio-economic impact of the conservation farming and watershed rehabilitation demonstration plot from project phases I and II. Data was collected through interviews with plot participants (FPs). However, the baseline data such as the characteristics of FPs and the economic conditions of farmer households were only collected from FPs in phase II.

a. Characteristics of FPs

The average age of the respondents was over 50 years (Table 7.). Based on the community information, the younger generations in the three villages are more interested in working in the cities (wandering). Their livelihoods are generally based on meatball or herbal medicine trading. The younger generation is not interested in the agricultural sector because dryland farming is considered insufficient for their daily needs.

Table 7. The average and range age of respondents

No.	Village	Average (years)	Range (years)
1.	Wonorejo	53	26-65
2.	Wonokeling	56	43-75
3.	Bubakan	55	55-70

The main livelihood of 91.67% of respondents consists of farming and 8.33% of the respondents are traders. Some of the farmers have secondary livelihoods as construction workers (9.09%), traders (6.06%), and casual laborers (6.06%). Respondents whose main livelihood is base on trading were migrants.

The education levels of the respondents were as follows: 47.22% had no formal education, 19.44% did not pass elementary school, 27.78% graduated from elementary school, and 5.56% graduated from junior high school. This indicates that the education level of the plot participants is very low.

b. The household economy of farmers

From an economic aspect, the agroforestry demonstration plot has a comparative advantage over other locations. It is due to very fertile soil condition with a topsoil thickness of more than 50 cm, made from Lawu volcanic parent material which has very high mineral content.

In terms of human resources, the age of respondent is 45-75 years old. This shows that the younger generation is no longer interested in dryland farming activities. According to the head of Wonokeling Village, the current results of farming cannot meet secondary needs. Therefore, some of the younger generations have migrated to the cities. This is also confirmed through the results

of our survey as 42% of the farmers participating in the demonstration plot have migrated permanently or seasonally. In the cities, they sell meatballs, noodles, and herbal medicine. From the experience of seeing progress in other areas and the results of their income overseas, they can contribute to building road infrastructure in their village to facilitate farming transportation. The survey showed that the respondents' income sources are as presented in Table 8.

Table 8. The respondent's income sources in 2020

Villages	Income Sources (Rupiahs)						Average Income (Rp)
	Farming	Livestock	Trading	Builder	Remittance	Total	
Wonorejo	1,202,875	5,488,750	16,425,000	-	2,487,500	25,604,125	41,728,000
Wonokeling	3,333,675	454,000	19,780,000	360,000	2,800,000	26,727,675	41,728,000
Bubakan	838,830	7,672,220	6,000,000	-	4,133,330	18,644,380	39,726,000
Average	1,791,793	4,538,323	14,068,333	120,000	3,140,277	23,658,727	41,060,667
Percentage	7.57	19.18	59.46	0.51	13.27	100.00	

Sources: primary data analysis

Data on the average income of the village or sub-district is needed to compare the average income of respondents with the average income of the people in the study area. However, this data is not available so that we used the average income per capita data of the district. The average income of the participants in Wonorejo and Wonokeling Villages is compared to the average income per capita of Karanganyar Districts while the income of participants in Bubakan Village is compared to the average income per capita of Wonogiri District.

Table 8 shows that the participants' income is so low compared to the average income. This is because participants live in rural areas with limited income sources, while the average income is calculated from income in districts that include both rural and urban areas with more diverse income sources than rural areas, including industry, banking, services, tourism, and others.

In the FGD the respondents prefer avocado as the dominant plant because this plant can grow and bear fruit well in the area. The market potential for avocado is

also very good following the development of Indonesian culinary businesses, especially in the Solo Raya region.

Another economic potential is livestock. Based on the survey, income from husbandry contributed second most to secondary income, after income from trading meatballs and herbal medicine. Income from livestock is approximately Rp. 4,500,000.- per year. The average livestock ownership of the respondents can be seen in Table 9.

Table 9. Average livestock ownership and source of animal forage

Villages	Average livestock ownership (amount/farmer)		Forage	
	Cows	Goats	Sources	Amount
Wonorejo	1.2	3.0	own land	abundant
Wonokeling	0.5	3.6	own land	abundant
Bubakan	1.8	6.3	own land	abundant

Sources: primary data analysis

The amount of animal forage is quite abundant. Farmers have planted several grass species such as elephant, king, Setaria, Bengal, and wild grasses as well as tree species such as Gamal and Lamtoro. Integrated livestock training needs to be carried out in order to accommodate the potential of this animal feed. The training materials include: the planting of forage grass, making silage (preserved forage), maintaining healthy and hygienic livestock, and processing livestock manure.

c. Environmental services and regional economy

In the upstream area of the NRM, there is the Muncar Reservoir which was developed into a tourist attraction by a local initiator in 2018. The reservoir was dredged and cleaned. Its surrounding was laid out and equipped with several facilities such as shelters, seating, and food stalls. Several types of fish, such as goldfish, tilapia, and koi, were released to the reservoir to attract visitors (Figure 1). The Bubakan Village Government also plans to develop agro-tourism in that location. To support this goal, this research activity is to plant fruit trees such as avocado and durian as well as albizia.

Visitors to the Muncar Reservoir are charged a ticket fee of Rp. 5,000 per person which is used to maintain village infrastructure. They can enjoy the beauty and coolness of the mountain air, feeding fish, rowing a raft, hiking to mountain routes, etc. Facilities that still need to be built include lodging, camping ground, places of worship and toilet renovations, and others

The infrastructure that needs to be built includes the road from Bubakan Village to the Muncar Reservoir and promotional facilities. To build these infrastructures, the management should collaborate with third parties such as Perhutani, Wonogiri District Public Work Services, and private parties engaged in the tourism sector.

d. Community praticipation

The local community in NMC has already done vegetative soil and water conservation for decades. At that time, soil and water conservation was only carried out in vegetative measure. The community has several local wisdoms to prevent erosion and protect soil fertility, such as planted woody plant, grass barriers in the waterways (*panciran*) to trap surface erosion, and several clumped plant species to trap the gully erosion.

The woody plant species is pine usually planted on land boundaries so that seasonal crops were not shaded. As a result, the conservation function is not optimal. Through extension and government programs, some communities have planted woody plants intercropped with seasonal crops, but have not implemented regular spacing. The species were also increasingly diverse, not only pine but also MPTS (fruit and plantation crops).

Based on our interviews, 94.12% of respondents had implemented a mixed cropping pattern between seasonal and perennial crops, both woody plants and Multi-Purpose Tree Species (MPTS) such as fruit and plantation crops. Some people plant perennial trees on the boundaries, and some plant intercropped with seasonal crops. Some of the tree seedlings that were planted come from government aids and partly are provided individually. Tree species received included albizia, limpaga, mahogany, avocado, durio, mango, and coffee. The species that are planted independently are generally albizia, but some people also plant limpaga, cloves, avocado, durio, or coffee. Although some respondents (64.71%) had received aids for tree seedlings, it does not necessarily increase community self-reliance. Of all respondents who had received aids, only 72.73%

of them planted perennial crops independently. However, respondents who have never recieved aids (35.29%) have planted perennial crops independently

Erosion that occurs in the NMC is surface erosion and gully erosion. To trap surface erosion, the community planted grass barriers in the waterways (*panciran*) and made mounds carried out on strips for seasonal crops. The fodder grass was chosen to be planted to feed the livestock. To control gully erosion, the community planted several clumped plant species such as bamboo, cordyline, and king grass planted at the toe of the gully.

e. Farmer groups

The farmer group is an institution for farmers to carry out activities together, therefore the farmer group is an institution that can be used to mobilize community participation in a sustainable manner. The existing farmer groups are based on hamlet (*dukuh*) rather than farming land.

