Strategy mitigation action of climate change of land-based in geopark karst area of Gunungsewu, Yogyakarta, Indonesia

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Abstract. Gunungkidul District has an area of 485.36 km², which is a karst area that is included in the Gunung Sewu geopark. The uniqueness of mount karst is mainly in the abundance of carbon stocks in the karst. The karst area's location has underground river flows, shallow soil solum, and high levels of drought. The objectives were to create actionable strategies for climate change mitigation to reduce the risk of damage to karst areas. The mitigation action strategy aims to reduce the carbon emissions rate from various sources and increase the Karts area's absorption rate, a community forest area. The methodology uses qualitative research comparing baseline carbon data based on the allometric model. Data collection carried out using the FGD (Focus Group Discussion) method. The results showed that community forests' average carbon stock was still below the lowest standard of carbon stock's feasibility in the woods. This situation does not guarantee optimal carbon storage sustainability due to the phenomenon of land-use change and need-cutting. Therefore, the mitigation action strategy needed is to encourage local policies at both the village and district levels in climate change mitigation efforts. This policy will form the basis for mainstreaming climate change mitigation as part of the government's widely supported work.

1. Introduction
Climate change is a natural phenomenon that cannot avoid, and its negative impacts have been felt at both the site and global levels [1]. Human activities in managing the environment and natural resources have proven detrimental to environmental sustainability and development benefits [2]. According to the UNFCC, climate change is directly or indirectly the effect of human activities that changes the composition of the global atmosphere and changes in natural climate variability over a certain period [3]. To deal with the impacts of climate change, adaptation and mitigation strategies are needed. Adaptation is a strategy for adjusting life activities that harm the environment.

Meanwhile, mitigation is a strategy to reduce greenhouse gas emissions from various sources and increase the absorption rate. Mitigation means efforts to reduce the intensity of climate change that will occur or preventive activities. The initiative to mitigate climate change has become the Indonesian government's commitment to maintaining growth rates in the long term and is participation at the global level, where Indonesia is committed to reducing emissions by 29% from the baseline until 2030. Forests play an essential role in climate change mitigation and adaptation through programs, policies, and project implementation [4]. Forests capture carbon from the atmosphere and store it, while deforestation accounts for 6–17% of global anthropogenic CO₂ emissions [5]. In addition, forest ecosystems provide various ecosystem services that can help people cope with and adapt to current...
climate hazards and future climate change [6]. Meanwhile, deforestation and degradation, which occur mainly in the tropics, account for around 20 percent of global carbon emissions [7]. Sustainable forest management activities contribute to climate change mitigation [8]. It is widely accepted that should forest ecosystem carbon stocks and management activities focused on reforestation, increasing the density of carbon stocks in existing forests, promoting C storage in harvested wood products, and replacing fossil fuels. This study's climate change mitigation strategy referred to the Guidelines for Determining Climate Change Mitigation Action in 2018. One way of mitigation is to maintain land cover in carbon sequestration areas, such as peatlands and karst. It is rare to find documents on studies and research on climate change mitigation strategies in karst areas and community forests.

A karst area is a typical landscape that occurs due to the dissolving process of carbonate or easily dissolved rocks. There are reliefs in rocky zones in this area that dissolve quickly, and underground rivers appear as large springs. The karst area is an area that is easily damaged. The high activity of the population and the expansion of settlements in this area affect the damage level.

In Indonesia, the Geopark area that the Union of Speleology first recognized as World Natural Heritage is the Gunungsewu karst area (Central Java - East Java). Most of the Gunungsewu karst area is located in Gunungkidul district and is a community forest area and state forest. The location of community forest and state forest spreads across 18 districts in Gunungkidul. In 2012, the community's state forest had carried out a carbon calculation by the HKm cooperative. The results of these calculations obtained an average carbon stock of 20.8 tonnes eq CO$_2$ per hectare [9]. Then in 2013, community forests carried out a carbon calculation. The result of calculating the average carbon stock is 32 tonnes eq CO$_2$ per hectare [9]. The standard classification of carbon stock's feasibility in forests is divided into 3 clusters, namely: 1). Low if the carbon stock is < 35-ton eq CO$_2$ per hectare, 2). Moderate if the carbon stock is between 35 - 100 tonnes eq CO$_2$ per hectare, and 3) High if the carbon stock is> 100 tonnes eq CO$_2$ per hectare [10].

