Is Carbon Sequestration a Function of Budget Amount? Lessons Learn from South Sumatra Province of Indonesia

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Abstract

To ensure that the mitigation actions become an integrated part the development process, it is very crucial to allocate sufficient budget and more importantly to safeguard that the available budget to be properly expended. In this study we established a clustering system to capture the relationship between magnitude of C sequestration (Mg e-CO_2 yr^{-1}) and budget amount (IDR) in forestry sector. Both variables were classified into three categories, namely Low (L), Medium (M), and High (H) and a 3x3 matrix was developed to capture if C sequestration is a function of budget amount. The relationships between magnitude of C sequestration and budget amount were grouped into one of nine clusters. A mitigation action could be clustered only if it was provided with a quantitative indicator. The results showed that the clustering system developed in the current study could distinguish the relationship between the performance of mitigation action and budget amount and classified the relationship into one of the nine clusters. The fact that only 7 out of 17 mitigation actions (41.18%) in 2013 and 4 out of 30 mitigation actions (13.33%) in 2014 under forestry sector could be scored was merely due to the unavailability of quantitative indicator on the magnitude of C sequestration. The results also showed that the increasing budget amount from low to high did not necessarily result in any increases in C sequestration.

Keywords: mitigation, budget, clustering, forestry

Introduction

Various climate-change related issues, for example floods, drought, landslides, and sea-level rises, have been widely discussed during last few years. Under IPCC scenarios, global atmospheric temperature was projected to increase around 0.72 to 3.92°C (Cruz *et al*. 2007). While for Indonesia, Hulme and Sheard (1999) mentioned that the rate of warming would rise from about 0.1 to 0.3°C per decade for the next 100 years. A further study by Boer and Faqih (2004) suggested that rate of warming in Indonesia would be slightly greater, ranging from 0.2 to 0.3°C per decade. Considering the impacts of climate change, it has been globally agreed to keep the threshold level of

temperature increases below 2°C as compared to the pre-industrial temperatures. This is probably one of the greatest challenges that mankind has ever faced (Gignac and Matthews, 2015; Hansen *et al.* 2008; Spratt, 2009).

It has been also acknowledged that there are close linkages between development and climate change. Because climate change could cause not only ecological impacts but also social and economic impacts, they should be addressed within development context (IPCC, 2012). Therefore it has been widely agreed to address the issues in integrated ways. Balancing the need to use ecosystems as a natural capital in efficient ways has also been recognized as fundamental to sustain both development and ecosystem (Pascual *et al*., 2017; Raymond *et al*., 2017). In response, Indonesia Government has voluntarily committed to reduce greenhouse gas (GHG) emissions by 26% of the business as usual scenario on its' own effort by 2020. Even in recent COP 21 in Paris 2015, Indonesia once again strengthened its' voluntary commitment to reduce GHG emission to 29% by 2030. Therefore, Indonesia promulgated two relevant presidential decree on national GHG emission reduction action plan and on GHG inventory. Since then Indonesia has been considered the most progressive developing country in the commitment for and effort in climate change mitigation.

Realizing some potential impacts of development on the environment and the importance of the sustainability of natural resources for future development, the Government of South Sumatra Province has been moving incrementally towards the implementation of climate change mitigation and adaptation actions. Based on the two presidential decrees above, the Government of South Sumatra Province has officially endorsed a provincial regulation on the Provincial Action Plan on GHG Reduction, which outlined the legal binding on emission-reduction targets. Such actions have involved participation of all stakeholders (local government, civil society, universities, NGOs, and private sectors). It is believed that mainstreaming climate change issues into development planning and decision-making is a fundamental measure to make a more sustainable, effective and efficient use of resources.

In fact mainstreaming climate change issues into development plan is a part of an integrated policy approach, which involves three levels of intervention – strengthening the development base, promoting mainstream adaptation measures, and promoting specific adaptation measures (UNDP-UNEP, 2011). Vincent and Colenbrander (2018) further described that mainstreaming climate change issues into development is meant

to minimize adverse impacts of development on environment sustainability. The mainstreaming will give all stakeholders a chance both to prevent impairment of development benefits and to give the opportunity to establish awareness of, readiness to, adaptive capacity to, and resilience to possible adverse impacts of climate change.