Interviews with respondents indicated that 88.24% of respondents stated that there were already farmer groups and the rest said they did not know. However, only 58.82% of respondents stated that they were members of farmer groups. Respondents who do not join farmer groups are generally due to seasonal migration to the cities. Farmer group meetings are usually held every 35 days (*selapan*), but there are also farmer groups that held meetings every three months. In general, members of farmer groups attend every meeting. The material discussed in the farmer group meeting included agricultural activities and mutual cooperation (*gotong royong*), but did not yet talk about erosion and preserving land. This indicates that the farmer groups have not fully contributed to land rehabilitation and soil conservation efforts.

The interviews also showed that the majority of respondents (80%) stated that extension agents rarely attended farmer group meetings. To increase the role of farmer groups in land rehabilitation and soil conservation, assistance is needed, one of which can be carried out by extension agents.

The evaluation results at the end of the project on the economic and social aspects are presented as follows.

a. Economic evaluation

Farmers in phase I of the project chose monoculture (pure albizia) and agroforestry (albizia, maize, and cassava, and avocado) cropping patterns. Financial analysis was performed on the two patterns, with seasonal crops serving as the comparison pattern (maize and cassava). This pure annual crop pattern was selected because it was the most common cropping pattern prior to the start of the APFNet project. The pattern of albizia agroforestry farming-seasonal plants and fruit crops (avocado) yielded the highest profit, followed by the pattern of seasonal crops and albizia monoculture (Table 10.).

The agroforestry cropping pattern yielded the highest profit of Rp. 174,725,575 per ha over a 5-year period (1 cycle of albizia stands), followed by corn and casava of Rp. 168,132, 945/year and monoculture albizia of Rp. 70,700,885/year. The financial analysis results are shown in the Table 10. Profits during the cycle (5 years) have the potential to increase income (Rp. 174,725,575 - 168,132,945): 5 = Rp. 1,318,486/ha/year. The average farmer owns 0.595 ha per household, the increasing income from agroforestry is Rp. 785,049/household/year.

Table 10. Benefit-Cost Ratio of Three Cropping Patterns in Phase I Participatory Demonstration Plots

Cropping Patterns	Discounted			BCR (Disc.)	IRR	Pay back periode (PP) (years)
	Benefit (Rp.)	Cost (Rp.)	Profit (Rp.)			
Seasonal crops (corn and cassava)	202,458,634	34,325,689	168,132,945	5.90	33.50%	1
Albizia trees (monoculture)	84,531,713	13,830,828	70,700,885	6.10	47.00%	6
Agroforestry (Albizia + seasonal crops + Avocado)	210,696,796	35,971,221	174,725,575	5.86	29.78%	1

Sources: Analyzed from primary data

Avocado from Phase I just started to bear fruit (Figure 30.). Based on observation, avocados that bear fruit are approximately 11% of the entire living avocados. Some albizia plants have been harvested by farmers (Figure 31.). Likewise, the lemon plants planted in Phase II, the first year after being planted had produced 1-2 fruits per plant and in the second year they produced 3-6 fruits.

Figure 30. An avocado tree planted in early 2018 is already bearing fruit

Figure 31. The harvest of Albizia planted in 2018

Corn production in the agroforestry plots (combination of corn and woody and fruit plants) remained relatively unchanged from the initial conditions (corn only), which were 4,410 kg/ha (Wonorejo), 4,230 kg/ha (Wonokeling), and 4,330 kg/ha (Bubakan) in one season. The output of seasonal crops has not been influenced by shade from woody and fruit-producing crops. One of the fruit trees, citrus, that was planted in 2020 has produced fruit (Figure 32.). This demonstrates that citrus trees are acceptable for the NMC environment and can help farmers enhance their household income. According to FP interviews, the shade of albizia planted at the end of 2018 (Phase I project) resulted in a 10% drop in maize production. This is due to competition for soil nutrients and sunshine between seasonal plants and woody plants (albizia).

Figure 32. Fruitful citrus plant which was planted in December 2020.

b. Community participation on soil and water conservation

Land rehabilitation and soil and water conservation efforts cannot only be carried out by the government, especially on private land. Therefore, community participation in land rehabilitation and water and soil conservation is very important. Community participation in the development of agroforestry demonstration plots has been carried out since the planning stage. The community is the decision maker in the selection of perennials crops species and cropping patterns including the spacing to be applied. In the development of agroforestry demonstration plots, the community learned to understand the benefits of planting perennial crops on the whole farmland with a certain plant spacing.

Based on observations and interviews, there were many albizia trees on the demonstration plots built in 2015 that have been cut down. The reason for premature harvesting was the attack of gall and the decrease of albizia price. The slowing wood industry as a result of the COVID-19 pandemic is one cause of the price drop. Communities tended to replace albizia with MPTS, especially fruit trees. The supply of fruit seedlings to replace albizia generally was provided independently by landowners. This shows the increasing awareness and independence of the community in planting perennial trees. The selection of fruit plants as a substitute for albizia is also based on the consideration that fruit trees can produce yields every year without having to cut down the plants, so that land is maintained sustainably.

The changes in perennial species can also be seen in the perennial tree species chosen in the development of demonstration plots in Phase II, where albizia no longer became a priority. Communities tended to choose MPTS. The most popular species was avocado, while some other species were also chosen such as durio, nutmeg, citrus, cacao, and cloves. However, the community was still planting woody plants, because it was considered as savings. This proves that the selection of perennial trees and community participation in soil and water conservation was strongly influenced by the economic benefits obtained through these activities.

However, farmers are often easily influenced by market conditions. When the price of a commodity drops, farmers would cut down the trees and replace them

with another commodity that has a higher price. This behavior often makes farmers lose money because, during harvest time, the supply is abundant and consequently the commodity prices will drop. Therefore, farmers not only should understand the cultivation techniques, but farmers must also learn post-harvest processing techniques to increase the product price. Therefore, in phase II, training was conducted to increase community capacity for post-harvest processing techniques and off-farm activities.

Regarding conservation structures made from cemented stone and gabion, the community has not yet made them independently, because of their high cost. In addition, the position of the gully is usually on the land boundary so that no one feels they have the responsibility to control it. However, some people have built conservation buildings made from bamboo independently, because the raw materials are available, with the low cost, and easily to be applied. This bamboo conservation building is the development of local wisdom in controlling gully erosion which is still being applied by some people.