Research on the karst area that has been carried out, among others; management of karst areas and the carbon cycle [11], the characteristics of the karst hydrogeological system [12], karst geo-archaeology [13], karst ecotourism [14]. This study aims to create a strategy mitigation climate change land-based model in the Gunungsewu Geopark karst area using the PRA approach. This approach is to look at all the factors that influence creating a climate change mitigation strategy. Besides, recognizing patterns of interrelationships between factors. And how to structure the interrelationships of these factors more effectively and efficiently.

2. Material and method

2.1. Material

This study evaluates the Indonesia Climate Change Trust Fund (ICCTF) project with the Java Learning Center (JAVLEC) Indonesia Foundation. And to explore information related to processing indicators and results of the implementation of Land-Based Mitigation projects Karst Areas, Critical Watershed, and Conservation Areas in Gunungkidul District in 2016 – 2019. The evaluation was carried out from December 2020 to April 2021, using the PRA method to measure the project's impact on the project recipient community and the parties (village government and local government organizations of Gunungkidul district). Respondents involved were representatives of the Hutan Rakyat (HR), the Hutan Kemasyarakatan (HKm), Hutan Tanaman Rakyat (HTR), and Hutan Desa (HD), the Bappeda Gunungkidul, the Forestry Service of DIY, representatives of the ICCTF, and business actors.

2.2. Method

Participatory Rural Appraisal (PRA) is a method that can use to evaluate policies/projects that are to carry out are being carried out or have already carried out [15]. This method involves the community as actors in the activity process and not as objects [16]. PRA used as a method of evaluating a policy or program at the beginning of planning (ex-ante), when the program is running (on-going), and at the end
of the program (ex-post) [17]. The PRA method evaluation indicators used in this study are process indicators and outcome indicators, shown in Table 1.

Table 1. Evaluation indicator by PRA method.

| Target of Problem | Indicator of Process | Indicator of Yield |
|-------------------|----------------------|--------------------|
| Community forest carbon stocks are below usual forest potential standards. | Increase carbon stock and reduce carbon emissions. | The addition of carbon reserves of 4,800 tons eq. CO₂ for demonstration activities to increase carbon stocks. |
| Land-use change. | Develop agroforestry for economic increase and catchment area protection. | Implementation manages forest based on planning and management. |
| Manage of Karst area not yet optimized. | Encourage local policy of village and district level as an effort climate change mitigation. | Support of local policy in tune with the national program of mitigation and climate change. |

Focus Group Discussion (FGD) is used in PRA to facilitate brainstorming techniques in ranking problems with the achievement of process indicators and project outcome indicators [18]. Furthermore, a descriptive analysis was carried out on the results of the project achievements that have been running.

3. Result and discussion

3.1. Carbon stock of types forest in Gunungkidul

Carbon counting in the project location villages was carried out in twenty villages, including revisions to the plots due to incorrectly entering tagging or location coordinates or the uneven distribution of the fields. Five villages have made revisions, including Bleberan, Girimulyo, Ngeposari, Jepitu, and Candirejo. Most of the calculation locations carried out were distributed to community management units. The management unit can be Community Plantation Forest (HTR), Village Forest (HD), Community Forest (HKm), and Private Forest (HR).

In the first phase of calculation, it still counted at some locations. At the advanced stage, carried out similar activities at locations, especially private forests (HR). The activities carried out are the final phase of carbon accounting at the project site. The process stratification for calculations uses the allometric method as in other previously executed locations.

