Nature-based Solution for Local Watershed and Coastal Flood Mitigation in Indonesia

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Abstract. This study evaluates the effectiveness of program implementation that combines Integrated Community-based Risk Reduction (ICBRR) with Nature-based Solution (NbS) in Manggarai Regency, East Nusa Tenggara and Tanggamus, Regency of Lampung Province. The method used is qualitative measurement using indicators of NbS achievement by the United Nations Office for Disaster Risk Reduction (UNDRR), the International Union for Conservation and Nature (IUCN), and the International Federation of the Red Cross and Red Crescent Societies (IFRC). Data were collected from quarterly evaluation reports by program implementers: the Indonesian Red Cross (PMI) and American Red Cross (Amcross) and interviews with program implementers. The results showed that the broad concept of NbS is difficult to apply and measure in short-duration programs because it takes a longer time to see significant and balanced changes in each variable, especially in the variables of net gain biodiversity, livelihood improvement, and regional policy integration. However, the program that has been implemented has been able to initiate an implementation framework that is easily understood at the local level and brings NbS to the context of community needs and capabilities.

1 Introduction

Since the Glasgow Climate Pact in the United Nations Framework Convention on Climate Change (UNFCC) COP-26, Nature-based Solutions (NbS) have been amplified by all countries that signed [1] but it is not easy to find a model for its implementation at the local level because the NbS formulation is very diverse and broad.[2] The practice of using natural methods to tackle human problems factually is not a new idea but NbS is a new concept [3] but the concept itself is very wide and may include all kinds of societal challenges that must be solved through an ecosystem [4]. On some experiences from many countries, NbS can be applied to various sectors and levels, from forest protection, species, infrastructure, urban planning, water management, and disaster risk reduction, and at the state to community level [5-12]. The dimensions of NbS applications are complex and multidisciplinary, and costs can range from very affordable to very expensive.

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Various guidelines have been published by international development agencies like the ADB [13], the European Union [14], The World Bank [15], UNEP [16], IUCN [17], UNDRR [18], and many more international development institutions. All the guidelines highlighted that NbS is not about simply being green [19]. It takes a complex system which challenging for small-local-based development agencies to operate. The intervention must derive a simpler model to ensure the implementation is tangible and accountable to avoid "the greening of everything" trap or even worse: the corporate-backed state's greenwashing as stated by Friend of the Earth International [20].

As a humanitarian organization, the Indonesian Red Cross (PMI) and the American Red Cross (Amcross) have long been working in Indonesia. Since the post-tsunami intervention in Aceh in 2004, PMI and Amcross have shifted from disaster response to forms of disaster prevention by utilizing an ecological approach along with disaster preparedness programs. The approach implemented by PMI in Indonesia is Integrated Community-based Risk Reduction (ICBRR) which emphasizes addressing each disaster cycle, ensuring the principle of sustainability, and building a base of international solidarity working at the community level [21]. During 2021-2023, PMI and Amcross innovated to include NbS into the ICBRR concept in the Semaka watershed of Tanggamus, Lampung, and the Wae Pesi watershed and coast of Manggarai, East Nusa Tenggara, which experience river floods almost every year. From the broad concept of NbS, this ICBRR program tries to reduce it into a down-to-earth implementation framework, based on local resources and affordable by communities on the theme of watershed and coastal landscapes.

This paper aims to present the results of an evaluation of the effectiveness of the integration between ICBRR and NbS in program implementation at the community level. The study is based on two key questions: The first question: How to implement the broad concept of NbS in watershed and coastal community level programs? Second question: To what extent is the effectiveness of the ICBRR-NbS integration program in both program locations so that it can be replicated and developed systematically and measurably in other locations?