To meet the implementation challenges of the mitigation actions, the mainstreaming should also be accompanied by sufficient budget amounts. It is fully acknowledged that the costs of mitigation actions vary among sectors. Hence, measuring impacts of mitigation actions on GHG reductions is important. A study by JICA (2014) in South Sumatra indicated that budget amount for climate change mitigation actions in South Sumatra Province from 2010 to 2014 varied according to each sector and activities in each sector. The results revealed that forestry sector showed the highest budget spending rate (above 90% of total budget allocated). However, such commitment is still evoking two important challenges. Firstly, is the government willing to pull the readily available financial resources to fund all climate change mitigation programs? Secondly, has the allocated funding been effectively used to reduce CO_2 emission? Addressing the two challenges is important because the allocated budget is a public expenditure. Therefore, it is important to assess whether the existing budget in the forestry sector has effectively and efficiently resulted in significant magnitude of C sequestration as expected. Such assessment became more important as the budgetary system on mitigation actions is performance-based. Current paper presented relationship between budget amount and magnitude of C sequestration. Such results are expected to be a useful tool to assess the accuracy of budget amount to support climate change mitigation actions as well as a feedback to the mitigation monitoring system.

Materials and Methods

Data Collection and Verification

Current study focussed on forestry sector due to the following three reasons; (1) in spite of contributing significantly to economic growth in South Sumatra, forestry it is also facing significant threats (mainly deforestation and fires), (2) forestry plays ecologically importants roles in offsetting adverse impacts of climate change in South Sumatra, and (3) forestry has complete data sets.

Two data sets - budget amount and C sequestration in forestry sector from 2013 to 2014 - were collected for this study. The data sources included the GHG reduction action plan and the annual work plan of forestry sector. The collected data were then short-listed and verified. The main purpose of the verification was to validate whether or not the short-listed mitigation actions were executed. The verification was carried out by cross-checking the short-listed mitigation actions against two reports, i.e. annual accountability report and monitoring and evaluation report in forestry sector. This verification step gave three results – status of mitigation actions (executed and not executed), budget amount (IDR), and C sequestration (Mg e-CO_2 yr^{-1}). The process of data collection, short-listing, and verification is presented in Figure 1.