The distribution of the locations must fulfill, and there was the delineation of private forests in Gunungkidul. This delineation was carried out due to the mismatch in the location and coordinates measurements. So that could calculate not all the results. Mainly to see the distribution of stands in private forests that are not delineated. Then overlay the delineation results with carbon calculations in private forest plots. Thus, the prediction of standing stock for carbon reserves can be calculated at private forest locations. Meanwhile, social forestry schemes such as HTR, HD, and HKm have been mapped in detail down to the level of community participation. However, to calculate the standing stock of carbon stock, an overlay approach is carried out on the intended social forestry management area.

Delineation with actual conditions in the distribution of private forests carried out using Landsat imagery. The resulting image is delineated with an arc map to obtain the closest sketch. However, the imagery does not fully represent the cutting-planting trend at all private forest locations in the Gunungkidul district. This satellite image helps determine how high the distribution of carbon stocks in
Gunungkidul, so that the priority locations for enrichment will be known and understood. Results of the study regarding the priority of enrichment can be presented in the tabulation distribution in Figure 1. as follows:

![Figure 1. Carbon average for forest management type.](image)

Overall, the average calculated carbon stock in the 200 measurement plots is 34.1 tonnes eq CO\textsubscript{2}/Ha. The calculation of carbon stock in Gunungkidul shows that the lowest typical reserve is Village Forest, while the highest carbon stock is in the private forest (HR). These are thought to be more due to different treatment factors. In community forests (HKm), because the land belongs to the community itself, the types and management methods are more intensive than in village forest areas or other forestry types, especially community plantation forests (HTR). This behaviour shows the community's understanding of ownership status, which gives an account that the working area of social forestry is, after all, not ownership status but is limited to management status for a certain period even though an heir and so on can pass it on. This management scale also supported by the complexity of licensing for social forestry management, making the community's choice to optimize land only in community forests. This choice shows that state land control can be optimal in community forests if the social forestry scheme presents a risk that is not as big as it is currently underway.

Calculation of carbon stock distributed to forms of community forest management represented by plots which are different in each village. Analysis of the accumulation of carbon stocks in each village and at each typical forest management can be presented in the tabulation in Table 2 as follows. Based on table 2 above, it is evident that the carbon stock in Gunungkidul is classified as low, only 34.1 tonnes eq. CO\textsubscript{2}/ha. This figure is below the feasibility standard for carbon stock in the forest, 35 tonnes eq. CO\textsubscript{2}/ha. This indicator shows that land cover in community forests and state forests managed by the community is not optimal. The community drives the carbon stock in the community forest, and community forest is still below the average forest potential standard (at least 35-100 ton eq CO\textsubscript{2}).

As part of climate change mitigation efforts, a strategy to increase carbon sequestration in community and state forest areas designed with demonstration activities in 6 villages out of 20 location villages. Villages where demonstration activities located, are encouraged to create annual programs that contribute to climate change mitigation. One of the flagship programs is the development of non-monoculture forests. The types of plants developed include Durian (Durio zibethinus), Jackfruit (Artocarpus heterophyllus), Petai (Parkia speciosa), Pule (Alstonia scholaris) and Teac (Tectona grandis), totalling 64,800 stems on an area of 3,160 hectares of the target location. The development aims to earn income from non-timber forest products without harvesting wood in the short term.
One factor that can reduce the accumulation of carbon dioxide (CO$_2$) in the atmosphere is absorption by plant vegetation. Trees can absorb CO$_2$ in the atmosphere through the process of photosynthesis [19]. Plants or trees in the forest function as a place for carbon storage and deposition and this term is called a carbon sink [20]. The process of storing carbon in growing plants is known as carbon sequestration. Calculating the increase in plants’ carbon and storing CO$_2$ from the air directly occurs [21]. The process of photosynthesis from plants, namely CO$_2$ from the atmosphere, is taken by green leaves, chlorophyll from both plants and microorganisms and, together with water (H$_2$O), converted into glucose (C$_6$H$_{12}$O$_6$) or simple carbohydrates and oxygen (O$_2$) [22]. Of course, energy is also produced in the process of photosynthesis. These are stored in plants in the body mass of stems, twigs, roots, leaves [23].