2 Methods

The Integrated Community-based Risk Reduction for Coastal and Watershed Areas-Community Ready to Act (CORTA) is the name of the two-year project. The basic methodology used in program implementation is ICBRR carried out in a series of action research by affected communities and Nature-based Solutions, particularly for coastal and watershed areas which is sometimes called Integrated Coastal and Watershed Management (ICARM) [22]. The combination of these two approaches is expected to effectively reduce the impact of flood risk in coastal and watershed areas while addressing the ecological and social sustainability challenges. After the program had been completed (phase-out), this study was conducted together with program actors to jointly see the level of achievement and effectiveness of ICBRR-NbS inclusion at the community level.

The method used to measure the effectiveness of the NbS program at the local level is to check based on the parameters that have been developed by IUCN, UNDRR, and IFRC because these three parameters are considered relevant to be applied to program evaluation with the theme of climate change, disaster risk reduction and ecosystem approach in the CORTA program. The three parameters will be put together in a matrix that complements each other so that the achievements and gaps from implementation can be captured by researchers. Data and information for the evaluation were collected from quarterly evaluation reports, and 15 program actors in two locations to verify the quarterly evaluation reports. The three parameters and analytical tools used in this evaluation study are presented in Table 1.

Table 1. NbS effectiveness parameters according to IUCN, UNDRR, and IFRC.

No	IUCN (2020)	UNDRR (2021)	IFRC (2021)
1	Addressing societal challenges	Include the ecosystem in the risk assessment	Effective in reducing the hazard
2	Design of NbS is informed by scale (biophysical, geographic, economy, policy , and culture)	Action plan incorporated into government strategies/policy on disaster	Efficient by cost. Affordable for locals
3	The net gain to biodiversity and ecosystem integrity	Generate investment for resilience (tourism, conservation, reforestation, revegetation, bioengineering)	Give a chance to scale up to a wider dimension of intervention
4	Nbs are economically viable	Enhancing disaster preparedness for effective response	Applicable for the local community to continue the intervention
5	Nbs are based on inclusive, transparent, and empowering governance process	Proper and research-based ecosystem rehabilitation	Addressing the needs of the community
6	Nbs equitably balance trade-off between the achievement of their primary goals and the continued		Generate adaptivity of community in a sustainable manner.
7	Nbs are managed adaptively, based on evidence		
8	Nbs are sustainable and mainstreamed within an appropriate jurisdictional context		

Source: IUCN 2020; UNDRR 2021; IFRC 2021

The method used in this program evaluation study is simple scoring based on secondary data analysis from program quarterly reports and interviews with 15 program staff in both regencies. The researcher scored each achievement on five levels of achievement: "1" for not applied; "2" for partially applied; "3" for applied but no measurement has been taken; "4" for applied with initial impact measured; and "5" for fully achieved and measured impact. All analyses were conducted qualitatively. The study locations were five villages in Reok District, Manggarai Regency, East Nusa Tenggara Province, and seven villages in Semaka District, Tanggamus Regency, Lampung Province. The locus of implementation and assessment is the watershed and coastal landscape, which has two important prerequisites for intervention: planning that has legal status, and a realistic basis that is appropriate to the scale of the problem, government capacity, and resource availability [23].

3 Result and discussion

3.1 Concept of Nature-based Solution (NbS)

According to Sowinska-Swierkosz and Garcia (2022) [2], there have been at least twenty definitions of NbS since its first appearance in 2008 by The World Bank [15]. According to The Bank (2008), NbS can include ecosystem protection, integration with disaster risk reduction, encouraging dialogue between countries to valuate resources, investment for protected areas, food and water security, integration of indigenous and traditional plants with water management, sustainable natural resource management, establishing mechanisms for

financing biodiversity and monitoring the effectiveness of integrated approaches [12]. The European Commission (2015) defines NbS as an action aimed at addressing environmental, social, and economic issues simultaneously by maximizing the benefits of nature naturally and sustainably [24]. There are three types of Nbs worldwide so far: Type 1-Better use of protected/natural ecosystem; Type 2-Nbs for sustainability and multifunctionality of managed ecosystem; and Type 3-Design and management of new ecosystem [14].