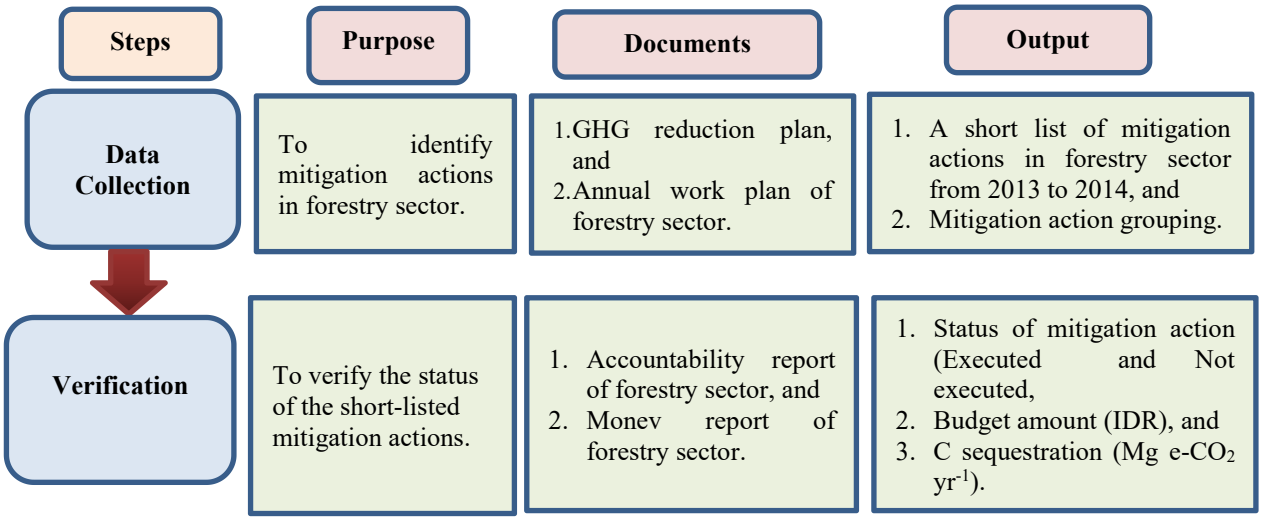

Figure 1. The flow of data collection, short-listing, and verification.\

Portfolio Analysis

Because allocating budget for climate change mitigation was regarded as an investment, we applied Portfolio Analysis (PA) as described by Crowe and Parker (2008) to cluster the budget amount (IDR) and magnitude of C sequestration (Mg e-CO_2 yr^{-1}). The principle is that spreading the budget over a range of mitigation actions also spreads the risks at the same time (Crowe and Parker, 2008). We included only the executed mitigation actions in the PA. Considering the scope and complexity of natures of the mitigation actions under the forestry sector (wide range of budget amount, data collection method, frequency and duration of data collection, evaluation time period, and type and number of stakeholders involved), we used absolute amounts of budget instead of clustering the C sequestration based on magnitude of C sequestration per IDR

invested to assess the association. Based on the activity output, the budget amount and magnitude of C sequestration were classified as given in Table 1.

Table 1. Classification of budget amount for GHG mitigation actions and its' impact on C sequestration in forestry sector

Budget Amount	C Sequestration		
	Low (<50 Mg e-CO_2 yr^{-1})	**Medium (from 50 to 100 Mg e-CO_2 yr^{-1})**	**High (>100 Mg e-CO_2 yr^{-1})**
Low (< IDR 250,000,000 yr^{-1})	Low Budget; Low Impact	Low Budget; Medium Impact	Low Budget; High Impact
Medium (from IDR 250,000,000 to IDR 500,000,000 yr^{-1})	Medium Budget; Low Impact	Medium Budget; Medium Impact	Medium Budget; High Impact
High (>IDR 500,000,000 yr^{-1})	High Budget; Low Impact	High Budget; Medium Impact	High Budget; High Impact

The application of PA in current study should be able to cohort the combination between the two variables to which they belonged. Therefore to capture the association between budget amount and magnitude of C sequestration categories, a 3x3-matrix with X and Y axes was developed, giving nine clusters. The X axis indicated C sequestration classifications (Low, Medium, and High), while the Y axis indicated budget amount (Low, Medium, and High), as shown in Figure 2. The nine clusters represented nine combinations showing the relationship between magnitude of C sequestration and budget amount, as follow:

1. Mitigation actions fell into Cluster 1 if they were provided with low budget amount and resulted in low C sequestration,
2. Mitigation actions fell into Cluster 2 if they were provided with low budget amount and resulted in medium C sequestration,
3. Mitigation actions fell into Cluster 3 if they were provided with low budget amount but they resulted in high C sequestration,
4. Mitigation actions fell into Cluster 4 if they were provided with medium budget amount but they resulted in low C sequestration,
5. Mitigation actions fell into Cluster 5 if they were provided with medium budget amount and resulted in medium C sequestration,
6. Mitigation actions fell into Cluster 6 if they were provided with medium budget amount but they resulted in high C sequestration,
7. Mitigation actions fell into Cluster 7 if they were provided with high budget amount but they resulted low C sequestration,
8. Mitigation action fell into Cluster 8 if they were provided with high budget amount but they resulted in medium C sequestration, and

9. Mitigation actions fell into Cluster 9 if they were provided with high budget amount and resulted in high C sequestration.