E. Output 5. Recommendation and policy brief of the best agroforestry model

1. Activity 5.1. Internal meeting to discuss and formulate the best agroforestry model

The internal meeting was held twice, on Monday, August 30, 2021 and Monday, August 8, 2022, respectively. Each meeting was attended by 20 persons such as the head of WMTC (BPSILHK Solo), technical consultants, the head of Planning and Evaluation Division of WMTC, the head of Data Information and Cooperation Division of WMTC, the researchers of WMTC, and all members of the project team. The topics of "Participatory and sustainable micro watershed management model" and "An economic analysis of some Albizia based agroforestry models in the NMC" were discussed in the meeting.

The meeting concluded: (1) The participatory and sustainable micro watershed management model in NMC can be used as the material for a policy brief to improve the Regulation of the Director General of RLPS Number: P.15/V-Set/2009 concerning Guidelines for the Development of Micro Watershed Models by emphasizing the balance and sustainability of economic, social, and environmental aspects, and (2) The agroforestry produces the best performance for physical plants

and is the most profitable financially, compare to the monoculture of albizia and seasonal crops.

2. Activity 5.2. Workshop to Share and discuss the project results

The workshop was held on August 31, 2022, in the WMTC office with the theme "The role of the parties in supporting the sustainable management of The NMC". The workshop aims to convey the results of project activities to the parties, discussion of the micro watershed management model, as well as the sustainability mechanism of NMC's management. The workshop was attended by 50 participants, including the project team, project consultants, steering committee, researchers, and stakeholders involved in the project activities. The workshop resulted in the formulation of an commitment agreement between the parties for collaborative management in the upstream Solo River Basin (Annex 8.).

Figure 33. Workshop to share the project outcomes with stakeholders

III. CHALLENGES, ISSUES AND PROJECT RESPONSES

During the project implementation, there are some obstacles in every level of implementation, i.e community and institutional levels.

A. Community level

Participation becomes the keyword in the construction of the demonstration plots. Community participation is the active engagement of people from problem identification, planning, implementation to evaluation. Participatory development brings many challenges. In phase I there were several obstacles in implementing activities. Based on this experience, in phase II several attempts were made to avoid the obstacles that occurred in phase I. The efforts made were:

- Planting was carried out from November to early December 2020 to anticipate water scarcity
- Mutually agreed with the FP of each village regarding the time of planting preparation, distribution of seeds, and planting

Through these efforts, the obstacles in phase I can be relatively reduced so that the implementation of tree planting is much better. However, there are still some FPs who have not planted according to the agreed plan. To overcome this, the team conducted intensive communication and supervision.

There were two techniques to develope the demonstration plots in project Phase II: participatory and non-participatory approaches. In the development of participatory demonstration plots, FPs were involved in the design, land preparation, planting, and maintenance of the plots, whereas the development of non-participatory demonstration plots were handled entirely by the project team.

The key obstacle in developing the two demonstration plot models is the landowners' commitment to follow through on the project team's agreement to maintain perennial crops and understory annual trees at the same time. To overcome the problem, the team used a lot of communication and supervision. In addition, the team attempted to promote the role of the forestry extension agent.

B. Multy-stakeholders level

One of the main obstacle in implementing watershed management at the operational level is the availability of funds. Farmers often find difficulties in providing funds for conservation activities. This will affect the sustainability of conservation activities. To respond to these conditions, efforts will be made to carry out activities collaboratively, especially within the NMC. These efforts will be carried out through stakeholder FGDs as a means of coordination and dissemination of participatory land management plans that have been prepared by the community so that the parties can contribute to activities that are under their duties and functions.

Other obstacles have to be addressed:

1. Issue related to the difference in the process of forming farmer groups between sectors. For example, institutions that are both involved in the management of natural resources, such as the forestry service and agriculture-plantation institutions form different farmer groups, even though the farmers involved are the same in the same village. This has an impact on frequent overlaps in the process of mentoring and funding farmer groups.
2. The phenomenon related to the formal farmer groups, which are usually formed based on administrative areas (hamlet). This makes it difficult to measure the impact of activities on group lands due to the land area that is not in one landscape. To respond to this phenomenon, a land-based farmer group was formed through this project. Farmer group assistance can involve extension agents from across sectors.

Another important point to be mentioned in the report is the change of the nomenclature and duty of the FORDIA into the Agency for Standardization of Environment and Forestry Instruments (BSI-LHK). Because WMTC is under the supervision of FORDIA, the change has been followed by change in WMTC's nomenclature to BPSILHK Solo (Institute for Implementation Standard of Environmet and Forestry Instrument). However, these changes did not affect or change the substance of proposed activities, project outputs, compositions of project teams and activity budgets.

Information on prospective funding was acquired from relevant stakeholders such as State-Owned Enterprises (Perhutani) and District Sectoral Services after holding focus groups with relevant stakeholders. These funds, however, have the potential to benefit all district regions and are not always prioritized for the NMC. As a result, the research team

reached out to the District Sectoral Services and encouraged village officials to work with the sectoral services to submit proposals. Farmers in the NMC benefit from incentives for coffee seedlings from Karanganyar Estate Services.

C. Technical level

The community's reluctance to use soil conservation measures on the land they manage is a problem in executing land management operations at the site and technical levels. This is due to two factors: a lack of awareness of soil conservation practices and a lack of financial resources.

To address these issues, the research team collaborated with field extension workers to provide advice on soil conservation methods. It was carried out by FGDs with key stakeholders to address financial issues. It is a way for project team and the communities to coordinate and disseminate participatory land management plans so that all stakeholders can participate in activities that fall under their responsibilities and functions.

Another technical obstacle was encountered at the stage of land preparation for rehabilitation activities. There are differences in understanding regarding "land managers" as the main actors in making decisions on land management, whether they are land owners, cultivators, or tenants. This affects how differently land managers consider how they treat their land. In cases of tenants or land cultivators acting as land manager, there are lack of application of the civil technique SWC measures on their lands.

D. Some lesson learned

During project implementation both in Phase I and II, some lessons learned can be taken for input in improving the next management, as follows:

1. The image that timber-based plants must be used in land rehabilitation activities has to be examined. After 4-5 years, timber-based plant species like Albizia (which are typically fast-growing species/FGS) will be harvested. As a result, there will be a period of bare soil that is vulnerable to erosion when it rains. The prevalence of gall (Uromycladium sp.), which has an impact on cycle success, is another barrier to the adoption of FGS like Albizia. In addition, changes in the local timber market's pricing have a significant impact on production stability. At the beginning of rehabilitation activities, planting MPTS (Multi-Purpose Tree Species) such fruit trees may be the best option. The absence of a critical period caused by tree felling is an ecological benefit, in addition to having advantages in production and prices that are more stable and

continuous. The planting of MPTS can still be combined in the field with small amounts of woody plants (such albizia and suren) as well as middle stratum crops (such as coffee, cocoa, etc.).