Initially, NbS was focused on ecosystem-based initiatives aimed at biodiversity conservation and environmental management [25]. The International Union for Conservation and Nature (IUCN) formulated test parameters on whether an action could be considered a form of NbS or not by creating five guiding questions [17]: 1) Does the action use a natural process or method?; 2) Does the action provide/increase social benefits?; 3) Does the action provide/increase benefits for the economy?; 4) Does the action provide/increase benefits for the environment; and 5) Does the action provide a net benefit for biodiversity?

Relate to the PMI and Amcross program of Disaster Risk Reduction, there is a strong interconnection between disasters and Nature-based Solutions because NbS does not only focus on climate change but also risk reduction, loss of biodiversity, and food insecurity as a single unit influence each other [16]. Regarding NbS, the International Federation of the Red Cross and Red Crescent Societies (IFRC) defines NbS as an effort to protect, manage, or sustainably restore ecosystems to respond to community needs including disaster risk, climate change, food security, water security, and human health. IFRC sees that the NbS approach in reducing risk must be efficient, effective, locally based, and easy for the community to implement, has the opportunity to increase the scale of its interventions, and helps communities adapt to climate change and sustainably build community resilience [26].

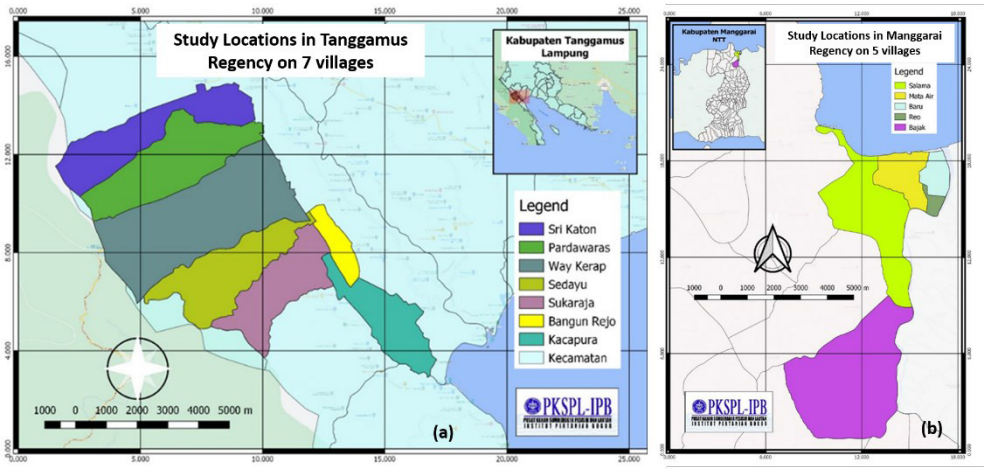

Fig. 1. Map of Study and Program Locations : (a) Tanggamus Regency, Lampung ; (b) Manggarai Regency, East Nusa Tenggara.

3.2 Nature-based Solutions frameworks in application

Table 2. Vulnerability and Capacity Assessment (VCA) for Watershed and Coastal NbS Program.

Stage	Element to Intervene	Theme of Works	
		Coastal	Watershed
Problem identification	- State of river and coastal - State of the basin - Sediment - Water dynamics	- Coastal type - Substrate - Coast basin use - Fisheries	- River type - Flood season - Land use - Vegetations