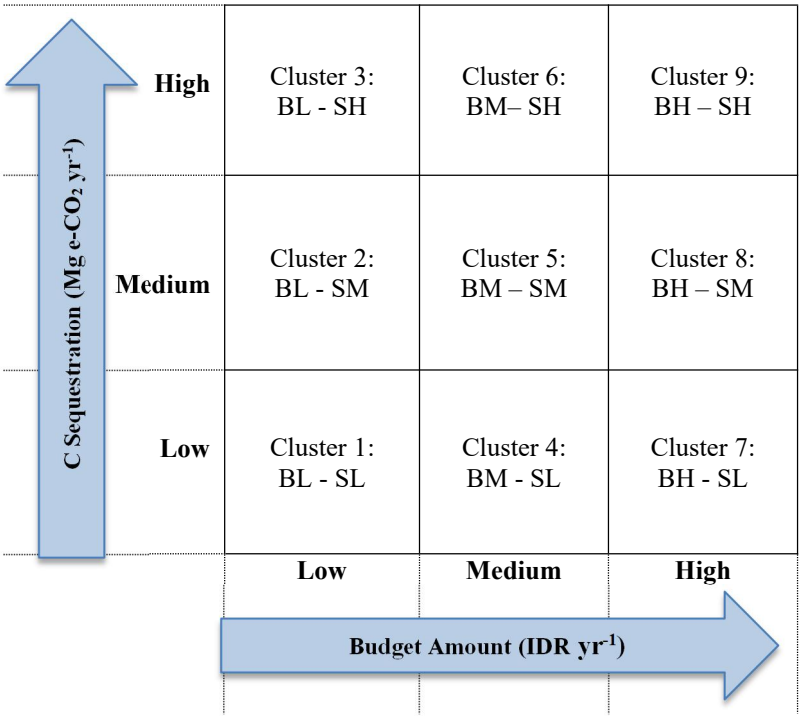

Figure 2. Matrix for clustering (B = Budget; S = Sequestration, while L = Low; M = Medium; and H = High).

The clustering in Figure 2 presented two extreme pools. The first pool was Cluster 3 where mitigation actions required small amount of budget (< IDR 250,000,000 yr^{-1}) but they resulted in high C sequestration (> 100 Mg e-CO_2 yr^{-1}). Cluster 3 was classified as the most ideal cluster. The opposite pool was Cluster 7 where mitigation actions needed high amount of budget (> IDR 500,000,000) nevertheless they resulted in low C sequestration (< 50 Mg e-CO_2 yr^{-1}). Therefore Cluster 7 was classified as the least efficient and the least effective cluster.

Results

Mitigation Action Classification

Current study shortlisted 16 mitigation actions in 2013 and 27 mitigation actions in 2014, consecutively (Table 2). Those mitigation actions scattered over four priority programs, i.e. Good Governance and Security, Education, Health and Socio-culture, Investment and Business Development, and Environment and Disaster Management.

The results in Table 2 also revealed that mitigation actions under the Good Governance and Security Program were predominant in both years, covering 44% of total mitigation actions in 2013 and 37% of total mitigation actions in 2014, respectively. The other mitigations actions respectively belonged to the Investment and Business Development Program (31% in 2013 and 15% in 2014), the Environment and Disaster Management Program (19% in 2013 and 18% in 2014), and the Education, Health and Socio-culture Program (6% in 2013 and 30% in 2014).

When the mitigation actions were further classified, it was found that about 75% of total mitigation actions 2013 belonged to the main activity, while the rest 25% belonged to the supporting activity. However, there were no distinct differences in activity classification in 2014. About 52% of total mitigation actions 2014 were under the main activity and the other 48% belonged to the supporting activity.

Mitigation Action Clustering

Mitigation action could be clustered only if they had quantitative indicators for budget amount (IDR) and for C sequestration (Mg e-CO_2 yr^{-1}). Current study revealed that some of the mitigation actions shortlisted in Table 2 were lack of a quantitative indicator. There were only 7 out of 16 mitigation actions in 2013 and 4 out of 27 mitigation actions in 2014 under forestry sector, which had a quantitative indicator (Table 2). It means that about 43.75% of mitigation actions in 2013 and only 14.81% of mitigation actions in 2014 under forestry sector could be clustered.

The results of clustering (Figure 3) indicated following findings:

1. There were 7 mitigation actions in 2013 that could be clustered. They scattered over the following 4 clusters;
   a. Cluster 1 which included 2 mitigation actions, i.e. planning and developing social forest, and planning and developing community forest products. These two mitigation actions spent a low amount of budget, about IDR 252,000,000 and IDR 224,800,000 and sequestered a low amount of C, only about 1.5 Mg e-CO_2 yr^{-1} and 1.875 Mg e-CO_2 yr^{-1}, consecutively,