The constant number that shows the amount of CO$_2$ absorbed by plants in the photosynthetic process is 3.67 [24]. Find out how many emissions (CO$_2$) plants can absorb/sequestrate; the stored carbon is multiplied by 3.67 to obtain CO$_2$ equivalent [25]. From the analysis process to determine the added carbon from planting activities in the six demonstration activities locations, the CO$_2$ sequestration can also be specified in the next ten years, as follows:

| No | Village | Sub-District | Carbon stock (ton eq. CO$_2$/ha) | HR | HKm | HTR | HD |
|----|---------|--------------|----------------------------------|----|-----|-----|----|
| 1  | Jepitu  | Girisubo     | 22.24                            |    |     |     |    |
| 2  | Balong  | Girisubo     | 34.65                            |    |     |     |    |
| 3  | Ngaposari | Semanu       | 31.70                            | 34.31 |     |     |    |
| 4  | Pacarejo | Semanu       | 28.76                            |     |     | 25.30 |    |
| 5  | Dengok  | Playen       | 35.79                            |     |     |     |    |
| 6  | Putat   | Patuk        | 51.25                            |     |     |     |    |
| 7  | Kedungpoh | Nglipar     | 67.67                            |     |     |     |    |
| 8  | Katongan | Nglipar      | 4168                            | 27.64 |     |     |    |
| 9  | Candirejo | Semanu      | 7.51                             |     |     |     |    |
| 10 | Purwodadi | Tepus       | 11.83                            |     |     |     |    |
| 11 | Bleberan | Playen       | 32.19                            | 29.79 |     |     |    |
| 12 | Getas   | Playen       | 65.44                            | 63.36 |     |     |    |
| 13 | Karangduwet | Paliyan   | 68.69                            |     |     |     |    |
| 14 | Banyusoca | Playen      | 37.42                            | 12.72 |     |     |    |
| 15 | Girisuko | Panggang     | 28.53                            | 17.35 |     |     |    |
| 16 | Girimulyo | Panggang    | 27.74                            | 24.88 |     |     |    |
| 17 | Kepek    | Saptosari    | 38.64                            |     |     | 6.41 |    |
| 18 | Kanigoro | Saptosari    | 38.59                            |     |     | 12.91 |    |
| 19 | Monggol  | Saptosari    | 26.44                            |     |     | 8.89 |    |
| 20 | Karangasem | Paliyan   | 38.31                            |     |     | 31.36 |    |

Typical average manage 39.76 31.43 17.01 9.40
Average across models 34.1

Sumber: Javlec, 2019.


**Table 3.** Simulation of carbon sequestration calculations in planting HR, HKm, HTR and HD.

| Year to | Carbon sequestration (tonnes CO₂) | Estimated sequestration from planting (tonnes CO₂) | Cumulative sequestration (tonnes CO₂) | Net average CO₂ sequestration (tonnes CO₂) |
|---------|----------------------------------|--------------------------------------------------|--------------------------------------|-------------------------------------------|
| 1       | 349,497.18                       | 202.38                                           | 349,699.56                           | 110.66                                    |
| 2       | 401,116.28                       | 622.72                                           | 401,739.00                           | 127.13                                    |
| 3       | 452,735.38                       | 1,500.99                                         | 454,236.37                           | 143.75                                    |
| 4       | 504,354.48                       | 3,459.91                                         | 507,814.39                           | 160.70                                    |
| 5       | 555,973.58                       | 7,100.02                                         | 563,073.60                           | 178.19                                    |
| 6       | 607,592.68                       | 12,883.91                                        | 620,476.59                           | 196.35                                    |
| 7       | 659,211.78                       | 21,214.06                                        | 680,425.84                           | 215.32                                    |
| 8       | 710,830.88                       | 32,455.16                                        | 743,286.04                           | 235.22                                    |
| 9       | 762,449.98                       | 46,944.84                                        | 809,394.82                           | 256.14                                    |
| 10      | 814,069.08                       | 64,999.88                                        | 879,068.96                           | 278.19                                    |
| Average | 464,571.90                       | 64,797.51                                        | 600,921.52                           | 190.17                                    |

The total reduction of CO₂ by planting  
Average CO₂ sequestration per year  
Average absorption of CO₂ per hectare per year

Source: Javlec, 2019.