Stage	Element to Intervene	Theme of Works	
		Coastal	**Watershed**
	- Basin vegetation - Basin land use - Seasonal flood - Asset surround watershed - Existing mitigation - Sociocultural issues	- Vegetations - Tidal season - Risk	- Existing mitigation - Early warning system - Fisheries - Agriculture - Risk
Interest group identification	- Watersheds and coastal primary users - Watersheds and coastal secondary users - Official on jurisdiction - Existing policies	- Fishers/Aquaculture - Settlers - Pastoralist - Tourist - Environmental groups - Local government - Disaster agency	- Farmers - Fishers - Rock Miners - Industry - Settlers - Environmental groups - Local government - Disaster agency
Policy response, livelihood, and resource management plan	- Policy responses - Responsibility - Rationale/regulations - Instruments/tools - Climate mitigation - Economic instruments - Physical intervention	- Local/regional - Multisector coordination - Bio-engineering and resource management plan. - Ecotourism/socio-entrepreneurship - Coastal protection and climate mitigation	- Local/Regional - Multisector coordination - Early warning installation and early action - Bio-engineering and resource management plan - Agricultural improvement - Watershed protection - Waste regulation
Training and Capacity Building on NbS	- Watershed and costal management, and Technical (rehabilitation) Training - Livelihood and local policy development training - Participative implementation by the community	- Basic coastal management training - Coastal ecosystem rehabilitation - Local-based alternative livelihood training - Local regulation development - Advocacy and partnership	- Basic watershed management training - Riparian ecosystem rehabilitation - Local-based alternative livelihood training - Local regulation development - Advocacy and partnership

Source: modified from Coccosis (1997)

Understanding the Resilient Community starts with determining the nature of the community, which is constantly evolving and changing, as well as the underlying vulnerabilities that become their problem. As a result, the IFRC blends humanitarian concern for hazards with a long-term and sustainable approach, as well as institutional building tied to development. People can protect their gains and overcome the influence of their underlying vulnerabilities by enhancing their adaptive ability and coping with disasters, crises, shocks, and pressures [27].

The first and key stage in the implementation of the CORTA program is the Vulnerability and Capacity Assessment (VCA) which will identify the locus of vulnerability and capacity that already exists on the ground as areas prone to river and sea flooding. The scope of this assessment is biophysical conditions (vegetation and fauna) and geography, history, and impacts of flooding, economic losses, and identification of regional policies related to the

flood disaster. Starting from these losses, this assessment will look for opportunities to strengthen the economy from existing resources. The results of this assessment will be used to develop a Risk Reduction Plan (RPP) consisting of four aspects, namely: strengthening disaster preparedness, ecosystem rehabilitation, development of alternative livelihoods, and local policy advocacy. This local policy advocacy is carried out starting from the village, district, and regency levels as the jurisdictional boundaries. Table 2 shows the initial stages before the implementation of NbS in the program location.

In this early stage, several facts related to the character of the resource were presented in Table 3. From this identification, the community developed the Risk Reduction Plan (RPP) as an implementation guideline and objectives of measurement quarterly.

Table 3. Characteristics Summary of Program Implementation Sites.

Stage	Location	Characteristics
Problem identification	Bajak, Salama, Mata Air, Baru, Reo Village, Reok Distrik, Manggarai Regency, East Nusa Tenggara Province	These five communities are spread over the Wae Pesi Watershed's bowl-like basin terrain. The river has several meanders and rocky substrates; the water flow is modest during normal conditions, and the river is used for small capture fisheries. Surface runoff causes flash floods regularly. River gabion walls are there to avoid abrasion, however, their design and construction do not exceed technical criteria. Communities use the basin for agricultural, grazing, and gravel mining. Flooding jeopardizes road access from the logistics port to the city. The rice and onion farms, towns, and pure water are all in jeopardy as a result of the flood. Some coastal areas have no beach protection, just a few Casuarinas survive on the coast bank, mangroves are threatened by firewood gatherers, tourism attractions are limited, and settlements are mere meters from the coastline and river edge. The river bank is a very open area with little vegetation. The sociological form of community is urban-rural, and it is not solely dependent on the sea and rivers.
	Srikaton, Pardawaras, Way Kerap, Sedayu, Sukaraja, Bangunrejo, and Kacapura Village, Semaka District, Tanggamus Regency, Lampung Province	Flooding and riverbank landslides are issues in the Semaka area. The flood happens as a result of surface runoff that accumulates in the river body from upstream to the middle, causing flooding and landslides on the river bank. Another concern is the erosion of river gabion walls and sedimentation in irrigation canals caused by sand and gravel. Due to the heavy sedimentation, river water overflows quickly, inundating agricultural land around the canal. Thus, because the river has a meander with high currents, gabions were installed to protect the river walls from abrasion. The Sedayu settlement is located on an incline and is surrounded by forest. Enrichment planting is needed in the catchment area to boost tree density and canopy cover. Sukaraja, Bangunrejo, and Kacapura villages are located downstream in a reasonably level terrain with a meander fortified by gabions. The vegetation along the riverbanks is an agricultural commodity with little ecological role in maintaining soil structure. Due to its low elevation, Kacapura village has the longest flooding of any of the program villages. In addition to flooding from overflowing rivers, the Kacapura area, which is near the shore, gets floods from heavy rains and tidal waves, causing brackish water to reach communities for an extended period. Most coastal flood plans include brackish water farming, but some are no longer in operation. A flood's devastation is relatively extensive, affecting rice fields, fruit orchards, and communities.
Interest group identification	Bajak, Salama,	- BPBD (Disaster Agency) - BPDASHL Benain Noelmina (River administration)