2. Farmers still have a limited level of technological skill expertise, necessitating extra care from associated parties. Through assistance actions by local and district-related parties, farmers' capacity in terms of cultivation method, post-harvest processing, and trade system of agricultural goods is continuously needed.
3. In community-based rehabilitation initiatives, community involvement must be the key factor. However, in order for the proposed participatory plan to be in line with the problem typology and the suitable technology selection, the bottom-up paradigm in rehabilitation planning must still be accompanied by a top-down pattern as a control.
4. There are still misconceptions in the community about the sustainability of the rehabilitation activities. Some people believe that maintenance is not vital or has not taken priority after the implementation both in planting efforts and the construction of SWC buildings. In fact, the success of the rehabilitation program in the long run will depend on these maintenance procedures.

IV. PROJECT MANAGEMENT

A. Organization and personnels

In accordance with those listed in AWP1, the organization of the implementation of this project consists of project staffs, project steering comittee, project consultants and external auditor. The details of each personnel are as follows:

a. Project staffs
   1. Dr. Agung Budi Supangat (Hydrologist) as a Project Director
   2. Dr. Nining Wahyuningrum (Forestry, Soil and Water Conservation, Mapping/GIS)
   3. Dr. Dewi Retna Indrawati (Community Development Scientist)
   4. Purwanto, MSc. (Natural Economic Scientist)
   5. Bambang Subandrio, BSc. (Researcher Assistant)
   6. Dody Yuliantoro, BSc. (Researcher Assistant)
   7. Edi Sulasmiko, BSc. (Researcher Assistant)
   8. Wika Ardianto (Researcher Assistant)

b. Project Steering Committee
   1. Drs. Ade Palguna (PSC Chair), Secretary Director General of BP2SDM
   2. Dr. Nur Sumedi, SP., M.Si., Secretary Agency of BSI-LHK (ex. FORDIA)
   3. Ir. Yoyok Sigit Haryotomo, MM., Head of BPSILHK Solo (ex. WMTC)

c. Project consultants
   1. Dwi Priyo Arianto, Ph.D. (Expert in Soil and Water Conservation)
   2. Dr. Ir. Joko Sutrisno, MP. (Expert in Social, Economic and Agribusiness)

d. External auditor

   It has been designated a local external editor Wartono & Partners Public Accountant, with business licence No. KEP-292/KM.6/2003 from The Ministry of Financial of Republic Indonesia, August 13, 2003, updated with practice permission No. KEP-106/KM.1/2013. The address of this Public Accountant is in GRAHA NINO, Jl. Ahmad Yani No. 335, Manahan, Solo, Central Java, Phone: +62-271-736403; 713615; 7000505. Fax.: +62-271-736403.

B. Communication and coordination

Based on experiences in project phase I, there are also some ways of communication used with stakeholders. The first type uses official correspondence and the second type uses social media, such as WA (WhatsApp), phone, and SMS (Short Message Services). Official correspondence was done amongst the government officers, such as the district government (Karanganyar and Wonogiri), the sub-district government (Jatiyoso and Girimarto), and the village government (Wonokeling, Wonorejo, and Bubakan). Some official letters have been issued, such as, a letter containing the notification of the implementation of research activities, the implementation of the FGDs at the village level which is conducted once in each village.

Communication using social media is done in discussions and communication among the research teams. This is intended to facilitate and accelerate the course of the fellow team members' information. Social media, email, and phone are used in personal communication between team members and related parties such FP's, village apparatus, and extension agents. This personal communication is usually done with people who are responsible in their field and already known personally. Direct communication between research teams, FPs, village apparatus, and extension agents is also done through direct discussions on-site.

Communication using various communication media mentioned above is quite effective and efficient to convey information and progress of the project. At the village and demonstration plot level, the research team informed the activity plan in line with the annual work plan to the farmer group and village apparatus while the progress of the activities was delivered by the farmer group and village apparatus in each village to the research team.

C. Monitoring, evaluation and dissemination

Monitoring and evaluation (M&E) were carried out by BP2SDM and BSI-LHK (in August 2022. The results of M&E conclude that the project activities have been done properly and follow the planning in AWP1 and AWP2. The physical conditions are also in accordance with the reports (Annual Project Report/APR 1 and Mid Year Report/MYR 2) that have been prepared.

Comments and advice from BP2SDM are:

1. The participatory approach applied in the demonstration plot development is the right approach for land rehabilitation efforts. In addition, the agroforestry pattern used in the demonstration plots is also a model that provides economic and environmental benefits. Therefore, it is necessary to disseminate information to the soil and water conservation implementing agencies such as CDK, BPDASHL, and other local agencies.
2. The forum between researchers, trainers, and extension agents (FKPWP) needs to be intensified so that the patterns and technology applied in demonstration plots can be widely disseminated and quickly adopted by the community.

Comments and advice from BSI-LHK (ex-FORDIA) are:

1. This activity is a forest and land rehabilitation effort that combines technical engineering (vegetative and civil engineering) and social engineering, namely community participation. Therefore, it can become a lesson learnt that those approaches can be implemented.
2. The local material utilization for the construction of erosion control can save on manufacturing costs; hopefully it can be applied independently by the community and be replicated in other places. Therefore, technology transfer – not only to the community but also to extension agents – is important.
3. The results can be used as a scientific basis for the establishment of standards, especially those related to forest and land rehabilitation.

This year's M&E was also carried out by the Expert Staff of the Minister of Environment and Forestry for Industry and International Trade as the Board of Director (BoD) of APFNet. The comments and advice given are:

1. Agroforestry planting patterns, especially with fruit trees as perennial crops, are the right choice because they meet the community economic needs and are sustainable from an environmental perspective.
2. Physically, the output achieved is good. However, technology transfer and community empowerment must be increasing for the sustainability of the activities.
3. The applied cropping pattern and participatory approach are expected to be replicated elsewhere. Therefore, the method needs to be socialized among the parties implementing soil and water conservation.

D. Miscellaneous

In the activities, some goods and services that have been purchased including:

a. Material for demonstration plots development including some species of seedling (Tabel 11.), labor cost: 260 mandays).
b. Office operational cost include paper, tonner, cartridge, and orderner
c. Dissemination materials for community trainings: seminar kit, banner and sticker

Table 11. The number of seedlings for demonstration plots

No.	Seedling Types	Specification	Amount
I. Participatory Plot			
1.	Avocado	Minimum height 50 cm	5,250 Pieces
2.	Citrus	Minimum height 50 cm	160 Pieces
3.	Mango	Minimum height 60 cm	50 Pieces
4.	Nutmeg	Minimum height 50 cm	70 Pieces
5.	Cacao	Minimum height 70 cm	130 Pieces
6.	Durio	Minimum height 60 cm	90 Pieces
7.	Clove	Minimum height 50 cm	100 Pieces
8.	Albizia	Minimum height 70 cm	1,000 Pieces
9.	Burflower	Minimum height 80 cm	550 Pieces
10.	Limpaga	Minimum height 50 cm	50 Pieces
11.	Ochroma	Minimum height 50 cm	950 Pieces
Total			8,400 Pieces
II. Non-Participatory Plot			
1	Coffee	Minimum height 40 cm	711 Plc
2	Avocado	Minimum height 50 cm	389 Plc
3	Albizia	Minimum height 60 cm	361 Plc
4	Limpaga	Minimum height 20 cm	222 Plc
Total			1,683 Plc