**Figure 2.** Graph of emission reduction through land-based mitigation efforts for HR, HKm, HD and HTR.

The estimated planting area in 3,160 ha of forest land in the location of demonstration activities, consisting of HR, HKm, HTR and HD, will result in an average emission reduction of 600,921.52 tonnes CO₂e or 190.17 tonnes of CO₂e per ha. Meanwhile, the planting business supported by ICCTF reduced emissions by up to 64,797.51 tonnes of CO₂e in the 10th year. Forest management planning and government support for mitigation programs will significantly influence forest functions' sustainability in reducing GHG emissions, so local policies are urgently needed to continue the trend of land
contributions in reducing emissions. The following is a graphical simulation of reducing carbon emissions through land-based mitigation efforts for HR, HKm, HD, and HTR.

3.2. Land-use change.
The sustainability of forest management by the community, both in terms of its existence and function as optimal carbon storage, is threatened by needing cutting and converting community forest land use into a settlement. To support forest management's sustainability as one of the ways to mitigate climate change. Facilitation has been made for forest managers, both state forests and community forests. The group was strengthening activities in the form of facilitating management and revitalizing forest management. The process includes activities to encourage group organizations to carry out management based on forest management plans to apply in the land.

Besides, strengthening management groups is also encouraged to access funding support to stimulate productive businesses, both forestry, and non-forestry. In this case, facilitation was carried out for groups seeking funding support through the Ministry of Forestry's soft loans through the Public Service Agency (BLU). Also carried out the form of program support for group strengthening in organizing groups that have decreased their organizational quality. The support structure is in the form of group facilitation in reorganizing members in managing state land, especially for the HTR group. It has also facilitated a forest management plan prepared for forest management planning at the KPH Yogyakarta level.

According to the cluster institutional conditions and forest area landscape, during the ICCTF project, activities to strengthen forest management in stages. However, in general, these strengthening activities, in the form of:

1. Mapping for village spatial planning. The purpose of village mapping is to determine the landscape character of each village. Mapping is carried out in the form of a ground check by the village government and its officials—mapping techniques using a Global Positioning System (GPS), image map and compass. The results of this ground check used to map village boundaries with maps. In the next stage, the village mapping results are presented in a forum meeting for stakeholders at the village, sub-district, and district levels. The village mapping results have been agreed upon used as the basis for the preparation of village spatial planning and preparing a village potential management plan. These agreement documents are included in the Village Medium Term Development Plan (RPJMDes) to become official documents at the village level.

2. Training on potential inventory and forest management. This training aims to determine the number of stands, age, number of cultivators at social interests, especially in HKm. The inventory results will become an annual work plan (RKT) document for each HKm group. For the management group, training on vegetation inventory on state land will guide efforts to ensure sustainable forest management. In this case, a forest management plan will make starting from planting, maintaining, harvesting, and post-harvest activities, including enrichment, embroidery, changing vegetation types, rehabilitation, and even in the form of ecotourism.

3. Furthermore, the inventory results will become the primary data for the Jogjakarta FMU to verify management permits by groups or villages. This data will serve as a guideline for FMU macro-scale management in SIPUHH Online, related to the overall national data. This integration will become a control regarding the level of management and sustainability of forest management in general.