Stage	Location	Characteristics
	Mata Air, Baru, Reo Village, Reok Distrik, Manggarai Regency, East Nusa Tenggara Province	- Balai Wilayah Sungai Nusa Tenggara II (Provincial River administration) - Bappeda (Planning) - Dinas PU (Public Works) - Dinas LH (Environment) - Dinas Kehutanan (Forestry) - Dinas Pertanian (Agriculture) - Dinas Perikanan (Fisheries) - Dinas Sosial (Social Service) - Dinas PemDes (Rural Development) - Reok District - Village and Sub-District Government - Diocese of Ruteng (Caritas, LPS, JPIL, and PSE) - CBAT from five villages - PERTAMINA Distribution Office of Reo - Forum DAS/Forum PRB Manggarai
	Srikaton, Pardawaras, Way Kerap, Sedayu, Sukaraja, Bangunrejo, and Kacapura Village, Semaka District, Tanggamus Regency, Lampung Province	- Dinas PU Provinsi/Balai Pelaksanaan Jalan Nasional (BPJN) (Road Service) - BPBD (Disaster Agency) - BPDASHL Way Seputih-Way Sekampung (Watershed administration) - Balai Wilayah Sungai (BWS) Way Semangka (River administration) - Taman Nasional Bukit Barisan Selatan (Post Semaka) (National Park) - Kesatuan Pengelolaan Hutan Lindung (KPHL) Kotaagung Utara (Dinas Kehutanan Provinsi) (Forest administration) - FORDAS Provinsi Lampung (Watershed Forum) - Bappeda (Planning) - Dinas PU (Public Works) - Dinas Pertanian (Agricullture) - Dinas Sosial (Social Service) - Dinas PemDes (Rural empowerment) - Semaka District - Village Government - CBAT from seven villages - AQUA Danone - Tanggamus Electrical Power - PC Nahdlatul Ulama Tanggamus - KORUT (Konsorsium Kota Agung Utara) -NGO
Policy response, livelihood, and resource management plan	Bajak, Salama, Mata Air, Baru, Reo Village, Reok Distrik, Manggarai Regency, East Nusa Tenggara Province	- Regional multisector coordination initiation - Physical bioengineering design to fortify existing structure (gabion) with the type of vegetation to conserve water catchment and riverbank reinforcement. - The nursery and plantation of local-based and layer-based mangroves and coastal vegetation to prevent abrasion. - Ecotourism/socio-entrepreneurship based on local vast products. Manggarai initiated the demonstration plot for cashew-based food processing as alternative food (syrup and shredded fruits), superior onions variety germination, and diversification of estate crops of okra, chilies, tomatoes, and ornamental chilies. In addition, silvofishery, mangrove-based alternative food, fish-based processing, and the establishment of a Sustainable Food Yard and established the Manggarai Mangrove Center (MMC) for educational tourism sites.