V. CONCLUSIONS

1. Micro watershed management planning activities need to start with gathering baseline data on the characteristics of the watershed, followed by participatory planning and building collaborative commitment of the parties
2. There is a change in people's preferences from timber-based plants to MPTS driven by economic and environmental reasons. This encourages the community to choose MPTS as the main crop in the implementation of phase II.
3. The main challenge in developing the two demonstration plot models (paticipatory and non-participatory approach), is the commitment of the landowners to comply with the agreement with the project team in the case of perennial trees maintenance and the under-forest stand land utilization.
4. From the obstacles encountered during project implementation, it can be learned that communication and coordination need to be more intensified at every stage and level of management and amongst the parties involved especially at the village level with FPs, village apparatus, and forestry extension agents.
5. Rehabilitation activities have impacted the ecological and socio-economic aspects of the community. Ecologically, agroforestry plot development activities have improved land cover and controlled erosion, but in the project term, there has not been any visible hydrological impact at micro watershed outlets (runoff and sedimentation). In social terms, activities have an impact on increasing farmers' knowledge of watershed management and SWC, as well as changing perception and motivation to implement SWC's measures. Economically, the agroforestry pattern has improved household income through the added value of wood and fruit crops at the end of the cycle of perennial crops.
6. Micro watersheds have the potential to be an alternative for long-term watershed management units. All management processes, from planning to monitoring, are easier to implement in small units.

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Annex 1. The list of farmers name and their land condition in Wonorejo village

No	Name	Land use	Land slope (%)	Opened land space (%)	Area of opened space (ha)
1	Midi	Seasonal crops	25-45	100	0.62
2	Saimin	Seasonal crops	25-45	100	0.59
3	Dimin	Seasonal crops	25-45	100	0.78
4	Slamet Riyadi	Seasonal crops	25-45	100	0.15
5	Kampret	Seasonal crops + trees	25-45	80	0.21
6	Surat	Seasonal crops + trees	25-45	40	0.70
7	Lanjar	Seasonal crops + trees	25-45	75	0.21
8	Tarmiji	Seasonal crops + trees	25-45	75	0.19
9	Kartono	Seasonal crops + trees	25-45	75	1.35
10	Sunu	Seasonal crops	25-45	100	0.39
11	Wanto	Seasonal crops	25-45	100	0.21
12	Sanem	Seasonal crops + trees	25-45	90	0.83
13	Mbok Jono	Seasonal crops	25-45	100	0.55
14	Suripto	Seasonal crops	25-45	100	0.27
15	Sukino	Seasonal crops + trees	25-45	90	0.83
16	Sono Karto	Seasonal crops + trees	25-45	90	0.32
17	Sularno	Seasonal crops	25-45	100	0.27
18	Sukadi	Seasonal crops + trees	25-45	75	0.11
19	Jumawan	Seasonal crops	25-45	100	0.56
20	Sadimin	Seasonal crops	25-45	75	0.20
21	Marimin	Seasonal crops + trees	25-45	80	0.33
22	Sidin	Seasonal crops + trees	25-45	80	0.37
23	Rebo	Seasonal crops + trees	25-45	50	0.11
24	Tanu	Seasonal crops	25-45	100	0.11
	Total				10.26

Annex 2. The list of farmers name and their land condition in Wonokeling village

No	Name	Land use	Land slope (%)	Opened land space (%)	Area of opened space (ha)
1	Parmin	Seasonal crops	45-65	50	0.97
2	Sido	Seasonal crops + trees	25-45	100	0.20
3	Sarimo	Seasonal crops + trees	25-45	100	0.08
4	Paikem	Seasonal crops	25-45	33	0.18
5	Narjo	Seasonal crops + trees	25-45	100	1.28
6	Larno	Seasonal crops	25-45	75	0.45
7	Mbah Midah	Seasonal crops	25-45	33	0.11
8	Sido	Seasonal crops	25-45	50	0.22
9	Tardi	Seasonal crops	25-45	80	0.21
10	Mino	Seasonal crops	25-45	90	0.10
11	Midin	Seasonal crops	25-45	60	0.19
12	Kemis WG	Seasonal crops	25-45	90	0.11
13	Karyo Riman	Seasonal crops + trees	25-45	100	0.16
14	Giman WG	Seasonal crops + trees	25-45	100	0.13
15	Semi	Seasonal crops + trees	25-45	100	0.18
16	Ramin	Seasonal crops + trees	25-45	100	0.08
17	Kasino	Seasonal crops + trees	25-45	100	0.10
18	Suyatno	Seasonal crops + trees	25-45	100	0.12
19	Jo Sentono	Seasonal crops	25-45	50	0.11
20	Sukidi	Seasonal crops	25-45	50	0.10
21	Sukiyem	Seasonal crops	25-45	75	0.24
22	Tolu	Seasonal crops	25-45	50	0.09
23	Sri Tarjo	Seasonal crops + trees	25-45	100	0.30
24	Narno	Seasonal crops	25-45	80	0.48
25	Suyarno	Seasonal crops	25-45	75	0.31

26	Sakino	Seasonal crops	25-45	75	0.14
27	Rambat	Seasonal crops + trees	25-45	100	0.11
28	Panut	Seasonal crops + trees	25-45	100	0.08
29	Tino	Seasonal crops + trees	25-45	100	0.16
30	Mariyo	Seasonal crops + trees	25-45	100	0.39
31	Sugino	Seasonal crops	25-45	75	0.15
32	Suyarno	Seasonal crops + trees	25-45	100	0.06
33	Suyar	Seasonal crops + trees	25-45	100	0.13
34	Sular WG	Seasonal crops + trees	25-45	100	0.09
35	Mbah Surip	Seasonal crops + trees	25-45	100	0.17
36	Sakino	Seasonal crops	25-45	75	0.16
37	Lasno	Seasonal crops	25-45	75	0.09
38	Panut	Seasonal crops	25-45	75	0.17
39	Samidi	Seasonal crops + trees	25-45	100	0.17
40	Senen	Seasonal crops	25-45	75	0.06
41	Pardi Mijan	Seasonal crops + trees	25-45	100	0.26
42	Sugino	Seasonal crops + trees	25-45	0	0.00
43	Suyatno	Seasonal crops + trees	25-45	100	0.10
	Total				8.98

Annex 3. The list of farmers name and their land condition in Bubakan village

No	Name	Land use	Land slope (%)	Opened land space (%)	Area of opened space (ha)
1	Sarjo	Seasonal crops + trees	45-65	75	0.63
2	Warjo	Seasonal crops + trees	25-45	50	0.90
3	Simin	Seasonal crops	25-45	100	0.50
4	Nongko Gadung	Seasonal crops	25-45	100	0.43
5	Giman	Seasonal crops	25-45	100	0.56
6	Sarijo	Seasonal crops	25-45	100	1.15
7	Kasino	Seasonal crops	25-45	100	0.31
8	Kino	Seasonal crops + trees	25-45	25	0.16
9	Nongko Gadung	Seasonal crops	25-45	100	0.90
10	Nongko Gadung	Seasonal crops	25-45	100	1.40
11	Padi	Seasonal crops + trees	25-45	50	0.05
12	Sardi	Seasonal crops + trees	25-45	75	0.41
13	Padi	Seasonal crops + trees	25-45	50	0.10
14	Slamet	Seasonal crops + trees	25-45	50	0.14
15	Nyono	Seasonal crops	25-45	100	0.20
16	Darmin	Seasonal crops + trees	25-45	75	0.14
17	Kasman	Seasonal crops + trees	25-45	75	0.27
18	Giman	Seasonal crops + trees	25-45	75	0.40
19	Karmo	Seasonal crops	25-45	100	0.20
20	Adine Sardi	Seasonal crops + trees	25-45	75	0.40
21	Samino	Seasonal crops	25-45	100	0.21
22	Sarmo	Seasonal crops	25-45	100	0.20
23	Samidi	Seasonal crops	25-45	100	0.25