Table 2. Shortlisted mitigation actions

Priority Program	Mitigation Actions			
	2013		2014	
	Main	Supporting	Main	Supporting
Good governance and security	1. Establishing Forest Management Unit (FMU), 2. Strengthening forest status and forest use, and 3. Establishing integrated forest safeguard unit.	1. Forest area inventory, 2. Drafting provincial regulation on FMU, 3. Reforestation planning, and 4. Registering and monitorng forest products.	1. Strengthening forest status and forest use, 2. Establishing Forest Management Unit (FMU), and 3. Safeguarding forest.	1. Forest area inventory, 2. Establishing Provincial Spatial Forestry Database Network, 3. Reforestation planning, 4. Exercising Forest Integrated Security System, 5. Synchronizing, and monitoring and evaluating forest development, 6. Optimizing non-tax revenues, and 7. Controlling forest product circulation.
Education, Health, and Socio-culture	1. Providing technical guidance on forest and land fires.	None	1. Establishing demonstration plot on agroforestry and soil and water conservation, and 2. Advocating industrial forest development.	1. Facilitating the execution of activities by Forester Forum, Watershed Forum, and Peatland Revitalization Task Force, 2. Building capacity on forest pest and disease controlling, 3. Facilitating REDD+ and Bio-clime, 4. In-house Training on GIS, 5. Forest expo and exhibition, and 6. Developing communal forest product processing unit.
Investment and Business Development	1. Planning and developing social forest and village forest, 2. Developing micro-scale business in forestry, 3. Planning and developing community forest product and village forest barn, 4. Developing non-timber product, 5. Developing community forest for future savings.	None	1. Planning and developing community forest and village forest, 2. Planning and developing community forest product and village forest barn, 3. Developing non-timber product, and 4. Developing community forest for future savings.	None
Environment and Disaster Management	1. Developing tree seedlings for tree planting program, 2. Rehabilitating water catchment area, 3. Preventing and controlling forest and land fires.	None	1. Developing tree seedlings for tree planting program, 2. Rehabilitating water catchment area, 3. Developing agroforestry in protected areas, 4. Rehabilitating water catchment area, 5. Preventing and controlling forest and land fires.	None