Stage	Location	Characteristics
		- Coastal protection and climate mitigation (revegetation of layer-based coastal vegetation and carbon storage baseline sequestration.
	Srikaton, Pardawaras, Way Kerap, Sedayu, Sukaraja, Bangunrejo, and Kacapura Village, Semaka District, Tanggamus Regency, Lampung Province	- Regional multisector coordination initiation - Physical bioengineering design to fortify existing structure (gabion) with the type of vegetation to conserve water catchment and riverbank fortification. - The nursery and plantation of local-based and layer-based mangroves and coastal vegetation to prevent abrasion. - Alternative livelihood/socio-entrepreneurship based on local vast products. The Tanggamus program initiates the demonstration plot for superior rice seeds and rice germination process of Invago variety of rice, aquaculture, and freshwater fish processing, and diversification of estate crops: okra, chilies, tomatoes, and ornamental chilies. Other than that, it also initiates Apis malifera apiculture and post-harvest product diversification. In agriculture, the program builds a demonstration plot for Vetiver's essential oil and hydrosol for natural insecticide and a silvofishery plot
Training and Capacity Building on NbS	Manggarai Regency, East Nusa Tenggara Province	- NbS-river basin and coastal management training: concept, typology of watershed, coastal area characteristic, and communal resource management training - Ecosystem rehabilitation (site selection, land suitability, and the determination of vegetation) - Cashew-based food processing training - Superior onion seed germination development training. - Horticulture training - Business development and simple accounting training - Fish-based product diversification training - Silvofishery training - Local regulation drafting training
	Semaka District, Tanggamus Regency, Lampung Province	- NbS-river basin and coastal management training: concept, typology Watershed, and coastal area characteristic, and communal resource management training - Ecosystem rehabilitation (site selection, land suitability, and the determination of vegetation) - The SOP for pest and disease treatment on Nutmeg, cocoa, and papaya fruit training - Superior Invago variety rice and germination training - Horticulture development training - The production of lemongrass essential oil and hydrosol training - Production of mangrove-based food products (syrup and jam) - Production of fish-based product training - Sivofishery training - Apis malifera apiculture training - Local regulation drafting training

Apart from the rehabilitation and training, the program also addressed advocacy, because the scope of issues to be managed needs to involve many sectors at the regency level, the implementation of this advocacy plan is conducted by the PMI in each regency. The PMI

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Table 4. Measurement of NbS achievement in Tanggamus Regency, Lampung Province.

No	IUCN (2020)	Score	UNDRR (2021)	Score	IFRC (2021)	Score
1	Addressing societal challenges	5	Include the ecosystem in the risk assessment	5	Effective in reducing the hazard	2
2	Design of NbS is informed by scale (biophysical, geographic, economy, policy and the culture)	5	Action plan incorporated into government strategies/policy on disaster	2	Efficient by cost. Affordable for locals	2
3	Net gain to biodiversity and ecosystem integrity	2	Generate investment for resilience (tourism, conservation, reforestration, revegetation, bioengineering)	2	Give a chance to scale up to wider dimension of intervention	3
4	Nbs are economically viable	2	Enhancing disaster preparedness for effective response	4	Applicable for local community to continue the intervention	3
5	Nbs are based on inclusive, transparent, and empowering governance process	3	Proper and research-based ecosystem rehabilitation	5	Addressing the need of community	4
6	Nbs equitably balance trade-off between achievement of their primary goals and the continued efforts	3				
7	Nbs are managed adaptively, based on evidence	4				
8	Nbs are sustainable and mainstreamed within an appropriate jurisdictional context	2				
	Total Score (n/max)	26/40		18/25		14/25
	Achievement by %	65%		72%		56%

Note : n=score by parameter ; max=maximum score
1: not applied; 2: partially applied; 3: applied but no measurement has been taken; 4: applied with initial impact measured; 5: fully achieved and measured impact.

on the management of watersheds and coastal areas. Meanwhile, the rehabilitation plan and bio-engineering to strengthen regional resilience to the threat of flooding as well as the plan for drafting local regulations are conducted at the site level by each community.