4. Training on monitoring of planting results. This training aims to see the growth rate of the plants planted by the community. Monitoring carried out as a whole of the planting activity carried out. The monitoring work area focuses on the HKm site to submit an operational plan (RO) for HKm submitted to the Jogjakarta KPH. The progress of plant enrichment in twenty villages with the target
being 100% planted. The method of calculating the plant's success uses the sampling method on the predetermined plot (PU). The source of seeds for plant species enrichment comes from the ICCTF project. There are additions from the Serayu Opak Progo Watershed Management Center (BPDAS SOP), village funds and community organizations. The details of the number of plants planted at the program location are as follows:

**Tabel 4. Many enrichment plant seeds for forest land.**

| No | Institution | Planting location | Number of plants seeds | Kind of plant seeds |
|----|-------------|-------------------|------------------------|-------------------|
| 1  | ICCTF - JAVLEC | Twenty village program (HR, HKm, HTR, H.D.) | 66,800 | Forest plant: *T.grandis; A.mangium; F.moluccana; C.calothrysus; G.arborea; N. cadamba;* Fruit plant: *M.indica; D. longan; N.lappaceum; Durio; P. guajava; S. aqueum; P. americana; A. muricata; P. pinnata; M. kauki; M. zapota; A. heterophyllus* Miscellaneous plant: *A. moluccanus; P. speciosa; A. pinnata; C. maxima; C. equisetifolia; M. eminii Engl.; T. indica; F. benjamina* |
| 2  | BP DAS SOP | Balong, Jepitu, Putat village | 15,000 | *A. heterophyllus; Citrus; T.grandis; A.mangium; F.moluccana* |
| 3  | APBD | Girimulyo, Monggol, Dengok village | 7,500 | *P. americana; A. muricata; A. moluccanus; M.indica* |
| 4  | Self-subsistent of society | Putat village | 32,000 | *T.grandis; F.moluccana* |

Source: Javlec, 2019.

It is facilitating forest management plans. The management plan facilitation process aims to ensure the implementation of the management plan that has prepared. Following land-based climate change mitigation planning, the focus of management plan facilitation carried out on the realization of planting plans, preparation and implementation of work area arrangement (PAK) and conducting forest inventories. Planting plans in social forestry areas in state forests, such as HKm, HTR, and HD must be well planned. This planning document contains data on forest potential, which is used as the basis for monitoring by KPH Jogjakarta. The planting target is to increase forestry and fruit tree potential and increase carbon uptake, proportional to increased wood volume (increment). Arrangement of working areas (PAK) in HKm places in management blocks facilitates area management and preparation of RKT. This RKT document becomes the basis for management actions: planting, maintaining, cutting down to marketing forest products, both timber and non-timber. As in general forest management, the database used includes calculating potential through forest inventory, census, and sampling. The data collection mechanism is enumerated with the scope of blocks. In each of these blocks, treatment is carried out according to the plan with the same block's activity unit. Forest management actions must be under the planning in the block—relevant data related to blocks, land area, a farmer (pesanggem), etc. The last
facilitation of the management plan is to carry out a forest inventory. Jobs that require a sizeable supporting system to strengthen data on the potential for wood and non-timber. So far, the group's data collection with the Jogjakarta FMU has different methods so that the data obtained can be other. In anticipation of these differences, should develop the same tools. It hoped that the inventory count results between HKm farmers and KPH Jogjakarta would not happen again.

3.3. Local policy support
Carry out policy schemes related to land-based mitigation in the Gunungkidul district by conducting a generic analysis about the orientation of the work sector at the provincial-district scale. These related to the implementation of Law 23/2014 on Regional Government which in Article 14 paragraph (1) concerns the withdrawal of forestry management authority from districts to provinces. The community formally no longer has the power to manage forestry. This control issue becomes a different obstacle in promoting policies to reduce greenhouse gas emissions in the forestry sector at the district level. Higher regulations constrain reducing greenhouse gas emissions by implementing National Action Plan – GHG (RAN-GRK) in the forestry sector. According to the regional authority (provincial level), the scope of procedures in implementing the Regional Action Plan (RAD) for climate change mitigation in Table 5 below.