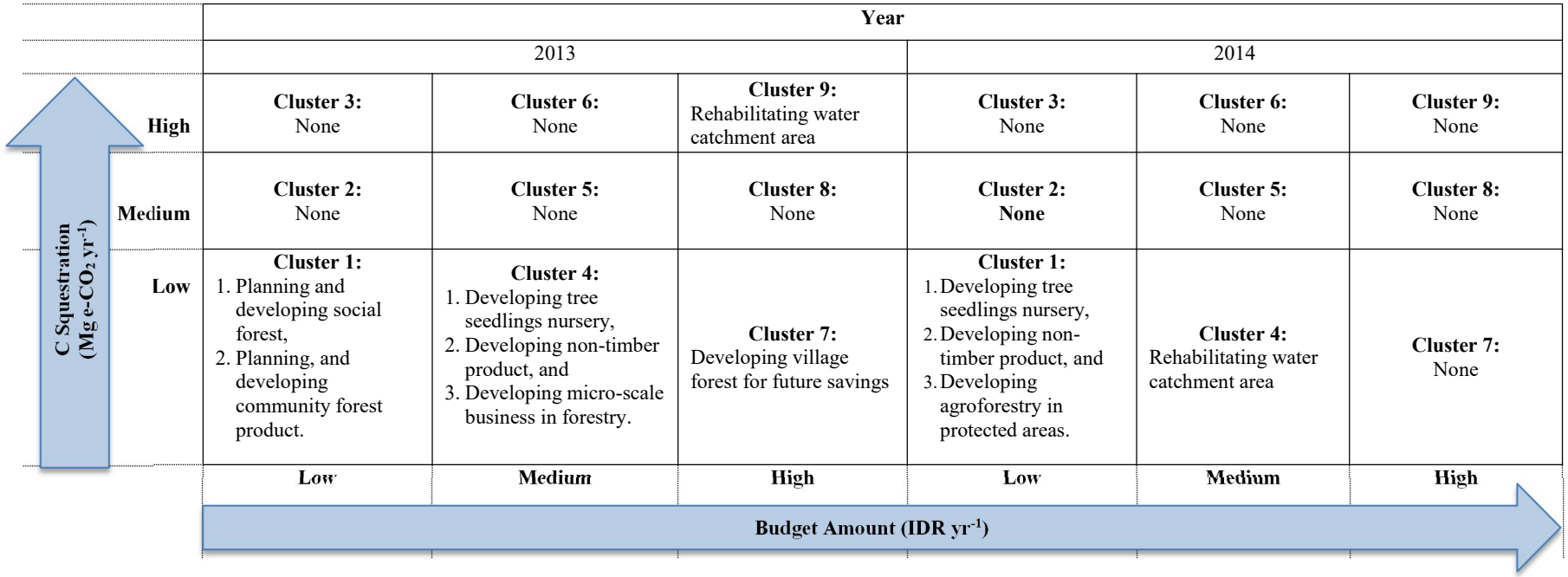

Figure 3. Results of mitigation action clustering (E = Emission; B = Budget; L = Low; M = Medium; and H = High)

b. Cluster 4 which included 3 mitigation actions, i.e. developing tree seedlings nursery, developing non-timber products, and developing micro-scale business in forestry. These three mitigation actions spent a moderate amount of budget - IDR 360,000,000, IDR 270,000,000, and IDR 396,000,000 but they sequestered a low amount of C, only about 1.5 Mg e-CO_2 yr^{-1}, 3.5 Mg e-CO_2 yr^{-1}, 1.875 Mg e-CO_2 yr^{-1}, and successively,
c. Cluster 7 which included only 1 mitigation action, i.e. developing village forest for future savings. This mitigation action spent a high amount of budget - about IDR 602,010,000 but it sequestered a low amount of C, only 1.875 Mg e-CO_2 yr^{-1}, and
d. Cluster 9 consisted of only 1 mitigation action, i.e. rehabilitating water catchment area. In spite of spending a high amount of budget - IDR 1,440,000,000, this action also sequestered a high amount of C - about 3,835 Mg e-CO_2 yr^{-1}.

2. There were 4 mitigation actions in 2014 that could be clustered. They scattered over the following 2 clusters;
   a. Cluster 1 which included 3 mitigation actions, i.e. developing tree seedling nursery, developing non-timber products, and developing agroforestry in protected areas. These three mitigation actions spent a low amount of budget – IDR 51,000,000, IDR 136,058,800, and IDR 211,300,000 and sequestered a low amount of C – only 2.5 Mg e-CO_2 yr^{-1}, 3.75 Mg e-CO_2 yr^{-1}, and 1.875 Mg e-CO_2 yr^{-1}, consecutively, and
   b. Cluster 4 which included only 1 mitigation action, i.e. rehabilitating water catchment area. This mitigation action spent a moderate amount of budget - around IDR 302,282,000 but it sequestered a low amount of C, only as much as 1.88 Mg e-CO_2 yr^{-1}.

Based on the results in Figure 3, it was clear that there was no any mitigation actions falling into Cluster 3 (the most ideal cluster). On the other hand, there was only one mitigation action – developing village forest for future savings – falling into Cluster 7 (the least efficient and the least effective cluster).

Discussion

It has been widely acknowledged that forestry plays major roles in climate change mitigation (Baccini *et al*. 2012; Locatelli *et al*. 2015; Pramova *et al*. 2012). Bearing in

mind that forests are multi-functional and the complexity of climate change issues can bear either positive, negative, or neutral effects both on ecosystem and on community, the efforts to address the issues require a holistic approach (Di Gregorio *et al*. 2015; Locatelli *et al.* 2015). For an example, although carbon payments enable local community to expand their livelihoods through crop diversification and to improve their economic resilience to climate changes, the inclusion of a fast growing tree into the diversification may reduce options for ecological adaptation (Campbell 2009; Ravindranath 2007). Therefore it is important to balance the positive and negative effects in order to obtain effective outcomes and avoid disorganizations in policy design (Duguma *et al.* 2014; Locatelli *et al.* 2015). The fact that the mitigation actions scattered over four priority programs (Table 2) indicates the importance of integrated actions to cope with the climate change issues. The policy of the South Sumatra Province to comprehensively scatter the mitigation actions over different priority programs above proved the ability of the planners to address the inter-linkages among all interdependent variables affecting the success of all mitigation actions in forestry sector in this province.