Table 5. Measurement of NbS achievement in Manggarai Regency, East Nusa Tenggara Province.

No	IUCN (2020)	Score	UNDRR (2021)	Score	IFRC (2021)	Score
1	Addresing societal challenges	5	Include ecosystem in the risk assessment	5	Effective in reducing the hazard	3
2	Designing of NbS is informed by scale (biophysical, geographic, economy, policy and the culture)	5	Action plan incorporated into government strategies/policy on disaster	3	Efficient by cost. Affordable for locals	3
3	Net gain to biodiversity and ecosystem integrity	3	Generate investment for resilience (tourism, conservation, reforestration, revegetation, bioengineering)	4	Give a chance to scale up to wider dimension of intervention	4
4	Nbs are economically viable	4	Enhancing disaster preparedness for effective response	4	Applicable for local community to continue the intervention	4
5	Nbs are based on inclusive, transparent, and empowering governance process	4	Proper and research-based ecosystem rehabilitation	5	Addressing the need of community	4
6	Nbs equitably balance trade-off between achievement of their primary goals and the continued efforts	4				
7	Nbs are managed adaptively, based on evidence	3				
8	Nbs are sustainable and mainstreamed within an appropriate jurisdictional context	3				
	Total Score (n/max)	31/40		21/25		1/25
	Achievement by %	77,5%		84%		76%

Note : n=score by parameter ; max=maximum score
1: not applied; 2: partially applied; 3: applied but no measurement has been taken; 4: applied with initial impact measured; 5: fully achieved and measured impact.

3.3 Result of measurements: achievement and gap

Based on the evaluation of project implementation over the last two years and the parameter questions raised by UNDRR, IUCN, and IFRC, several issues can be discussed concerning what the Amcross and PMI have achieved in Manggarai and Tanggamus and to assess what extent the effectiveness of the NbS to implement in local levels. Table 4 and Table 5 show the score of achievement of two project sites based on the secondary data and interview interpretation.

The results in the Table 4-5 show that the most successful application of NbS was in the planning and design of the intervention. In both sites, the earliest stages of VCA and context analysis, research based ecosystem rehabilitation, and addresing the societal challenges were measurably achieved. All baseline documents, VCA, risk reduction plan, rehabilitation plan, and advocacy plan were well completed. Therefore, in this variable, all parameters of the three reference points showed excellent results.

At the operational stage, the level of achievement tends to decrease. Six issues remain challenges in achieving the NbS parameters. First, until the program ends, although the program plan is running, the visible impact is still at a very early stage and has not fully provided a significant impact. The NbS program has encouraged the activation of early warning systems both through mechanical and human mechanisms. The tools that are built sometimes provide false information. Even so, in human organizations, early warning mechanisms through chain messages are running, but not institutionalized in a Standard Operating Procedure. Secondly, the implementation of NbS in Manggarai has provided indications of additional income in the form of local-based products, although still on a small scale, not yet commercially sufficient. In Tanggamus, the economic viability of the program is only limited to trials, not yet commercially viable.

Third, the implementation of NbS has not fully encouraged good, transparent, inclusive and empowering watershed and coastal management. In the Tanggamus location, the program has not yet reached the stage of inviting more communities to manage their potential independently and is still internalized in volunteer groups. Meanwhile, in Manggarai this parameter has shown indications of involving communities outside the group in NbS efforts and participating in management. Fourth, the NnS program has not been able to show a direct impact on hazard reduction. The intensity and frequency of hazards are still relatively the same as before the program. At this stage, communities have made mitigation efforts and built capacity, but the reduction of hazards cannot be measured.