24	Giyarso	Seasonal crops + trees	25-45	50	0.15
25	Kariyo	Seasonal crops	25-45	100	0.64
26	Sugiyo	Seasonal crops	25-45	100	0.30
27	Sukini	Seasonal crops + trees	25-45	75	0.21
28	Suyar	Seasonal crops	25-45	100	0.20
29	Giyanto	Seasonal crops	25-45	100	0.24
30	Soman	Seasonal crops	25-45	100	0.43
31	Kasmo	Seasonal crops	25-45	100	0.67
32	Giyarto	Seasonal crops	25-45	100	0.11
33	Tarman	Seasonal crops + trees	25-45	75	0.18
34	Yaman	Seasonal crops + trees	45-65	75	0.40
35	Warno	Seasonal crops	45-65	100	0.36
36	Mijo	Seasonal crops + trees	45-65	50	0.52
37	Warno	Seasonal crops + trees	45-65	75	0.97
38	Gudel	Seasonal crops + trees	45-65	75	0.38
39	Jono	Seasonal crops + trees	45-65	50	0.25
40	Sukidi	Seasonal crops + trees	45-65	50	0.05
41	Sarjo	Seasonal crops	45-65	100	0.32
42	Yaman	Seasonal crops + trees	45-65	75	0.23
43	Tami	Seasonal crops + trees	45-65	75	0.23
44	Winih	Seasonal crops + trees	45-65	50	0.06
45	Tanu	Seasonal crops	45-65	100	0.14
46	Kemis	Seasonal crops + trees	45-65	50	0.08
47	Kino	Seasonal crops	45-65	100	0.17
48	Tarno	Seasonal crops + trees	45-65	75	0.11
	Total				17.32

Annex 4. Erosion prediction before and after treatment in Wonorejo demonstration plot

	Wonorejo Village															
NO	Name	Land Area (ha)	Landuse 2020	Crop Factor (CP) 2020	Landuse 2025	Crop Factor (CP) 2025	Slope (%)	Slope Factor (LS)	Monthly Rainfall (mm)	Rainfall Factor (R)	Soil Types	Soil Factors (K)	Land Management	Land Management Factor (P)	Predicted erosion (2020) (ton.ha-1.yr-1)	Predicted erosion (2025) (ton.ha-1.yr-1)
1	Midi	0.62	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
2	Saimin	0.59	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
3	Dimin	0.78	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
4	Slamet Riyadi	0.15	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
5	Kampret	0.26	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
6	Surat	1.76	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
7	Lanjar	0.28	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
8	Tarmiji	0.25	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
9	Kartono	1.80	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
10	Sunu	0.39	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
11	Wanto	0.21	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
12	Sanem	0.92	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
13	Mbok Jono	0.55	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
14	Suripto	0.27	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
15	Sukino	0.92	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
16	Sono Karto	0.36	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
17	Sularno	0.27	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
18	Sukadi	0.15	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
19	Jumawan	0.56	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
20	Sadimin	0.26	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
21	Marimin	0.41	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
22	Sidin	0.46	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
23	Rebo	0.23	Dry field+ perennial trees	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
24	Tanu	0.11	Dry field	0.64	Mix garden	0.2	25-45	9.8	269	1009.28	Inseptisol	0.28	Counturing	0.06	106.3	33.2
Average Soil Loss															106.3	33.2

Annex 5. Erosion prediction before and after treatment in Wonokeling demonstration plot

	Wonokeling Village															
NO	Name	Land Area (ha)	Landuse 2020	Crop Factor (CP) 2020	Landuse 2025	Crop Factor (CP) 2025	Slope (%)	Slope Factor (LS)	Monthly Rainfall (mm)	Rainfall Factor (R)	Soil Types	Soil Factors (K)	Land Management	Land Management Factor (P)	Predicted erosion (2020) (ton.ha-1.yr-1)	Predicted erosion (2025) (ton.ha-1.yr-1)
1	Parmin	1.94	Dry field	0.64	Mix graden	0.2	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204.8	64.0
2	Sido	0.20	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
3	Sarimo	0.08	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
4	Paikem	0.56	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
5	Narjo	1.28	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
6	Larno	0.60	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
7	Mbah Midah	0.33	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
8	Sido	0.45	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
9	Tardi	0.27	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
10	Mino	0.11	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
11	Midin	0.32	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
12	Kemis WG	0.12	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
13	Karyo Riman	0.16	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
14	Giman WG	0.13	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
15	Semi	0.18	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
16	Ramin	0.08	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
17	Kasino	0.10	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
18	Suyatno	0.12	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
19	Jo Sentono	0.23	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
20	Sukidi	0.20	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9

	Wonokeling Village															
NO	Name	Land Area (ha)	Landuse 2020	Crop Factor (CP) 2020	Landuse 2025	Crop Factor (CP) 2025	Slope (%)	Slope Factor (LS)	Monthly Rainfall (mm)	Rainfall Factor (R)	Soil Types	Soil Factors (K)	Land Management	Land Management Factor (P)	Predicted erosion (2020) (ton.ha-1.yr-1)	Predicted erosion (2025) (ton.ha-1.yr-1)
21	Sukiyem	0.32	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
22	Tolu	0.18	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
23	Sri Tarjo	0.30	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
24	Namo	0.60	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
25	Suyamo	0.41	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
26	Sakino	0.19	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
27	Rambat	0.11	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
28	Panut	0.08	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
29	Tino	0.16	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
30	Mariyo	0.39	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
31	Sugino	0.20	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
32	Suyamo	0.06	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
33	Suyar	0.13	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
34	Sular WG	0.09	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
35	Mbah Surip	0.17	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
36	Sakino	0.22	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
37	Lasno	0.12	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
38	Panut	0.22	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
39	Samidi	0.17	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
40	Senen	0.08	Dry field	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
41	Pardi Mijan	0.26	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
42	Sugino	0.11	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
43	Suyatno	0.10	Dry field+ perennial trees	0.64	Mix graden	0.2	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118.1	36.9
Average Soil Loss															120.1	37.5

Annex 6. Erosion prediction before and after treatment in Bubakan demonstration plot