Not to neglect the importance of other priority programs, the fact that the mitigation actions in forestry sector in the Province of South Sumatra were mostly (43.75%) under the priority program of Good Governance and Security reflected the awareness of the government over the importance of good governance and security stability in ensuring the sustainability of natural resources for future development. The issue of good governance has been emerging as an important theme within the global forest discussions since the early 1980s along with the other important issues, such as biodiversity and sustainable development (Müller and Tuomasjukka 2010; Buszko-Briggs, 2010). It has been well recognized that good governance is a crucial driver in building a good management of natural resources. Bearing in mind that the implementation of good governance mainly in forestry sector in many developing and transitional countries are facing big challenges and potential risks, such as week understanding in the inter-linkages among all interdependent variables (Wingqvist *et al*. 2012), it is important for the Province of South Sumatra to prioritize and sequence all the efforts in the future.

Although Duguma *et al*. (2014) argued that both planning process and decision-making process on mitigation actions were rarely integrated, experiences proved that

better environmental management must be placed obviously as a nucleus of policies, systems, and institutions, through a process called mainstreaming (UNEP, 2009). Therefore, the Government of South Sumatra Province has mainstreamed the climate change mitigation actions into their provincial mid-term development plan mainly to ensure the incorporation of the linkages between development and the sustainability of natural resources for the future of South Sumatra Province. In addition, the mainstreaming became important because it could also build aggregated goals, consistency among policy elements, and institutional frameworks. Therefore, the mainstreaming was an appropriate policy because it provided both budgetary and political bindings. In addition, it could improve the opportunity of South Sumatra Province to achieve mitigation outcomes, i.e. community resilience to changing conditions and preparedness for rapid recovery from disturbances caused by changing climate.

The absence of supporting activities in some mitigation actions (Table 2) indicated the failure to take into account multifaceted characteristics of climate change issues during planning process. In fact the stand-alone mitigation actions might reflect the eagerness of forestry sector in South Sumatra Province to directly channel all resources (both human and financial capitals) and to directly address the related climate-change issues and achieve community resilience as mentioned above. However, such approach could potentially hinder the efforts to realize the targeted outcomes because the complexity of forestry circumstances in South Sumatra Province, such deforestations, fires, and land conflict, actually required a comprehensive approach model.

The success of mitigation actions at field scale frequently requires non-technical supports. For example, providing technical guidance on forest and land fires under the priority program of Education, Health, and Socio-culture (Table 2) would be stronger if it was initiated by firstly strengthening the capacity of all related governmental staffs in safeguarding natural resources. Similarly, the success in developing investment and business in forestry sector under the priority program of Investment and Business Development also required policy support from the government. Some important policies included simplified permit process, pro community banking support, and of course fair law enforcement. In conclusion, the failure to include the supporting activities in planning the mitigation actions, hence in allocating budget, by forestry

sector in the South Sumatra Province, reflected the weaknesses of this sector in projecting and anticipating possible constraints.

In spite of the fact that climate change issues have been globally and intensively discussed since the early 19th century, to our knowledge, no specific method has been widely accepted to capture the relationship between mitigation actions and budget amount. Current study showed that the clustering, into which the two variables incorporated, could distinguish the relationship between budget amount and performance of mitigation action into one of the nine clusters (Figure 3). Although the clustering results showed that only 43.75% and 14.81% of total mitigation actions in 2013 and 2014 could be clustered, such facts did not imply that the clustering failed to function. Rather it was merely due to the unavailability of quantitative indicators in the magnitude of C sequestration. Instead of using a quantitative indicator, the mitigation actions, which could not be clustered, used either a qualitative or a normative indicator to measure the success of the mitigation actions in the field. For example, mitigation actions on the preventing and controlling forest and land fires both in 2013 and 2014 used number of reports, number of participants or groups, or even locations where the mitigation actions were implemented, as main indicators. Those indicators could not be converted into a quantitative C sequestration.

The government of South Sumatra Province has fully realized that mitigating climate change has been creating direct costs. The results in Figure 3 showed that budget amount for mitigation action ranged from low to high. Unfortunately, increases in amount of budget for climate change mitigation actions in forestry sector did not necessarily resulted in increases in C sequestration.