| Sector                  | Policy                                                                 | Strategy                                                                 |
|-------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Agriculture             | 1. Consolidating national food security and increasing agricultural production with low GHG emissions; 2. Increase the function and maintenance of the irrigation system. | 1. Optimizing land and water resources; 2. Applying land management technology and agricultural cultivation with the lowest possible GHG emissions and optimally absorbing CO₂; 3. Stabilize the water level and facilitate water circulation in the irrigation network. |
| Forestry and peatlands  | 1. Reducing GHG emissions while simultaneously increasing environmental comfort, preventing disasters, absorbing labour, and increasing community and state income; 2. Management of network systems and water systems in swamps; 3. Maintenance of the swamp reclamation network; 4. Increase productivity and efficiency of agricultural production on peatlands with the lowest possible emissions and optimally absorbing CO₂. | 1. Reducing the rate of deforestation and forest degradation to reduce GHG emissions; 2. Increase planting to increase GHG absorption; 3. Increasing efforts to protect forest areas from fire and illegal logging and the application of sustainable forest management; 4. Repairing the water system (network) and dividing blocks, as well as stabilizing the water level in the swamp water system; 5. Optimizing land and water resources without deforestation; 6. Applying land management technology and agricultural cultivation with the lowest possible GHG emissions and optimally absorbing CO₂. |
Several respondents stated that they are participating at the regional and local levels to tackle climate change. Some examples of their role at the regional and local levels include providing technical support, acting as a focal point on issues related to climate change, developing RAN-GRK and strategic coordination. However, it is essential to note that communication between regional and local stakeholders working on climate change has not been effective. Responses to climate change face obstacles, namely weak information dissemination and support among actors, especially government actors and non-government actors, and weak institutional relations between parties. These can be seen from the frequency of interactions between related actors at the regional and local levels.

In the RAN-GRK design document, the DIY government compiles the RAN-GRK implementation activities in the agriculture and forestry sector as follows: (1) Maintenance and repair of irrigation networks; (2) Application of plant cultivation technology; (3) Utilization of organic fertilizers and bio-pesticides; (4) Utilization of livestock manure/urine and agricultural waste for biogas; (5) Development of Forest Management Units (KPH); (6) Planning for utilization and enhancement of forest area businesses, in particular for the achievement of increased production of non-timber forest products / environmental services; (7) Confirmation of forest area; (8) To carry out forest and land rehabilitation and forest reclamation in priority watersheds, particularly in: a) implementation of forest rehabilitation in priority watersheds covering an area of 500,000 ha; b) the implementation of critical land rehabilitation in priority watersheds covering an area of 1,954,000 ha; c) establishment of an urban forest covering an area of 6,000 ha; (8) Development of social forestry in the form of: a) facilitated implementation of community forest (HKm) / village forest (H.D.) management work areas covering an area of 2,500,000 ha; b) facilitate the formation of business partnerships in community forests covering an area of 250,000 ha; (9) Increasing plantation forest business.

Most respondents identified the government as the most influential actor in the implementation of integrated climate change policies. Furthermore, they state that influences, support for programs and projects related to climate change, lobbying, fund mobilization, knowledge and control of climate change, institutional mandate and expertise and official authority responsible for implementing RAN GRK according to the criteria used. Although forests are the centre of attention in protecting karst areas from the impacts of current and future climate change regimes, there need to be relevant actors to implement the program. However, what is most needed now is policy support to promote climate change mitigation actions at regional and local levels [26].

Within the framework of the ICCTF program, the need for mainstreaming policies at the district level to support the mitigation action plan of the forestry sector prepared in the 2018 RAD-GRK DIY can be followed up by the Gunungkidul district government. Legal rules required to contain policies on (1) Additional land cover; (2) Maintaining land cover in the form of the forest; (3) Doing good forest planning; (4) Restrictions on land use for settlements; (5) Forest rehabilitation; (6) Urban forest development; and (7) Rehabilitation of critical and potentially critical lands.

4. Conclusion
The ICCTF project to develop action strategy mitigation of climate change a land-based in the Karst area in Gunungkidul shows that the average carbon stock of community forests is still below the lowest standard of the feasibility of carbon stock in forests. This situation does not guarantee the sustainability of optimal carbon storage due to the phenomenon of land-use change and need-cutting. Therefore, the mitigation action strategy needed is to encourage local policies at both the village and district levels in climate change mitigation efforts. This policy will form the basis for mainstreaming climate change mitigation as part of the government's widely supported work.

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