	Bubakan Village															
NO	Name	Land Area (ha)	Landuse 2020	Crop Factor (CP) 2020	Landuse 2025	Crop Factor (CP) 2025	Slope (%)	Slope Factor (LS)	Monthly Rainfall (mm)	Rainfall Factor (R)	Soil Types	Soil Factors (K)	Land Management	Land Management Factor (P)	Predicted erosion (2020) (ton.ha-1.yr-1)	Predicted erosion (2025) (ton.ha-1.yr-1)
1	Sarjo	0.84	Dry field	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
2	Warjo	1.80	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
3	Simin	0.50	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
4	Kino (Nongko Gadung)	0.43	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
5	Giman	0.56	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
6	Sarijo	1.51	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
7	Kasino	0.31	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
8	Kino	0.65	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
9	Kasmo(Nongko Gadung)	0.90	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
10	Giman (Nongko Gadung)	1.40	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
11	Padi	1.10	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
12	Sardi	0.55	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
13	Padi	0.19	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
14	Slamet	0.28	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
15	Nyono	0.20	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
16	Darmin	0.19	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
17	Kasman	0.36	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
18	Giman	0.53	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
19	Karmo	0.20	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
20	Adine Sardi	0.53	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
21	Samino	0.21	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
22	Sarmo	0.20	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
23	Samidi	0.25	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
24	Giyarso	0.30	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9

	Bubakan Village															
NO	Name	Land Area (ha)	Landuse 2020	Crop Factor (CP) 2020	Landuse 2025	Crop Factor (CP) 2025	Slope (%)	Slope Factor (LS)	Monthly Rainfall (mm)	Rainfall Factor (R)	Soil Types	Soil Factors (K)	Land Management	Land Management Factor (P)	Predicted erosion (2020) (ton.ha-1.yr-1)	Predicted erosion (2025) (ton.ha-1.yr-1)
25	Kariyo	0.64	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
26	Sugiyo	0.30	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
27	Sukini	0.28	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
28	Suyar	0.20	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
29	Giyanto	0.24	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
30	Soman (Nongko Gadung)	0.43	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
31	Kasmo	0.67	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
32	Giyarto	0.11	Dry field	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
33	Tarman	0.24	Dry field+ perennial trees	0.64	Mix garden	0.20	25-45	9.8	269	1120.5	Inseptisol	0.28	Counturing	0.06	118,1	36,9
34	Yaman	0.54	Dry field+ perennial trees	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
35	Warno	0.36	Dry field	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
36	Mijo	1.05	Dry field+ perennial trees	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
37	Warno	1.29	Dry field+ perennial trees	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
38	Gudel	0.51	Dry field+ perennial trees	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
39	Jono	0.49	Dry field+ perennial trees	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
40	Sukidi	0.10	Dry field+ perennial trees	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
41	Sarjo	0.32	Dry field	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
42	Yaman	0.31	Dry field+ perennial trees	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
43	Tami	0.31	Dry field+ perennial trees	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
44	Winih	0.13	Dry field+ perennial trees	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
45	Tanu	0.14	Dry field	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
46	Kemis	0.16	Dry field+ perennial trees	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
47	Kino	0.17	Dry field	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
48	Tarno	0.15	Dry field+ perennial trees	0.64	Mix garden	0.20	45-65	17.0	269	1120.5	Inseptisol	0.28	Counturing	0.06	204,8	64,0
Average Soil Loss															147,0	45,9

Annex 7. Local, commercial and scientific names of each seedling types

Local	**Commercial**	**Scientific**
Alpokat	Avocado	Persea americana
Balsa	Ochroma	Ochroma pyramidale
Cabai	Chili	Capsicum sp.
Cempedak	Cempedak	Artocarpus integer
Cengkeh	Clove	Syzygium aromaticum
Coklat	Cacao	Theobroma cacao L
Damar	Agathis	Agathis dammara
Durian	Durio	Durio zibethinus
Jabon	Burflower	Anthosephalus cadamba
Jahe emprit	Ginger	Zingiber officinale
Jagung	Maize	Zea mays
Jati	Teak	Tectona grandis
Jambu mete	Cashew	Anacardium occidentale
Jeruk	Citrus/Orange	Citrus sp.
Kelengkeng	Longan	Dimocarpus longan
Kopi	Coffee	Coffea sp.
Kunyit	Turmeric	Curcuma domestica Val.
Kapulaga	Cardamom	Amomum compactum
Lengkuas	Galangal	Alpinia galanga
Mangga	Mango	Mangifera indica
Pala	Nutmeg	Myristica fragrans
Padi Gogo	Upland rice	Oryza sativa L
Petai	Parkia	Parkia speciosa
Albizia	Albizia	Paraserianthes falcataria
Sayuran	Vegetables	-
Sirsak	Soursop	Annona muricata
Suren	Limpaga	Toona sureni
Sukun	Breadfruit	Artocarpus altilis
Salam	Indonesian bay-leaf	Syzygium polyanthum
Singkong	Cassava	Manihot utillissima
Talas	Taro	Colocasia esculenta
Tembakau	Tobacco	Nicotiana tabacum

Annex 8. Resume and agreement of the stakeholder's workshop (in Indonesian)

RUMUSAN WORKSHOP
"PERAN PARA PIHAK DALAM MENDUKUNG KEBERLANJUTAN KEGIATAN PENGELOLAAN DAS MIKRO NARUAN"
Surakarta, 31 Agustus 2022

Memperhatikan arahan kepala BPSI LHK Solo dan paparan Ketua Tim Peneliti BRIN dan BPSI LHK Solo: "Model Pengelolaan DAS Mikro Partisipatif-Berkelanjutan: Hasil Kegiatan dan Harapan ke Depan", serta diskusi para pihak pada tanggal 31 Agustus 2022 di kantor BPSI LHK Solo, dirumuskan sebagai berikut.

1. Pengelolaan DAS Mikro Naruan dilakukan melalui tahapan yang komprehensif, dimulai dari perencanaan partisipatif, implementasi secara kolaboratif, sampai dengan monitoring dan evaluasi, serta pelibatan para pihak mulai dari pemerintah pusat, pemeritah propinsi, pemerintah kabupaten, BUMN, Perumda, Pemerintah Desa, sampai dengan masyarakat.
2. Dari wilayah DAS Mikro Naruan seluas ± 957 Ha sudah dilakukan implementasi berupa: 1). pembangunan demplot penanaman pohon/agroforestry (penghasil kayu dan buah-buahan) tahun 2016-2018 seluas ± 50 ha secara partisipatif yang melibatkan 86 petani pemilik lahan, BPDASHL Solo, Perum Jasa TIrta I, PDAM Kabupaten Wonogiri dan Lembaga Donor (APFNet), 2). Pembangun demplot penananam pohon/agroforestry (penghasil buah-buahan, perkebunan, dan kayu) seluas 39,5 ha yang melibatkan 122 petani pemilik lahan; 3). Pembuatan bangunan pengendali jurang (DPn, Gullyplug dan Gullyhead Structure) berbahan bambu, gabion, dan spesi sebanyak 58 unit; serta 4). Monitoring dampak pengelolaan terhadap sosial, ekonomi, dan hidrologi.
3. Disamping pembangunan fisik konservasi tanah dan air, kegiatan peningkatan kapasitas masyarakat dilakukan melalui: 1). Studi banding, 2). Pelatihan pembuatan bangunan pengendali jurang berbahan bambu, 3). Pelatihan pembuatan pupuk organik (kompos dan cair) serta pestisida organic, 4) Pelatihan budidaya lebah trigona dan pemberian insentif 35 stup koloni lebah secara kelompok, 5). Pelatihan budidaya tanaman kopi, tenik pengolahan dan penyajian kopi ala barista, 6). Pelatihan pengendalian dan pengolahan sampah rumah tangga dan pertanian, dan 7). Pelatihan teknik okulasi bibit alpukat dan budidaya tanaman alpukat.
4. Dari pengelolaan DAS Mikro Naruan selama 6 tahun (2016 – 2022) telah berdampak positif pada perilaku sebagian masyarakat tentang perubahan pemikiran dan perilaku pemilihan jenis tanaman dari penghasil kayu menjadi mpts dan buah-buahan, serta perilaku konservasi tanah dan air, peningkatan pendapatan dengan penerapan sistem tanam agroforestry, serta berdampak pada penurunan laju erosi dan sedimentasi.