Fifth, not all communities are able to make investments to achieve resilience. During the program, communities in Manggarai have taken the initiative to develop ecotourism, conduct revegetation and reforestation independently and start a business for food security as an investment in their resilience, but unfortunately bio-engineering has not been carried out. In the Tanggamus location, investments for resilience were only partially made during the program but did not continue when the program ended. Meanwhile, the sixth issue is that not all communities feel financially capable enough to self-finance program implementation. There is still a need for incentives or external financing to be able to carry out activities. Manggarai has been self-financing but it has never been measured how much it contributes.

At the final stage when the program ends, there are five main parameters that should be measured from the three reference points, namely: integration and mainstreaming in policy, management that is adaptive to change, the proportion to continue independently after the program, opportunities to scale up more widely, and achievement of net gains for biodiversity and ecosystem integrity. Application during the program has been partially achieved, but after the end of the program, independent continuation and significant changes cannot be measured because it has not yet shown indications of maturity or progress.

Based on the eight IUCN parameters, the biggest challenge for the implementation of NbS at the local level is the calculation of net gains in biodiversity and ecosystem integration.

The nature-based approach of NbS does not provide significant changes if it is only carried out on a small scale and limited time. Another challenge is measuring the impact on policy. At the village or community level, this parameter can be achieved but at higher and more complex policies such as the district level, the impact requires a longer intervention time.

Using reference points from UNDRR, the biggest challenge to using NbS is to incorporate the NbS approach into government strategies/policies on disaster. Policy sensitization on disasters still uses the old paradigm of crisis management and structural (hard) mitigation. The NbS approach is still difficult to integrate with local policy-making models and mechanisms in Indonesia. Meanwhile, from the IFRC reference point, the biggest challenge is the effectiveness to directly reduce hazards and to make an efficient and local financial ability not depending on the external or previous program. More strategies are required to create adaptive governance on disaster for regional governments.

4 Conclusions

The implementation of NbS in Manggarai and Tanggamus can go hand in hand with ICBRR as long as ecosystem problems and issues are accurately mapped from the start. The availability of biophysical data in the form of vegetation and fauna, geography, vulnerability, economy, socio-cultural challenges related to resources, and existing policies are key for NbS and ICBRR planning. Ecosystem literate VCA assessment and analysis is the stage for addressing societal challenges and needs, recognizing hazards and identifying opportunities for intervention. After planning, the stage of work for NbS in ICBRR is the utilization of baseline data and analysis for three issues: a) encouraging social investment towards resilience; b) encouraging significant changes for biodiversity and ecosystem integrity; c) encouraging efforts for transparent, inclusive and independent governance practices; d) encouraging preparedness and early warning early action efforts, and other important parts, namely: e) strive for efficient budgeting and encourage the use of local resources and minimal external inputs.

In each monitoring cycle, the parameters in the reference points become relevant measuring tools to assess the effectiveness of the program after running for a certain duration of time. In the study conducted using three NbS reference points, namely IUCN, UNDRR, and IFRC, all activities in ICBRR by PMI and Amcross are covered by NbS, but in terms of achievements, the results indicate a variety of achievements. Regardless of the conditions and capacity of implementers, some parameters are only partially implemented or implemented but cannot be measured. Four groups of parameters cannot be fully measured, namely: incorporation of NbS planning with local policies, adaptive and independent management capacity, encouragement for investment towards resilience, significant changes in biodiversity net gain, and the level of community independence to continue activities independently.

However, the merging of ICBRR and NbS is appropriate and provides a viable framework that may be implemented at the local level for disaster reduction contexts. The combination of the two allows for scientific investigation as well as local activities to improve the quality of the coastal and riparian environment through a practical approach that tackles local issues. The deployment and development of integration between the two approaches is potential for more comprehensive NbS applications at the local level. On an operational scale, feedback and development on the ICBRR-NbS integration framework are still open to diverse organizations, including village development agencies, disaster management agencies, and corporations.

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