The results in Figure 3 showed that the mitigation actions on developing community forest for future savings in 2013 fell into Cluster 7. In spite of the high amount of budget amount (IDR 602,000,010,000) to run this mitigation action, it resulted in low C sequestration, only 1.875 Mg e-CO_2 yr^{-1}. Therefore this mitigation action was regarded as the least efficient and the least effective mitigation actions in current study. The failure to obtain a trade-off between these two variables (developing community forest for future savings vs C sequestration) in current study occurred because of two reasons. First, the community forest developed in 2013 was only 132 ha in two separate locations, each of which was only 66 ha. It was quite a small area as compared to deforested areas in both locations, which were about 170,587 ha (JICA,

2014). Secondly, the areas developed for the community forest were severely deforested areas, which were then replanted with a fruit tree (*Durio zibethinus*) and a local tree species (*Madhuca aspera* H.J.Lam.). When measurement was conducted, the trees were still at the early stage of growth (about 1-yr old). Therefore the averages of C sequestration reported in the current study (1.875 Mg e-CO_2 yr^{-1}) was still much lower than those reported earlier by Kridiborworn *et al*. (2012) and Schöngart *et al*. (2011). It has been well acknowledged that the roles of trees as atmospheric CO_2 sink was actually a function of ages. A significant relationship between tree ages and DBH and accumulated C-stock in the aboveground biomass has been reported earlier by Kridiborworn *et al*. (2012) and Schöngart *et al*. (2011). Findings reported by Schöngart *et al*. (2011) showed that maximum C-sequestration by *Vochysia divergens* in northern Pantanal of the Brazilian occurred at the age of 80 yr. Therefore, in spite of the fact that current study did not find any significant C sequestration, replanting deforested areas might provide long-term benefits, both ecological and economic benefits. Well-managed community forests in previously deforested areas is expected not only to counterbalance the increasing CO_2 emissions but also to bring other co-benefits, such as timber productions, food sources, environmental protections, improved biodiversity (both flora and fauna), and land rehabilitation (Aggangan, 2000; Grüneberg *et al*., 2014; Unwin and Kriedemann, 2000).

Realizing the ecological and economic significances of water catchment area, the Government of South Sumatra Province allocated a huge amount of budget (IDR 1,440,000,000) in 2013 to rehabilitate the degraded water catchment areas in the province. In return, such action resulted in huge amount of C sequestration, as much as 3.835 Mg e-CO_2 yr^{-1}. Hence it has been regarded as a successful action in spite of the high budget. Therefore, the government continued to financially support this mitigation action in 2014 with much lower budget amount (IDR 302,282,000) as compared to that of 2013 (IDR 1,440,000,000). Although such mitigation action resulted in low additional C sequestration in 2014 (only about 1.8 Mg e-CO_2 yr^{-1}), the expected long-term ecological co-benefits of this mitigation action, such as sustaining water supply and health, C sequestration, and improving biodiversity, in turn will upset the altering effects of land use changes, GHG emissions, and forest fires. Precise management interventions in the degraded water catchment areas are expected to concurrently

enhance positive correlation between ecosystem management practices with multiple environmental service provisions.

Some mitigation actions in 2013 and 2014 spent low amount of budget and sequestered low amount of C (Figure 3). The low amount of budget required was due to the fact that those mitigation actions were carried out in an agroforestry pattern either in village forest area (in 2013) or in protected areas (in 2014). The development of agroforestry was designed and developed collaboratively by government and community. The government facilitated planning process and provided financial assistance. The assigned budget was spent mainly for tree seedling procurement and maintenance. While the other requirements, such as land clearing (communal-based land clearing), food crop seeds and/or seedlings, were directly provided by the farmers. The choices in tree species and crops were collaboratively agreed upon both by the government and the community.

Conclusion

1. Clustering approach applied in current study could distinguish the relationship between budget amount and performance of mitigation action, and classified the relationship into one of the nine clusters,
2. Low percentages of the mitigation actions (43.75% in 2013 and only 14.81% in 2014) that could be clustered is merely due to the unavailability of quantitative indicators on the magnitude of C sequestration, and
3. Increases in budget amount from low to high did not necessarily result in any increases in C sequestration. Even most of mitigation actions (85.71%) in 2013 and all mitigation actions (100%) in 2014 resulted in low C sequestration.

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