5. Pengelolaan DAS Mikro Naruan telah menarik perhatian pengguna sehingga dijadikan objek studi banding: 1). Forum Komunikasi Peneliti-Widyaiswara- Penyuluh (FKPWP) Kementerian LHK (2018), 2). Kunjungan tim monev dari APFNet-China, serta peserta magang dari Fiji dan Timor Leste (2019), 3). Kunjungan Cabang Dinas Kehutanan se Jawa Timur (2020), 4). Objek praktek lapang mahasiswa UNS (Surakarta), UNISMA (Malang), UNSOED (Purwokerto), dan UNPAD (Bandung), dan 5). Tim peneliti dan teknisi diminta sebagai tenaga ahli oleh Balai Pengelolaan DAS dan Hutan Lindung Cimanuk-Citanduy (Bandung) untuk membangun Desa Konservasi di Cilampuyang, Tasikmalaya, Jawa Barat dan oleh Cabang Dinas Kehutanan III Jawa Tengah, untuk merancang pengelolaan mikro DAS Sepakung, Kecamatan Banyu Biru, Kabuapaten Semarang, Jawa Tengah.
6. Hasil kegiatan penelitian aksi Pengelolaan DAS Mikro Naruan telah didesiminasikan ke berbagai pihak terkait, serta dipublikasikan secara ilmiah di berbagai jurnal, prosiding (nasional dan internasional), serta majalah ilmiah semi popular.
7. Proses dan hasil kegiatan penelitian aksi Pengelolaan DAS Mikro Naruan akan dijadikan materi bagi BPSILHK Solo dalam merumuskan usulan standar dan instrumen bidang pengelolaan DAS, khususnya pada tahapan perencanaan dan implementasi di tingkat tapak (DAS Mikro).
8. Dari proses perencanaan, implementasi dan dampak positif baik fisik, sosial, dan ekonomi maka Pengelolaan DAS Mikro Naruan berpotensi untuk dijadikan contoh model pengelolaan DAS Mikro secara partisipatif di Indonesia.
9. Mengingat kegiatan penelitian pengelolaan DAS Mikro Naruan telah berakhir pada Agustus 2022 maka diperlukan dukungan untuk keberlanjutan pengelolaan DAS Mikro Naruan tersebut sesuai dengan tupoksi masing-masing pihak.

10. Potensi dukungan dari masing-masing pihak mulai pemerintah pusat sampai desa sebagai berikut.

1.	Pemerintah Pusat		
	a. BPDAS HL Solo	:	- Fasilitasi implementasi kegiatan baik vegetatif antara lain melalui penyediaan bibit tanaman keras dan KBR, maupun sipil teknis seperti pembuatan sumur resapan, Dpi, DPn, dan gully plug.
	b. BBWS Bengawan Solo	:	- Memfasilitasi komunitas dalam rehabilitasi dan konservasi air sesuai dengan program GNKPA.
	c. BPSI LHK Solo	:	- Penerapan standar dan instrument pengelolaan DAS - Pemantauan dan pengujian standar dan instrumenpengelolaan DAS dan dampaknya
2.	Pemerintah Provinsi	:	
	a. CDK Provinsi Jawa Tengah Wilayah X dan XI	:	- Penyuluhan berkaitan dengan upaya pengelolaan DAS - Pembinaan dan pendampingan untuk pemberdayaan masyarakat - Kegiatan RHL (Vegetatif dan sipil teknis) dalam pengelolaan DAS sesuai dengan anggaran yang tersedia
	b. Balai PSDA Bengawan Solo	:	- Pembuatan bangunan konservasi seperti check dam di anak sungai, resapan air dll
3.	Pemerintah Kabupaten	:	
	a. Baperlitbang Kabupaten Karanganyar b. BAPPEDA dan LITBANG Kabupaten Wonogiri	:	- Fasilitasi koordinasi OPD untuk alokasi kegiatan di DAS Mikro Naruan baik melalui kegiatan pemerintah daerah maupun kegiatan GNKPA - Fasilitasi integrasi kegiatan konservasi tanah dan air dalam perencanaan desa
	c. Dinas LH	:	- Kegiatan konservasi air seperti upaya konservasi mata air dan pembuatan sumur resapan - Pemberdayaan masyarakat dalam pelestarian lingkungan seperti kegiatan bank sampah
	d. Dinas terkait peternakan	:	- Fasilitasi dan pendampingan pengembangan ternak untuk pemanfaatan rumput yang telah dikembangkan sebagai salah satu bentuk konservasi
	e. Dinas terkait perkebunan		- Program pengembangan tanaman perkebunan berbasis kayu (misal: kopi dan kakao)
	f. BPBD		- Sosialisasi untuk masyarakat sadar bencana dan deteksi awal kebencanaan
4.	BUMN/BUMD		
	a. Perum Jasa Tirta I		- Alokasi dana CSR dalam bentuk materi (misal: bibit tanaman keras, bangunan konservasi) maupun dalam bentuk kerjasama dengan berbagai pihak untuk kegiatan konservasi baik vegetatif maupun sipil teknis
	b. PDAM		- Alokasi dana CSR untuk program penghijauan di daerah tangkapan
5.	Pemerintah Desa	:	Pembinaan dan pengawasan terhadap masyarakat dalam implementasi kegiatan
6.	Masyarakat	:	SDM, lahan dan keswadayaan masyarakat untuk implementasi kegiatan

11. Para pihak secara bersama-sama akan berupaya mewujudkan model percontohan pengelolaan DAS mikro Naruan secara partisipatif.

Surakarta, 31 Agustus 2022

1.	BPDASHL Solo (Pemerintah Pusat)	
2.	CDK Wilayah X (Pemerintah Provinsi Jawa Tengah)	
3.	CDK Wilayah XI (Pemerintah Provinsi Jawa Tengah)	
4.	BAPPEDA dan LITBANG Kab. Wonogiri	
5.	Baperlitbang Kab. Karanganyar	
6.	BPSI LHK Solo	
7.	BRIN	